SUPPLEMENTAL SPECIFICATIONS FOR NORTHLAKE LIFT STATION AND FORCEMAIN

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SUPPLEMENTAL SPECIFICATIONS

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ITEM NO. 100

Mobilization

100.1 DESCRIPTION: This item shall govern the mobilization of personnel, equipment, and supplies at the project site in preparation for beginning work on other contract items that will be performed by the Contractor. Mobilization shall include, but is not limited to, the movement of equipment, personnel, material, supplies, etc. to the project site, application fees, permit fees for all necessary permits and the establishment of the Contractor's office and other facilities prior to beginning the work. The cost of required insurance and bonds shall be include in this item.

100.2 MEASUREMENT: Measurement of the Item No. 100, Mobilization, as specified herein, will be by the "Lump Sum," (LS) as the work progresses

100.3 PAYMENTS: Payment shall be compensation for all work including the furnishing of all materials, equipment, tools, labor, and incidentals necessary to complete the work. Payment earned for this line item will be withheld, until said documents are submitted and approved by SAWS: all material submittals, Specification Item No. 902 Safety and Health Program, Specification Item No. 903 Construction QC/QA Program, Specification Item No. 1114 Pre-Construction Videos, and Specification Item No. 1110 Progress Schedule. Partial payments of the "Lump Sum" bid for mobilization will be as follows: (The adjusted contract amount for construction items, as used below, is defined as the total contract amount, less the lump sum bid for Mobilization and Preparing Right-Of-Way).

1. When 1% of the adjusted contract amount for construction items is earned, 50% of the "Lump Sum" bid or 5% of the total contract amount, whichever is less, will be paid.

2. When 5% of the adjusted contract amount for construction items is earned, 75% of the "remainder of the Lump Sum" bid or 10% of the total contract amount, whichever is less, will be deducted from the above amount.

3. When 10% of the adjusted contract amount for construction items is earned, 90% of the "remainder of the Lump Sum" bid or 15% of the total contract amount, whichever is less, will be paid. Previous payments under this item will be deducted from the above amount.

4. Upon completion of all work under this contract, payment for the remainder of the "Lump Sum" bid for Mobilization will be made on the final pay estimate.

5. SAWS General Conditions (GCs) ARTICLE 7.2 states payments shall be made by the Inspector for approved materials stored on the project site that are deemed necessary and required for the "PROJECT WORK". Materials considered as "on-site" material must be stored on the project site and/or within off-site facilities either owned or leased (signed by both parties) by the Contractor. Materials On-Site are limited to the items listed in Table 1.

Table 1

"Materials On-Site" Payment Guidelines

"Materials On-Site" Application	
Water, Recycle, Re-Use or Wastewater Pressure Main	
Pipe	4-inch diameter or greater (rounded down to the nearest whole foot)
Valves	4-inch diameter or greater (only when bid as a separate line item)
Fire Hydrants	Includes all items for complete assembly
Wastewater Gravity Main Facilities	
Pipe	6-inch. diameter or greater (rounded down to the nearest whole foot)
Manholes	Includes base and cone section, risers, rings and covers. Excludes risers for FRP unless proper stations are provided noting location.
Wet wells	Excludes covers

"Materials On-Site" Limitations	
SAWS will ***not*** pay "Materials On-Site" for:	Quantities that exceed plan quantities
	Items that are not specifically listed as individual lines items (example: 6-in. valves that are included in the unit price of a fire hydrant assembly)
	Fittings, flanges, small diameter pipe or valves, cleanouts, meter boxes or incidentals.
	Materials stored at a supplier's yard or facility.
	Materials that are stored at an excessive distance from the project site (based solely on the judgment of the SAWS Inspector)
	Any other items not specifically included in the "application" section of *Table 1: "Materials On-Site" Payment Guidelines*

End of Specifications

ITEM NO. 101

Preparing Right- Of-Way

101.1 DESCRIPTION: This item shall govern preparing the right-of-way for construction operations by removing and disposing of all obstructions from the right-of-way and from designated easements where removal of such obstructions is not otherwise provided for in the contract documents.

1. It is the intent of this specification to provide for the removal and disposal of all obstructions and/or materials, not specifically provided for elsewhere by the contract documents.

2. This item shall also include the removal of trees, stumps, bushes, shrubs, brush, roots, vegetation, logs, rubbish, paved parking areas, miscellaneous stone, brick, drainage structures, manholes, inlets, abandoned railroad tracks, scrap iron and all debris, whether above or below ground, except live utility facilities.

3. This item shall not govern the demolition of buildings by the use of explosives. Such demolition work shall be governed by the use of a special specification controlling the work.

101.2 CONSTRUCTION METHODS: Areas designated in the contract documents shall be cleared of all obstructions, vegetation, abandoned structures, etc., as listed within this specification Item No. 101 Preparing Right-Of-Way and as shown on the plans, except trees or shrubs specifically designated by the Engineer for preservation.

1. Such obstructions shall be considered to include, but not be limited to, remains of houses or structures not completely removed by Contractor or others, foundations, floor slabs, concrete, brick, lumber, plaster, cisterns, septic tanks, basements, abandoned utility pipes or conduits, equipment or other foundations, fences, retaining walls, outhouses, shacks, and all other debris, as well as buried concrete slabs, curbs, driveways and sidewalks.

2. All fences along the right-of- way which are damaged or removed temporarily by the Contractor shall be replaced by the Contractor to an equal or better condition, at no expense to SAWS.

3. Contractor shall adhere to the current City of San Antonio Tree Ordinance

4. Trees and shrubs designated by the tree ordinance for preservation shall be carefully trimmed as noted in the contract documents and shall be protected from

scarring, barking, or other injuries during construction operations. Exposed ends of pruned limbs shall be treated with an approved pruning material.

5. Unless otherwise indicated in the contract documents, all underground obstructions shall be removed to the following depths:

   a. In areas to receive embankment, 2 ft below natural finished grade.

   b. In areas to be excavated, 2 ft below the lowest elevation of the excavation;

   c. All other areas, 2 ft below finished grade.

6. Holes remaining after removal of all obstructions, objectionable materials, vegetation, etc., shall be backfilled and tamped as directed by the SAWS Inspector, and the entire area shall be bladed to prevent ponding of water and to provide drainage. In areas that are to be immediately excavated, backfilling and blading may be eliminated, if approved by the SAWS Inspector.

7. Areas to be used as borrow sites and material sources shall have all obstruction, objectionable materials, vegetation, etc., removed to the complete extent necessary to prevent such objectionable matter from becoming mixed with the material to be used in the construction.

8. Where a conduit is shown to be replaced, it shall be removed in its entirety, and all connections to the existing conduit or pipe shall be made. Where an existing conduit or pipe is to be cut and plugged, the line shall be cut back not less than 2 ft, and a plug of concrete not less than 2 ft long shall be poured and held in the end of the conduit or pipe. The plug may also be accomplished by using a precast stopper grouted into place.

9. Material to be removed will be designated as "salvageable" or "non-salvageable in the contract documents prior to bidding by the Contractor. All "salvageable" material will remain the property of the SAWS and will be stored at the site as directed by the SAWS Inspector. All "non-salvageable" materials and debris removed shall become the property of the Contractor and shall be removed from the site and shall be disposed of properly.

10. All asphaltic material shall be disposed of or recycled at the facility authorized to accept the asphalt for such purposes and applicable to appropriate guidelines and regulations.

101.3 MEASUREMENT: Measurement of the Item No. 101, Preparing Right of Way, as specified herein, will be by the "Lump Sum," as the work progresses.

101.4 PAYMENTS: Payment shall be compensation for all work including the furnishing of all materials, equipment, tools, labor, tree pruning, removal, protection, landscape impacts, and incidentals necessary to complete the work. Payment earned for this line item will be withheld, until said documents are submitted and approved by SAWS: all material submittals, Item No. 902 Safety and Health Program, Item No. 903 Construction QC/QA Program, Item No. 1114 Pre-Construction and Post Construction Videos, and Item No. 1110 Progress Schedule. Partial payments of the "Lump Sum" bid for preparing right-of-way will be as follows: (The adjusted contract amount for construction items, as used below, is defined as the total contract amount, less the lump sum bid for Mobilization and Preparing Right-Of-Way).

1. When 1% of the adjusted contract amount for construction items is earned, 50% of the "Lump Sum" bid or 5% of the total contract amount, whichever is less, will be paid.

2. When 5% of the adjusted contract amount for construction items is earned, 75% of the "remainder of the Lump Sum" bid or 10% of the total contract amount, whichever is less, will be deducted from the above amount.

3. When 10% of the adjusted contract amount for construction items is earned, 90% of the "remainder of the Lump Sum" bid or 15% of the total contract amount, whichever is less, will be paid. Previous payments under this item will be deducted from the above amount.

4. Upon completion of all work under this contract, payment for the remainder of the "Lump Sum" bid for Preparing Right-Of-Way will be made on the final pay estimate.

- End of Specification -

ITEM NO. 103

Revegetation

103.1. DESCRIPTION: This item shall govern for preparing ground, providing for sowing of seeds, mulching with 70/30 wood/cellulous blend fiber mulch, and other management practices along and across such areas as are designated on the plans and in accordance with these specifications. All areas shall be covered with live grass before acceptance.

103.2. MATERIALS: All seed must meet the requirements of the Texas Seed Law including the labeling requirements for showing purity, germination, name and type of seed. Seed furnished shall be of the previous season's crop for the date of the project. Each variety of seed shall be furnished and delivered in separate bags or containers. A sample of each variety shall be furnished for analysis and testing when directed by the Engineer. The amount of seed planted per acre shall be of the type specified in plans and contract documents.

1. Annual Rye grass will be free of Johnson grass, field bind weed, dodder seed, and free of other seed to the limits allowable under the Federal Seed Act and applicable State Seed Laws.

2. Hydromulch Annual Rye grass will be added into slurry between October 1 and March 15.

3. No additional cost will be charged to the SAWS

4. Fertilizer shall have a chemical analysis of 15-15-15 with micronutrients and shall be water soluble (The figures in the analysis represent the percent of nitrogen, phosphoric acid and potash nutrients, respectively). Fifty percent or greater of the Nitrogen required shall be in the form of Nitrate Nitrogen (N03). The remaining Nitrogen required may be in the form urea Nitrogen (C0(NH2)2).

5. In the event it is necessary to substitute a fertilizer of a different analysis, it shall be a pelleted or granulated fertilizer with a lower concentration, but the total amount of nutrients furnished and applied per acre shall equal or exceed that specified for each nutrient.

6. The fertilizer shall be dry and in good physical condition. Fertilizer that is powdered or caked will be rejected.

7. **Water.** Shall be furnished by the Contractor and shall be clean and free of substances harmful to the growth of vegetation.

8. **Herbicide.** Herbicide used shall be an easy to apply, effective in a short term, chemical agent to inhibit or destroy weed growth, while being harmless to seed and grass being implanted.
9. **Topsoil.** Topsoil shall conform to the provisions of City of San Antonio Item 515, "Topsoil."

103.3. EQUIPMENT: Provide the machinery, tools and equipment necessary for proper prosecution of the work. All machinery, tools and equipment used shall be maintained in a satisfactory and workmanlike manner.

103.4. CONSTRUCTION: Security of stored hydromulch, seeding and sodding materials will be the sole responsibility of the Contractor at no additional expense to SAWS. It is the Contractor's responsibility to verify the location of all utility lines, electric cables, sprinkling systems and conduits so that the proper precautions must be taken not to disturb or damage any subsurface improvements. Should obstructions be found, the Contractor will promptly notify SAWS Inspector. Any damage caused by the Contractor shall be repaired by himself at no cost to SAWS. Any such repairs shall be subject to approval by the Inspector.

1. The following construction sequences and procedures shall be observed:

2. The Contractor shall notify the Inspector not less than 48 hours in advance of any hydromulching, seeding, or sodding operation and shall not begin the work until areas prepared or designated for seeding have been approved.

3. Inspect subsoil for the presence of objectionable materials, such as rocks (2 inches in diameter and larger), concrete waste, building debris, weeds, grass or other material that would be detrimental to the growth of grasses.

4. Protect existing underground improvements from damage.

5. Cultivate to a depth of 3 inches in areas to receive hydromulch, seeding or sod.

6. If compaction is due to equipment, traffic or storage, cultivate to a depth of 6 inches, and apply herbicide as directed by manufacturer.

7. Remove any foreign or objectionable materials collected during cultivation.

8. Grade placement area to eliminate rough spots and low areas where ponding may occur.

9. Assure positive drainage away from all buildings. Maintain smooth, uniform grades.

10. Hydromulch seed or sod, area and weed control shall consist of killing all weeds and maintaining a weed free condition until completion of the project by applying herbicide as directed by the manufacturer.

11. Before placement of hydromulch, seeds or sod, all areas shall be cultivated to a depth of 3 inches unless otherwise specified or ordered by the Engineer. Cultivation of the soil may be done by disc, spring tooth harrow, roto-tiler, or similar equipment.

12. This operation shall be done at right angles to the natural flow of water on the slopes.

13. The area shall then be rolled in two directions; the second shall be done at right angles to the first rolling.

14. Rake the area to make it smooth and level. Add soil where necessary or as directed by the Inspector.

15. The finished grade shall be 1 inch below all curbs, sidewalks, and/or other appurtenances.

16. Apply the fertilizer at the rate and mixture specified. The fertilizer shall be applied by an approved hand or mechanical method.

17. Roll the area in one direction.

18. Slurry for Hydromulch to be sprayed evenly in two intersecting directions with a hydraulic seeder.

19. Erect a barrier of stakes and strings, and post warning signs where necessary, or as directed by the Inspector.

20. Apply water as required to keep the mulch damp at all times throughout germination and initial growth period as determined by the Inspector.

21. Upon completion, all excess material shall be removed and disposed of off the project site at Contractor's expense.

22. **Guarantee and Lawn Established Period.** The guarantee and lawn established period shall begin immediately after the completion of the planting and shall start with the Provisional Acceptance and end with the Final Acceptance.

23. **Provisional Acceptance.** Upon completion of hydromulching, seeding or sodding and written request of Contractor, the Inspector will inspect all the work for Provisional Acceptance.

24**. Guarantee Period.** The guarantee period shall begin upon completion of the provisional acceptance. All plant materials shall be guaranteed by the Contractor for a period of sixty days (60) from the date of provisional acceptance, to be in good, healthy, and nourished condition. The exceptions are damages resulting from neglect by the property owner, abuse or damage by others, or unusual phenomena or incidents which are beyond the Contractor's control. During the lawn establishment period, it shall be the Contractor's responsibility to ensure the continuing healthy growth. This care shall include labor, water and material necessary to keep

the project in a presentable condition, including but not limit to removal of litter, mowing, trimming, removal of grass clippings, edging, fertilization, insecticide and fungicide applications, weed control, and repair and reseeding any and all damaged areas.
Water application shall be accomplished each week from March through October. An even application of one inch minimum of water shall be required over all lawn areas weekly. The rate and frequency of water application may be changed, as directed by the Inspector, depending on weather, and soil conditions.

25**. Replacement.** The Contractor shall replace, without cost to SAWS, and as soon as weather conditions permit, all dead grassed areas not in a vigorous, thriving condition, as determined by the Inspector during and at the end of the guarantee period. Replacements shall be subject to all requirements stated in this specification. The Contractor shall make all necessary repairs to grades, grassed areas, and terrace paving required because of grass replacement at no cost to SAWS.

26. **Final Inspection and Acceptance.** At the end of the guarantee period and upon written request of the Contractor, the Inspector will inspect all guaranteed work for final acceptance. The written request shall be submitted to SAWS ten (10) days prior to the anticipated date of inspection.

Acceptance of hydromulching, seeded and sodded lawns as herein specified shall be based on a uniform stand of grass and a uniform grade at the time of final inspection. Area of two square feet or more that are bare or have a poor stand of grass and area not having a uniform grade for any cause before final inspection shall be regraded, hydromulched, seeded, and sodded, as specified at the Contractor's expense.

Upon completion by the Contractor of all repairs or renewals which may appear at that time to be necessary in the judgment of SAWS or its authorized representative, the final acceptance of the hydromulching, seeding and sodding will be issued.

103.5. MEASUREMENT: Measurement of acceptable Revegetation complete in place, shall be made by the square yard and only for those areas designated on the plans, or for other areas directed by the Inspector. Fertilizers, wood cellulose fibers, seeds, herbicide and water will not be measured for payment.

103.6. PAYMENT: “Revegetation” measured as provided above, will be paid for at the contract unit price bid per square yard, which price shall be full compensation for furnishing, hauling and placing all materials, for all fertilizer and water required and for all labor, tools, equipment and incidentals necessary to complete the work.

-End of Specification-

ITEM NO. 110

Recycled Water System

110.1 DESCRIPTION: Any work done on the existing or proposed recycled water distribution system shall be accomplished with the SAWS Standard Specifications for Water, except as otherwise noted. All proposed contract documents must be reviewed and approved by SAWS Backflow Prevention personnel prior to the start of any work.

110.2 REFERENCE STANDARDS: Reference standards cited in this Specification Item No. 110 refer to the current reference standard published at the time of the latest revision date logged.

1. San Antonio Water System (SAWS):
    a. Specifications for Water and Sanitary Sewer Construction
    b. SAWS Materials Specifications
2. City of San Antonio (COSA) Standard Specification for Construction
3. Texas Commission of Environmental Quality (TCEQ)
    a. Chapter 210 Use of Reclaim Water and TCEQ 290 Rules and Regulations for Public Regulations for Public Water Systems and
    b. 217 Design Criteria for Domestic Wastewater Systems
    c. 213 Edwards Aquifer.
4. American National Standards Institute (ANSI)/American Water Works Association (AWWA)
    a. ANSI†/AWWA C105/A21.5—Polyethylene Encasement for Ductile-Iron Pipe Systems.
    b. ANSI A 21.11/AWWA C111 - Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
    c. ANSI/AWWA C150/A21.50—Thickness Design of Ductile-Iron Pipe.
    d. ANSI/AWWA C151/A21.51—Ductile-Iron Pipe, Centrifugally Cast.

e. ANSI/AWWA C500—Metal-Seated Gate Valves for Water Supply Service.

f. ANSI/AWWA C515—Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service.

g. ANSI/NSF Standard 61 - Drinking Water System - Health Components

h. AWWA C 206 - Standard for Field Welding of Steel Water Pipe.

i. AWWA C 207 - Standard for Steel Pipe Flanges for Waterworks Service - Sizes 4 Inches through 144 Inches.

j. ANSI/AWWA C509—Resilient-Seated Gate Valves for Water Supply Service.

k. AWWA C605, "Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water

l. AWWA C651 Disinfecting Water Mains

m. AWWA C900, "Polyvinyl Chloride (pvc) Pressure Pipe And Fabricated Fittings, 4 In. Through 60 In. (100 Mm Through 1,500 Mmfor Water Distribution"

n. AWWA C907, "Polyvinyl Chloride (PVC) Pressure Fittings for Water –4 in. through 8 In (100 mm Through 200 mm)

o. AWWA Manual M27, External Corrosion: Introduction to Chemistry and Control.

p. AWWA M28 Rehabilitation of Water Mains

q. AWWA Manual M41—Ductile-Iron Pipe and Fittings

5. American Society for Testing and Materials (ASTM) International:

a. ASTM A 36 - Standard Specification for Carbon Structural Steel.

b. ASTM A 536 - Standard Specification for Ductile Iron Castings.

c. ASTM A 126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and

d. Pipe Fittings.

e. ASTM B 21 - Standard Specification for Naval Brass Rod, Bar, and Shapes.

f. ASTM B 98 - Standard Specification for Copper-Silicon Alloy Rod, Bar, and Shapes.

g. ASTM B 301 - Standard Specification for Free-Cutting Copper Rod and Bar.

h. ASTM B 584 - Standard Specification for Copper Alloy Sand Casting for General Application.

i. ASTM E 165 - Standard Test Method for Liquid Penetrant Examination.

j. ASTM E 709 - Standard Guide for Magnetic Particle Examination.

k. ASTM F 1674 - Standard Test Method for Joint Restraint Products for Use with PVC Pipe.

6. International Organization of Standardization (ISO)

   a. ISO9001

110.3 SUBMITTALS: All submittals shall be in accordance with most recent version of SAWS's General Conditions requirements. Contractor shall submit manufacturer's product data, instructions, recommendations, shop drawing, and certifications. All submittals shall be in accordance with Engineer's requirements and submittals shall be approved prior to delivery.

1. Certifications:

   a. Per General Conditions section 5.12.2 all Contractor submittals for all pipe and other products or materials furnished under this specification shall be marked as reviewed and approved by Contractor for compliance with Contract Documents and the referenced standards.

   b. The Manufacturer shall provide ISO 9001 Certificate by a third party.

   c. Submit written verification that the pipe Manufacturer has been manufacturing pipe per required ASTM with similar design pressure and size as this Project.

   d. Submit written verification from the pipe Manufacturer demonstrating compliance with the production and delivery schedule of the pipe as indicated in the Contractor's preliminary Critical Path Method schedule.

   e. Submit written verification from mechanical fitting Manufacturer that fittings are compatible with proposed pipe and meets the requirements of this section.

2. Contractor shall submit Manufacturer's product data, installation recommendations, shop drawings, and certifications.

3. Shop Drawings:

a. Catalog Data Sheets for all materials confirming pipe, fittings, and other materials conform to requirements of this specification.

b. Pipe Supplier Information. Submit company name, contact name, and contact number.

c. Details of all piping systems components confirming that the pipe and fittings conform to the specified requirements.

d. The Contractor shall submit shop drawings of pipe, fittings, gaskets, hardware, flanges, appurtenances, special details sufficient to demonstrate compliance with these Specifications and applicable pipe installation Specification.

e. Fabrication drawings showing:

1) Wall thickness.

2) Pipe length.

3) Pipe joint (i.e. mechanical, flanged. fused)

4. Testing Plan: See SAWS Specification Item No. 812 Water Main Installation

110.4 MATERIALS: All material used in the improvement, adjustment, removal and/or construction of the recycled water system shall meet SAWS Standard Specifications for Water requirements and standards (i.e., uses of CSC pipe, trenching and excavation, etc.), except as otherwise noted, and must be wrapped or painted with pantone 512 color.

1. For PVC pipe: Tracer wire shall be utilized for location and taped directly to the pipe. #14 UF rated tracer wire shall be used for direct burial conditions.

a. Tracer wire shall be properly spliced at each end connection and each service connection.

b. Tracer wire shall be adequately wrapped utilizing 3M Waterproof tape or heat shrink wrap and protected at each splice location in accordance with manufacturer recommendations.

c. No bare tracer wire shall be accepted.

d. Wire shall also come up to the top of valve extensions and fire hydrant stems, as directed by the Inspector.

e. Tracer wire shall be utilized for location purposes and taped directly to the top of pipe.

f. Tracer wire shall be of solid core (14 gauge insulated), and shall

be taped to the main in minimum of 10 inch increments.

g. Detection tape shall not be used in lieu of tracer wire.

110.5 CONSTRUCTION: The construction and installation of any recycle water system components shall be done in accordance with the SAWS Standard Specifications for Water, except as otherwise noted. Recycled Water mains shall also be installed at the TCEQ required separation distance between sewer and/or water mains as required by Texas Administrative Code (TAC) rules to include: The latest provision of 30 TAC § chapters 290,and 217, or most applicable approved equal provision.

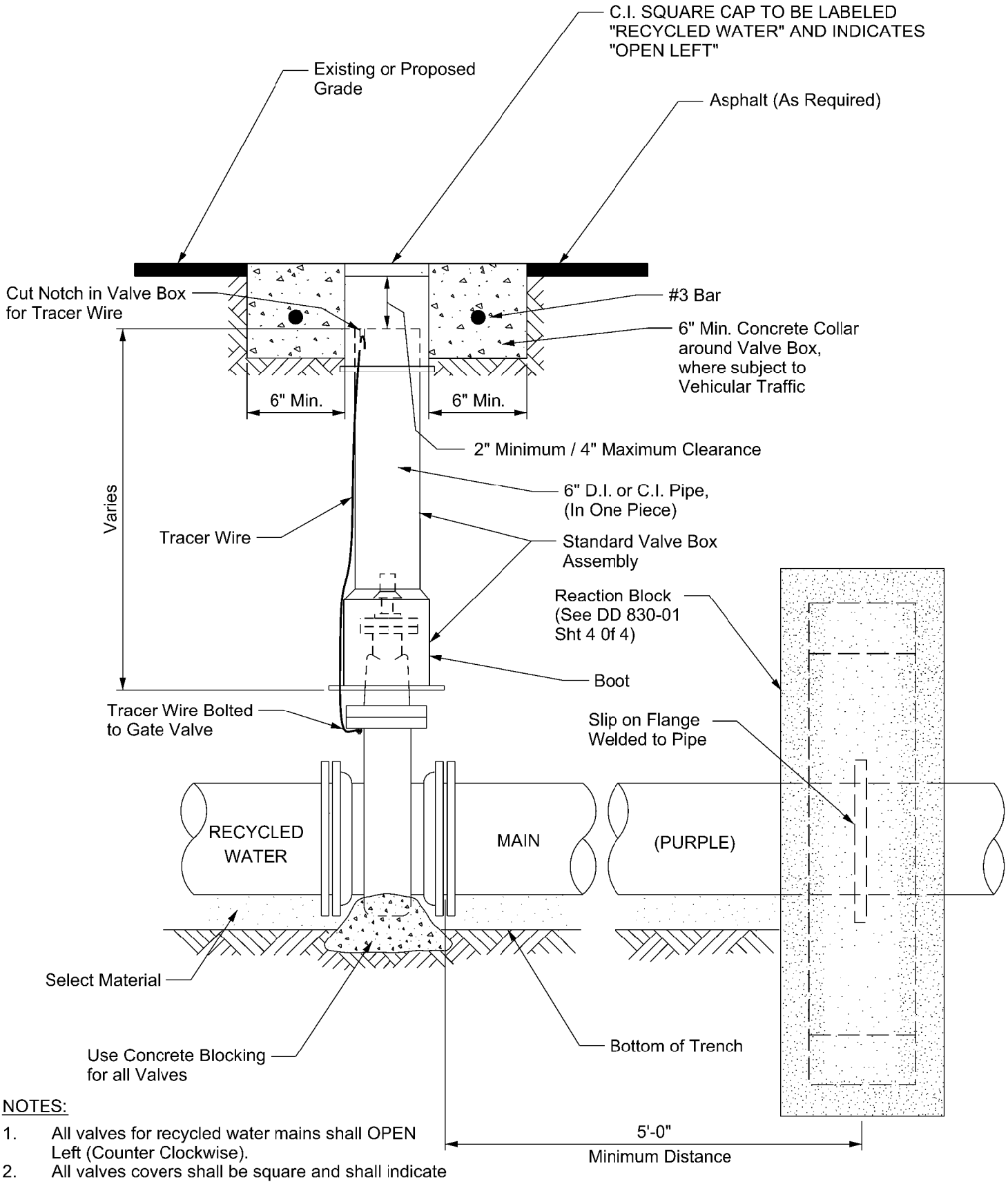
110.6 TESTING: See SAWS Specification Item No. 841 Water Hydrostatic Testing.

110.7 MEASUREMENTS: All work shall be measured in accordance with applicable specifications.

110.8 PAYMENT: All work shall be paid in accordance with applicable SAWS Construction specifications.

1. Materials paid on site will be in accordance with Table 1 of Specification Item No. 100 Mobilization.

-End of Specification-



NOTES:

1. All valves for recycled water mains shall OPEN Left (Counter Clockwise).
2. All valves covers shall be square and shall indicate OPEN LEFT.
3. Tracer wire for PVC (Typ. for PVC only)
4. All concrete to be 3,000 psi

PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	RECYCLED WATER VALVE DETAIL	APPROVED MARCH 2008	REVISED AUG 2019
		DD 110-01	SHEET 1 OF 1

ITEM NO. 200

Flexible Base

200.1 DESCRIPTION: This item shall govern a foundation course for surfacing, pavement, or other base courses in conformity with the typical sections shown in the contract documents and to the lines and grades as established by the Engineer.

200.2 REFERENCE STANDARDS: Reference standards cited in this Specification Item No. 200 refer to the current reference standard published at the time of the latest revision date.

1. San Antonio Water System (SAWS):
   a. Specifications for Water and Sanitary Sewer Construction
   b. SAWS Materials Specifications
2. City of San Antonio (COSA) Specifications for Construction
3. American Society for Testing and Materials (ASTM) International:
   a. ASTM C 131/C131M – Standard Test Method for Resistance to Degradation of Small-Size Course Aggregate by Abrasion and Impact in the Los Angeles Machine
   b. ASTM D 1556 - Density of Soil in Place by the Sand-Cone Method.
   c. ASTM D 698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12.44 ft-lbf/ft3).
   d. ASTM D 2922 - Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
   e. ASTM D 361 - Test Method for Water Content of Soils and Rock in Place by Nuclear Methods (shallow depth).
   f. ASTM D 3017 - Test Method for Water Content of Soils and Rock in Place by Nuclear Methods.
   g. ASTM D 4318 - Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
4. Texas Department of Transportation
   a. TxDOT Tex-101-E - Preparation of Soil and Flexible Base Materials for Testing.
   b. TxDOT Tex-103-E – Determining Moisture Content in Soil Materials

c. TxDOT Tex-104-E – Determining Liquid Limits of Soils

d. TxDOT Tex-105-E – Determining Plastic Limit of Soils

e. TxDOT Tex-106-E – Determining Plasticity Index of Soils

f. TxDOT Tex-107-E Determining the Bar Linear Shrinkage of Soils

g. TxDOT Tex-108 -E Determining the Specific Gravity of Soils

h. TxDOT Tex-110-E - Determination of Particle Size Analysis of Soils.

i. TxDOT Tex-113-E – Laboratory Compaction Characteristics and Moisture-Density Relationships of Base Materials

j. TxDOT Tex-114-E – Laboratory Compaction Characteristics and Moisture –Density Relationship of Subgrade, Embankment Soils, and Backfill Material

200.3 SUBMITTALS: Contractor shall submit manufacturer's product data, instructions recommendations, shop drawings, and certifications. All submittals shall be in accordance with Engineer's requirements and submittals shall be approved prior to delivery.

200.4 MATERIAL: The material shall be crushed as necessary to meet the requirements hereinafter specified, and shall consist of durable stone crushed and/or screened to the required particle size, with or without other approved fine- sized material. The material shall be from approved sources.

200.5 TESTING: Testing of flexible base materials shall be in accordance with the following TxDOT standard laboratory test procedures:

1 .	Preparation for Soil Constants and Sieve Analysis	Tex-101-E
	Liquid Limit	Tex-104-E
	Plastic Limit	Tex-105-E
	Plasticity Index	Tex-106-E
	Linear Shrinkage	Tex-107-E
	Sieve Analysis	Tex-110-E
	Los Angeles Abrasion	ASTM C131 (Grade A)

2. Samples for testing the material shall be made available to the Inspector and taken prior to the compaction operations.
3. The material shall be well graded and, when properly tested, meet the following requirements:

Retained on 1- ¾ inch sieve	0 %
Retained on No. 4 sieve	45 to 75 %
Retained on No. 40 sieve	60 to 85 %

4. The material passing the No. 40 sieve shall be known as Soil Binder and shall meet the following requirements:

Liquid Limit shall not exceed	40
Plasticity Index shall not exceed	12

5. The crushed stone shall have an abrasion of not more than 40, when subjected to the Los Angeles Abrasion Test.

200.6 CONSTRUCTION METHODS: The flexible base material shall be placed on the approved subgrade, in courses not to exceed 6 inches compacted depth.

1. It shall be the responsibility of the Contractor that the required amount of material be delivered and uniformly spread and shaped.

2. All material shall be removed from the place where it is dumped by cutting into windrows.

3. It shall be sprinkled, spread, shaped, and rolled in proper sequence to prevent segregation and as necessary for required compaction.

4. Upon completion, the surface shall be smooth and in conformity with typical sections and to the established lines and grades.

5. Any deviation in excess of ¼ inch in cross section and in length of 16 feet measured longitudinally shall be corrected.

6. All irregularities, depressions, or weak spots which develop shall be corrected at no expense to SAWS.

7. Flexible base shall be compacted to a relative dry density of not less than 95% of the maximum dry density as determined in accordance with TxDOT Test Method Tex 113-E.

8. All density tests will be made within 24 hours after compaction operations are completed.

9. Just prior to the placing of any succeeding course of flexible base or surfacing on a previously completed course, the density and moisture of the top 3 inches of flexible base shall be checked and if the test shows the density to be more than 2% below the specified minimum or the moisture content to be more than 3% above or below the optimum, the course shall be reworked as necessary to obtain the specified compaction and moisture content.

10. The Contractor shall be responsible for compaction in accordance with the appropriate Specification.

    a. Compaction tests will be done at one location point randomly selected or as indicated by the SAWS Inspector/Test Administrator.

    b. The inspector shall determine the depth at which the density test shall be taken.

    c. All depths shall be considered for testing without a predetermined maximum or minimum

    d. Test requirements above are indicated as a minimum requirement, but may be subjected to follow more stringent requirements as established by other appropriate agencies (such as COSA Public Works Right of Way Management Plan, etc.)

    e. Any failed test shall require the Contractor to remove and replace that layer of material to a length 50 feet in both directions from the failed test location.

        1) The Contractor will also be required at no cost to SAWS to provide two additional tests at the replaced location where the initial test failed and at one location point, randomly selected or as indicated by the SAWS Inspector/Test Administrator.

    f. The Contractor shall be responsible for all costs associated with the proctor and density tests, and for providing to SAWS and Consultant, if applicable, verification that necessary compaction levels were achieved.

11. These tests shall be performed by a nationally-accredited, independent testing laboratory.

12. If the material fails to meet the density specified, it shall be reworked as necessary to meet the required density.

200.7 MEASUREMENT: Flexible Base will be measured by the square yard, complete in place, for the thickness specified in the contract documents, or by the cubic yard, complete in place as indicated in the contract documents.

200.8 PAYMENT: This item will be paid for at the contract unit price bid for "Flexible Base" which price shall be full compensation for all work herein specified, including the furnishing, hauling, and placing of all materials, for all water required, and for all equipment, tools, labor, testing, and incidentals necessary to complete the work.

- **End of Specification -**

ITEM NO. 299

Flowable Fill

299.1 DESCRIPTION: The work covered by this item consists of furnishing, transporting, mixing, testing and installing flowable fill. Flowable fill is a concrete material suitable as a backfill for utility trenches, abandoned pipes, manholes and valves. It is a heavy material and will exert a high fluid pressure against any forms, embankment, or wall used to contain backfill.

299.2 REFERENCE STANDARDS: Reference standards cited in this Specification Item No. 299 refer to the current reference standard published at the time of the latest revision date.

1. San Antonio Water System (SAWS):
   a. Specifications for Water and Sanitary Sewer Construction
   b. SAWS Materials Specifications
2. City of San Antonio (COSA) Standard Specifications for Construction
   a. ASTM C 31 – Making and Curing Concrete Test Specimens in the field.
   b. ASTM C 39 – Compressive Strength of Cylindrical Concrete Specimens.
   c. ASTM C 40 – Organic Impurities in Fine Aggregates for Concrete.
   d. ASTM C 94 - Ready-Mixed Concrete.
   e. ASTM C 150 - Portland Cement.
   f. ASTM C 192 – Making and Curing Concrete Test Specimens in the Laboratory.
   g. ASTM C 260 – Air-Entraining Admixtures for Concrete.
   h. ASTM C 494 - Chemical Admixtures for Concrete.
   i. ASTM C 618 – Coal Fly Ash and Raw or Calcined Natural Pozzolan for use as a Mineral Admixture in Concrete.
3. ASTM C 4318 – Liquid Limit, Plastic Limit and Plasticity Index of Soils. Texas Department of Transportation (TxDOT)
   a. TxDOT DMS-4600 Hydraulic Cement
   b. TxDOT DMS-4610 Fly Ash
   c. TxDOT DMS 4640 Chemical Admixtures for Concrete
   d. Tex-401-A
   e. TxDOT Tex-106-A
   f. TxDOT-Tex-418-A
   g. TxDOT-Tex-447-A

299.3 SUBMITTALS:

1. All submittals shall be in accordance with Engineer's requirements. All submittals shall be approved by the Engineer and acknowledge by the Inspector prior to delivery of materials and commencing any portion of the proposed scope of work.
   a. Submit proposed mix design. Mix design shall state the following information:
      1) Mix design number or code designation to order the concrete from the supplier.

2) Design strength at 7 days (unless otherwise noted on the Plans).
3) Cement type and brand.
4) Fly ash type and brand.
5) Admixtures type and brand.
6) Proportions of each material used.
7) Submit a copy of delivery tickets accompanied by batch tickets, providing the information required by ASTM C 94 to SAWS Inspector in the field at time of delivery.

299.4 MATERIALS:

1. Cement. Furnish hydraulic cement that meets the requirements of TxDOT's DMS-4600, "Hydraulic Cement," TxDOT's Hydraulic Cement Quality Monitoring Program (HCQMP), and ASTM C-150 Type I Portland Cement. Sources not on the HCQMP or other sources to be used in combination with an approved source will require approval before use.
2. Fly Ash. Furnish fly ash conforming to TxDOT DMS-4610, "Fly Ash."
3. Chemical Admixtures. Furnish chemical admixtures conforming to TxDOT DMS-4640, Chemical Admixtures for Concrete.
4. Fine Aggregate. Provide fine aggregate that will stay in suspension in the mortar to the extent required for proper flow and that meets the gradation requirements of Table 1. Test fine aggregate gradation in accordance with TxDOT standard laboratory test procedure Tex-401-A. Plasticity Index (PI) must not exceed 6 when tested in accordance with TxDOT standard laboratory test procedure Tex-106-A.
5. Mixing Water. Use mixing water conforming to the requirements of Specification Item No. 300, Concrete (Natural Aggregate).

Table 1
Aggregate Gradation Chart

Sieve Size	***Percent Passing***
¾ inch	100
No.200	0-30

299.5 CONSTRUCTION: Unless otherwise shown on the plans, furnish a mix meeting the requirements of this section as set forth below.

1. Strength. The compressive strength range shall be between the following strength values unless otherwise directed by the Engineer or shown on the plans:
   a. Low Strength. Between 80 psi and 150 psi at 28 days,
   b. High Strength. Greater than 500 psi at 28 days. For emergency repairs, strength shall be greater than 50 psi at 2 hours.
2. Consistency. Design the mix to be placed without consolidation and to fill all intended voids.
   a. Fill an open-ended, 3 inch diameter by 6 inch high cylinder to the top to test the consistency.
   b. Immediately pull the cylinder straight up. The correct consistency of the mix must produce a minimum 8 inch diameter circular spread with no segregation.

c. When necessary, use specialty type admixtures to enhance the flowability, reduce shrinkage, and reduce segregation by maintaining solids in suspension.
d. All admixtures must be used and proportioned in accordance with the manufacturer's recommendations.
e. Mix the flowable fill using a central-mixed concrete plant, ready-mix concrete truck, pug mill, or other approved method.

3. Shrinkage and Bleeding. Limit shrinkage to 0.5% or less based upon the results from ASTMC 827, "Change in Height at Early Ages of Cylindrical Specimens from Cementitious Mixtures."
   a. Batch, mix and transport flowable fill in accordance with ASTM C 94, except when directed otherwise by the Engineer.
   b. Mix flowable fill in quantities required for immediate use. Do not use portions which have developed initial set or which are not in place within 90 minutes after the initial water has been added.
   c. Do not mix flowable fill while the air temperature is at or below 35 degrees F without prior approval from the Engineer.
   d. Monitor and control the fluid pressure during placement of flowable fill prior to set. Take appropriate measures to avoid excessive pressure that may damage or displace structures or cause flotation. Cease operations if flowable fill is observed leaking from the area.
   e. Repair or replace damaged or displaced structures at no additional cost to SAWS.
   f. Clean up excess flowable fill discharged from the work area and remove excess flowable fill from pipes at no additional cost to SAWS.

299.6 TESTING: Testing shall be in accordance with TxDOT standard laboratory test procedure Tex-418-A

1. Contractor to furnish all labor, equipment, tools, containers, and molds required for sampling, making, transporting, curing, removal, and disposal of test specimens. Furnish test molds meeting the requirements of TxDOT standard laboratory test procedure Tex-447-A
2. Two specimens are required for a strength test, and the compressive strength is defined as the average of the breaking strength of the 2 cylinders.
3. Contractor to transport, strip, and cure the test specimens as scheduled at the designated location.
4. Cure test specimens in accordance with TxDOT standard laboratory test procedure Tex-447-A.
5. The Contractor will sample, take, and test all quality control testing.
6. Contractor to dispose of used, broken specimens in an approved location and manner.
7. The frequency of job control testing will be at the direction of the Engineer.
8. SAWS will be responsible for quality assurance testing.

299.7 MEASUREMENT: This Item will be measured by the cubic yard of material placed of accepted work complete in place.

1. Measurement will not include additional volume caused by slips, slides, or cave-ins resulting from the Contractor's operations.

PAYMENT: The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" is for full compensation for furnishing, hauling, and placing materials and for equipment, tools, labor, and incidentals and will be paid for at the unit price bid for "Flowable Fill (Low Strength)," "Flowable Fill (High Strength)," or "Flowable Fill (High Strength emergency Repair)" for Pipe. Flowable Fill shall be paid for at the contract unit price per cubic yard based on the maximum trench widths as established per SAWS Construction Specification Item No. 804, schedule of pay or as indicated on the contract plans and is for full compensation for furnishing, hauling, and placing materials and for equipment, tools, labor, and incidentals.

The use of flowable fill around manholes as per specification items Nos. 850, 851, 852, 853, and 855 is incidental and there will be no additional separate payment item for the material.

-End of Specification -

ITEM NO. 300

Concrete (Natural Aggregate)

300.1 DESCRIPTION: This item shall govern the storage, handling and usage of materials; and the proportioning, mixing and transportation of concrete for all concrete construction. This specification does not cover the placement, consolidation, curing, or protection of the concrete.

300.2 REFERENCED STANDARDS: Reference standards cited in this Specification Item No. 300 refer to the current reference standard published at the time of the latest revision date.

1. San Antonio Water System (SAWS):
    a. Specifications for Water and Sanitary Sewer Construction
    b. SAWS Materials Specifications
2. City of San Antonio (COSA) Specifications for Construction
3. American Concrete Institute
    a. ACI 117 - Standard Tolerances for Concrete Construction and Materials.
    b. ACI 211.1 - Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete.
    c. ACI 302.1R - Guide for Concrete Floor and Slab Construction.
    d. ACI 304R - Guide for Measuring, Mixing, Transporting, and Placing Concrete.
    e. ACI 308 - Standard Practice for Curing Concrete.
    f. ACI 309R - Guide for Consolidation of Concrete.
    g. ACI 311 - Guide for Concrete Plant Inspection and Field Testing of Ready-Mix Concrete.
    h. ACI 315 - Details and Detailing of Concrete Reinforcement
    i. ACI 318 - Building Code Requirements for Reinforced Concrete and Commentary.
    j. ACI 544 - Guide for Specifying, Mixing, Placing, and Finishing Steel Fiber Reinforced Concrete.
4. American Society for Testing and Materials (ASTM) International:

a. ASTM A 82 - Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.

b. ASTM A 185 - Standard Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement.

c. ASTM A 615 - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.

d. ASTM A 767 - Standard Specifications for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement.

e. ASTM A 775 - Standard Specification for Epoxy-Coated Reinforcing Steel Bars.

f. ASTM A 820 - Standard Specification for Steel Fibers for Fiber-Reinforced Concrete.

g. ASTM A 884 - Specification for Epoxy-Coated Steel Wire and Welded Wire Fabric for Reinforcement.

h. ASTM C 31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field.

i. ASTM C 33 - Standard Specification for Concrete Aggregates.

j. ASTM C 39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.

k. ASTM C 42 - Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.

l. ASTM C 94 - Standard Specification for Ready-Mixed Concrete.

m. ASTM C 138 - Standard Test Method for Unit Weight Yield and Air Content (Gravimetric) of Concrete.

n. ASTM C 143 - Standard Test Method for Slump of Hydraulic Cement Concrete.

o. ASTM C 150 - Standard Specification for Portland Cement.

p. ASTM C 172 - Standard Practice for Sampling Freshly Mixed Concrete.

300.3 SUBMITTALS: Contractor shall submit manufacturer's product data, instructions recommendations, shop drawings, and certifications. All submittals shall be in accordance with Engineer's requirements and submittals shall be approved prior to delivery.

1. Submit proposed mix design and test data for each type and strength of concrete in Work.

2. Submit laboratory reports prepared by independent testing laboratory stating that materials used comply with requirements of this Section.

3. Submit manufacturer's mill certificates for reinforcing steel. Provide specimens for testing when required by Engineer.

4. Submit certification from concrete supplier that materials and equipment used to produce and deliver concrete comply with this Specification.

5. When required on Drawing, submit shop drawings showing reinforcement type, quantity, size, length, location, spacing, bending, splicing, support, fabrication details, and other pertinent information.

6. For waterstops, submit product information sufficient to indicate compliance with this Section, including manufacturer's descriptive literature and specifications.

300.4 MATERIAL: The concrete shall be composed of Portland cement, mineral filler, if necessary, natural aggregates (fine and coarse), and water, proportioned and mixed as hereinafter provided in these specifications. Concrete shall meet all the requirements as set forth in the latest provision of ASTM C94 or the most applicable approved equal provision.

1. The minimum cement content, maximum allowable water content, and maximum slump of the various classes of concrete shall conform to Table 1.

300.5 MEASUREMENT: The quantities of concrete, of the various classifications which constitute the completed and accepted structure, will be measured by the cubic yard in place. Only accepted work will be included, and the dimensions used will be those shown in the contract documents or ordered in writing by the Engineer. Measurement will not include additional quantities due to over excavation, trench slides, and caving.

300. 6 PAYMENT: The concrete quantities, measured as provided above, will be paid for at the contract unit prices bid per cubic yard for the various classifications of concrete shown, which prices shall be full compensation for furnishing, hauling and mixing all concrete materials; placing, curing, and finishing all concrete; all grouting and pointing; furnishing and placing all drains and expansion joints, except as hereinafter provided; furnishing and placing metal flashing strips; and for all forms and faux work, labor, tools, equipment, and incidentals necessary to complete the work.

1. The above provisions for payment for drains and expansion joints shall not be interpreted to provide payment for cast iron or structural steel shapes used in drains; for structural steel, cast iron or cast steel bearing plates; or for

steel members used in armoring roadway joints.

2. Payment for these materials shall be full compensation for work herein specified, including the furnishing of all materials, equipment, tools, labor, and incidental necessary to complete the work.

3. No payment for additional quantities will be made due to over excavation, trench slides, and caving.

4. Payment for reinforcing an item which specifically includes the cost of reinforcement shall be paid for as provided in the specifications for those items

5. No direct measurement or payment will be made for Concrete Class "G," but shall be considered subsidiary to the particular items required by the contract documents.

Table 1

Class	Minimum compressive strength @ 28 days, psi (Mpa)	Maximum water/cement ratio	Slump range, inches	Min.-max. sacks cement, cubic yard
A	4,000 (28)	4.5	2-4	5
B	2,500 (17)	8	2-5	4.5
C	2,000 (14)	9	1-4	4
D	1,000 (6)	11	1-4	2
G	(as specified in the contract documents)	5.5	2-3	6.0-8.0

- End of Specification -

ITEM NO. 301

Reinforcing Steel

301.1 DESCRIPTION: This item shall provide for the furnishing and placing of bar reinforcing steel for use in structures and other concrete items that require reinforcing steel as shown in the contract documents.

301.2 REFERENCED STANDARDS: Reference standards cited in this Specification Item No. 301 refer to the current reference standard published at the time of the latest revision date.

1. San Antonio Water System (SAWS):
    a. Specifications for Water and Sanitary Sewer Construction
    b. SAWS Materials Specifications
2. City of San Antonio (COSA) Specifications for Construction
3. American Society for Testing and Materials (ASTM) International:
    a. ASTM A 615, Grades 60,75, or 80
    b. ASTM A996, Type A, Grade 60
    c. ASTM A996, Type R, Grade 60, permitted in concrete pavement only(Furnish ASRM A996, Type R bars as straight bars only and do not bend item. Bend tests are not required.) or
    d. ASTM A706, Grades 60 or 80
4. Texas Department of Transportation Specification Item 440 Reinforcement for Concrete

301.3 SUBMITTALS: Contractor shall submit manufacturer's product data, instructions recommendations, shop drawings, and certifications. All submittals shall be in accordance with Engineer's requirements and submittals shall be approved prior to delivery.

301.4 MATERIALS: Reinforcing steel shall be grade 60 and all bar reinforcement shall be deformed, conforming to the latest provision of Item No. 440, "Reinforcing Steel" of the TxDOT Standard Specifications or most applicable approved equal provision.

Reinforcing steel bars produced outside of the United States are acceptable, if such bar reinforcement conforms to the requirements of the latest provision of the ASTM Specifications for the various designations of bars.

301.5 CONSTRUCTION: Unless otherwise shown on plans the reinforcing steel shall meet the requirements of this Section as set forth below.

1. BENDING, TOLERANCES AND STORAGE: Bending, tolerances and storage of reinforcing steel shall conform to the latest provision of Article 440.3.A-C, in Item No. 440, "Reinforcement for Concrete" of the TX-DOT Standard Specifications or most applicable approved equal provision.

2. SPLICES: No splicing of bars, except when provided in the contract documents, will be permitted without written approval of the Engineer.

3. PLACING REINFORCEMENT**:** All steel reinforcing shall be accurately placed in the position shown in the contract documents and firmly held during the placement and setting of concrete. All reinforcement shall be free from dust, rust, mill scale, paint, oil, mortar or foreign material. Bars shall be tied at all intersections. Where spacing of bars in each direction is less than 12 inches, only alternate intersections need be tied. Distances from forms shall be maintained by means of stays, precast blocks, ties, hangers, metal chairs or other approved supports. Blocks for holding reinforcing bars from contact with the forms shall be precast concrete blocks of approved shape and dimensions or other equally suitable devices. The use of pebbles, pieces of broken stones or brick, metal pipe and wooden blocks shall not be permitted. Reinforcement in any sections shall be placed and then inspected and approved by the Inspector before the placing of concrete begins.

301.6 MEASUREMENT: The measurement of quantities of bar reinforcing furnished and placed will be based on the calculated weight of the steel actually placed in accordance with the contract documents with no allowance made for added bar lengths or splices, nor for extra steel used when bars larger than those specified are substituted with the permission of the Engineer. Tie wires and supporting devices will not be included in the calculated weights. The calculated weight of bar reinforcement will be determined using the theoretical bar weight set forth in Table No. 1, with no allowance for overrun or under runs:

301.7 PAYMENT: Reinforcing Steel measured, as provided above, will be paid for at the contract unit price bid per pound of "Reinforcing Steel," which price shall be full compensation for furnishing, bending, fabricating, welding and placing reinforcement; for all clips, blocks, metal spacers, ties, wire or other materials used for fastening reinforcement in place, and for all tools, labor, equipment and incidentals necessary to complete the work.

1. Payment for reinforcing an item which specifically includes the cost of reinforcement shall be paid for as provided in the specifications for those items.

TABLE 1

Bar size, number	Nominal diameter, inches	Nominal Area, square inches	Weight, pound per linear foot
2	0.250	0.05	0.167
3	0.375	0.11	0.376
4	0.500	0.20	0.668
5	0.625	0.31	1.043
6	0.750	0.44	1.502
7	0.875	0.60	2.044
8	1.000	0.79	2.670
9	1.128	1.00	3.400
10	1.270	1.27	4.303
11	1.410	1.56	5.313
14	1.693	2.25	7.65
18	2.257	4.00	13.60

-End of Specification-

ITEM NO. 307

Concrete Structures

307.1 DESCRIPTION: This item shall govern the construction and repair of headwalls, wingwalls, box transitions, approach slabs, retaining walls, and other designated structures. All concrete structures shall be constructed and repaired in accordance with the specifications herein outlined and in conformity with the required lines, grades, sections and details shown in the contract documents or as directed by the Engineer. New Sanitary Sewer Structures shall be Polymer Concrete See Specification Item No. 850 Polymer Concrete Sanitary Sewer Structures or Specification Item No. 853 Glass Fiber Reinforced Polymer (FRP) Manholes and Structures.

307.2 REFERENCED STANDARDS: Reference standards cited in this Specification Item No. 307 refer to the current reference standard published at the time of the latest revision date.

1. San Antonio Water System (SAWS):
    a. Specifications for Water and Sanitary Sewer Construction
    b. SAWS Materials Specifications
2. City of San Antonio (COSA) Specifications for Construction
3. American Society of Mechanical Engineers
    a. ASME B 16.1 –Cast Iron Pipe Flanges and Flanged Fittings
4. American Society for Testing and Materials (ASTM) International:
    a. ASTM A 307 - Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile
    b. ASTM A 615 - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
    c. ASTM C 270 - Standard Specification for Mortar for Unit Masonry
    d. ASTM C 443 - Standard Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.
    e. ASTM C 478 - Standard Specification for Precast Reinforced Concrete Manhole Sections

f. ASTM C 890 - Standard Practice for Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures

g. ASTM C 913 – Standard Specifications for Precast Concrete Water and Wastewater Structures

h. ASTM C 923 - Standard Specifications for Resilient Connectors between Reinforced Concrete Manhole Structures and Pipes.

i. ASTM C 990 – Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants

j. ASTM C 1107 - Standard Specification for Packaged Dry, Hydraulic - Cement Grout (Nonshrink).

k. ASTM D 698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lb/ft3).

l. ASTM D 2665 - Standard Specification for Poly Vinyl Chloride (PVC) Plastic Drain, Waste and Vent Pipe, and Fittings.

m. ASTM D 2996 - Standard Specification for Filament-wound Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.

n. ASTM D 2997 - Standard Specification for Centrifugally Cast Fiberglass (Glass-Fiber- Reinforced Thermosetting-Resin) Pipe.

o. ASTM F 2306 – Standard Specification for 12 to 60 in. [300 to 1500 mm] Corrugated profile Wall Polyethylene (PE) Pipe Fittings for Gravity-Flow Storm Sewer and Subsurface Drainage Applications.

p. ASTM F 2510 – Standard Specification for Resilient Connectors Between Concrete Manhole Structures and Corrugated High Density Polyethylene Drainage Pipes

q. ASTM D 698 - Standard Test Method for Laboratory Compaction Characteristics of Soil 3 Using Standard Effort (12,400 ft-lb/ft)

r. ASTM D 2665 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste and Vent Pipe and Fittings

s. ASTM D 2996 - Standard Specification for Filament-Wound "Fiberglass" (Glass-Fiber- Reinforced Thermosetting-Resin) Pipe

t. ASTM D 2997 - Standard Specification for Centrifugally Cast "Fiberglass" (Glass-Fiber- Reinforced Thermosetting Resin) Pipe

u. ASTM F 2306 – Standard Specification for 12 to 60 in. [300 to 1500 mm] Annular Corrugated Profile-Wall Polyethylene (PE) Pipe and Fittings for Gravity-Flow Storm Sewer and Subsurface Drainage Applications

v. ASTM F 2510 – Standard Specification for Resilient Connectors between Concrete Manhole Structures and Corrugated High Density Polyethylene Drainage Pipes.

5. American Water Works Association (AWWA)

   a. AWWA C 213 - Standard for Fusion Bonded Epoxy Coating for Interior and Exterior of Steel Water Pipelines

6. American Association of State Highway and Transportation Officials (AASHTO)

   a. M306: Standard Specification for Drainage, Sewer Utility and Related Changes.

307.3 SUBMITTALS: Contractor shall submit manufacturer's product data, instructions recommendations, shop drawings, and certifications. All submittals shall be in accordance with Engineer's requirements and submittals shall be approved prior to delivery.

1. Submit proposed design mix and test data for each type and strength of concrete.
2. Submit manufacturer's data and details of following items for approval:

   a. Frames, grates, rings, and covers.

   b. Materials to be used in fabricating drop connections.

   c. Materials to be used for pipe connections at structure walls.

   d. Materials to be used for stubs and stub plugs.

   e. Installation instructions for forms.

   f Shop drawing of manhole sections, base units and construction details, including reinforcement, jointing methods, materials and dimensions.

3. Summary of criteria used in structure design including, as minimum, material properties, loadings, load combinations, and dimensions assumed. Include certification that structure design is in full accordance with ASTM C478 and /or ASTM C 890 and design criteria.

4. Materials and procedures for corrosion-resistant liner and coatings or concrete additive, if required.

5. Seal submittal drawings by Professional Engineer registered in State of Texas.

307.4 MATERIALS:

1. Concrete: All concrete shall conform to the latest provisions of Item No. 300, "Concrete (Class A)" or the most applicable approved equal provision, or the concrete shall be of a class as noted in the contract documents.

2. Reinforcing Steel: All reinforcing steel shall conform to the provisions of Item No. 301, "Reinforcing Steel."

3. Membrane Curing Compound: Provide membrane curing compounds that conform to the latest provision of TxDOT's DMS-4650, "Hydraulic Cement Concrete Curing Materials and Evaporation Retardants" or most applicable approved equal provision.

4. Expansion Joint Materials: Provide materials that conform to the latest provision of TxDOT's DMS-6310, "Joint Sealants and Fillers" or most applicable approved equal provision.

5. Cast Iron Castings: All cast iron castings shall conform to the latest provision of the City of San Antonio Department of Public Works' Standard Specifications for Construction Item No. 409, "Cast Iron Castings", or most applicable approved equal provision.

6. Metal for Structures: Metal for structures shall conform to the latest provision of the City of San Antonio Department of Public Works' Standard Specifications for Construction Item No. 302, "Metal for Structures", or most applicable approved equal provision.

307.5 CONSTRUCTION METHODS:

1. Forms: Forms shall be of wood, metal or other approved materials and shall conform to the following requirements

   a. Wood Forms:

1) Unexposed concrete surfaces, No. 2 common or better lumber.

2) Exposed concrete surfaces, dressed and matched boards of uniform thickness and width.

b. Plywood: Commercial Standard Douglas Fir, moisture resistant, concrete form plywood, not less than 5 ply and at least 9/16th of an inch in thickness. The face of the plywood shall be free from knot holes and other blemishes.

c. Metal Forms: Metal forms of an approved type that will produce surfaces equal to or better than those specified for wood forms.

1) Forms may be constructed of any of the above substances or of other material if suited to the intended purpose and when approved by the Inspector.

2) Forms shall be built mortar tight and of sufficient strength to prevent bulging between supports and shall be set and maintained to the line and grade designated until the concrete is sufficiently hardened to permit removal.

3) All details of form construction shall be subject to the approval of the Inspector and, in special cases, the approval of the Engineer may be required.

4) Permission to place concrete will not be given by the Inspector until all form work has been placed in accordance with the above requirements.

5) If at any stage of the work, the forms show signs of bulging, sagging or moving, that portion of the concrete causing such conditions shall be immediately removed, if required by the Inspector, and the forms reset and securely braced against further movement. All form resets will be at no additional cost to SAWS and will not warrant any claims for delays on the project.

6) All corners and edges, which will be exposed after construction, shall be chamfered with triangular chamfer strips ¾ inch measured on the sides.

2. Placing Reinforcement: All steel reinforcement shall be placed in accordance with Item No. 301, "Reinforcing Steel."

3. Placing Concrete: The base slabs of inlets, junction boxes, headwalls, culverts and other structures shall be placed and allowed to set before the remainder of the structure is constructed.

a. Suitable provisions shall be made for bonding the sidewalls to the base slab by means of longitudinal keys so constructed as to prevent the percolation of water through the construction joints.

b. Before concrete is placed in the walls, the keyed-edge joints shall be thoroughly cleaned of all shavings, sticks, trash or other extraneous materials.

c. The top slabs of culverts and like structures may be poured monolithic with the walls, provided the walls are poured and allowed to set a minimum of 1 hour, no more than 2 hours, shall elapse between the placing of the concrete in the wall and that in the top slab; such interval is to allow for shrinkage of the concrete in the wall.

d. Under adverse weather conditions, the minimum time will be increased by the Inspector.

e. All concrete shall be placed with the aid of mechanical vibrating equipment supplemented inside the forms.

f. Vibrating equipment shall be of the internal type and shall maintain a speed of 6,000 impulses per minute, when submerged in concrete. Vibrators shall be adequate in number of units to properly consolidate all concrete. Provide a backup vibrator for large concrete pours.

g. Form or surface vibrators shall not be used. The duration of vibration shall be limited to properly consolidate the concrete without causing objectionable segregation of aggregates.

h. Insertion of vibrators into lower courses that have commenced initial set, or the disturbance or reinforcement in concrete beginning to set, shall be avoided.

i. Concrete shall not be allowed to drop freely more than 5 feet in unexposed work, nor more than 3 feet in exposed work; where greater drops are required, a tremie or other approved means shall be employed.

j. Concrete shall not be placed when the ambient temperature is below 40^{o}F, nor where the concrete is likely to be subject to freezing before final set has occurred.

k. When the air temperature is expected to drop below 40^{o}F during the first 72 hours of the curing period, polyethylene sheeting or burlap-polyethylene blankets shall be placed in direct contact with the top surface of the concrete.

l. Concrete may be poured in temperatures below 40^{o}F, when poured in

protected areas, or where adequate protection can be provided against freezing, if approved by the Engineer.

m. When concrete is poured in air temperatures above 85°F, an approved retarding agent, meeting the latest provision of ASTM C494, Type B or most applicable approved equal provision, will be required in all concrete used in superstructures and top slabs of culverts unless directed otherwise by the Engineer.

4. Form Removal: Forms shall be removed only with the approval of the Inspector and in a manner to insure complete safety of the structure when the structure as a whole is supported on shoring.

a. Form removal from structures shall not begin until the concrete has attained the following compressive strengths:

b. Vertical forms shall not be removed until the concrete has set a minimum of 24 hours, or the concrete has attained a minimum compressive strength of 500 psi.

c. When wall and top slabs are poured monolithically, wall forms shall not be removed until the concrete has attained a minimum compressive strength of 2,000 psi, or as directed by the Engineer.

5. Finish: Honeycomb and other minor defects shall be patched with one part of cement to 2 parts fine aggregate. All exposed surfaces shall be given one of the following finishes:

a. Rough Finish: Concrete for which no other finish is indicated or specified shall have fins and rough edges removed.

b. Smooth Finish: Smooth finish shall be given to the interior of inlets, junction boxes, culverts and other structures. Joint marks, fins and rough edges shall be smoothed off and blemishes removed, leaving finished surfaces smooth and unmarred, subject to approval by the Inspector.

c. Floor Finish: Floor finish shall be given to the floors of all inlets, culverts and other structures, and shall be struck off true to the required grade as shown in the contract documents and floated to a smooth, even finish by manual or mechanical methods. No coarse aggregate shall be visible after finishing.

d. Rubbed Finish: All exposed surfaces of retaining walls, wingwalls, headwalls and other structures, after patching and painting has been completed and the surface has been wetted, shall be given a first rubbing with a No. 16 Carborundum Stone.

i. After the first rubbing is completed and the ground material has been evenly spread, the material shall be allowed to take a reset.

ii. After sufficient aging, the surface shall be wetted and given a finish rubbing with a No. 30 Carborundum Stone, after which the surface shall be neatly striped with a brush and allowed to take a reset.

iii. On the inside surfaces of all culvert walls an area from the top slab, on a line 30 degrees from the vertical, to the bottom slab shall be rubbed as specified above.

e. The entire structure shall be left with a clear, neat, uniform finish, free from form markings and shall be uniform in color.

f. Sidewalk surfaces shall be given a wood float finish, a light broom finish, or may be stripped with a brush as directed by the Inspector or specified in the contract documents.

g. Roadway slabs shall be given a broom finish after completion of the floating or straight-edging operation, but before the disappearance of the moisture sheen.

i. The grooves of the finish shall be parallel to the centerline of the roadway.

ii. The average texture depth of the grooves shall be a minimum of 0.035 inches.

h. The Contractor has the option of substituting the surface finish described in the latest provision of the City of San Antonio Department of Public Works' Standard Specifications for Construction Item No. 311, "Concrete Surface Finish," or most applicable approved equal provision, on the surface areas listed in the specification.

6. Curing: Immediately after placing or finishing, concrete surfaces not covered by forms shall be protected from loss of surface moisture for not less than 4 curing days. When forms are left in place, they shall be kept sufficiently wet to reduce cracks in the forms and prevent the form joints from opening.

a. If forms are removed before 4 curing days have transpired, the formed surface shall be protected for the remainder of the 4 day curing period. Protection and curing shall be accomplished by one of the following methods and shall be subject to the approval of the Inspector during the entire curing process:

b. Water Curing: Water curing shall be effected by covering exposed surfaces

with cotton or burlap mats, previously wetted before applying, and kept thoroughly wet during the entire curing period.

c. The application of the mats shall not mar or disturb surfaces which will be exposed on completion.

d. Membrane compound curing: Provide membrane curing compounds that conform to the latest provision of TxDOT's DMS-4650, "Hydraulic Cement Concrete Curing Materials and Evaporation Retardants" or the most applicable approved equal provision.

7. Fine Grading: All fine grading of structure foundations shall provide for seating on firm, clean, natural earth foundation except as otherwise provided.

8. Any under-cut foundations, except where authorized, shall be corrected to the satisfaction of the Inspector, at the sole expense of the Contractor.

9. Excavation and Backfilling shall conform to the latest provision of the City of San Antonio Department of Public Works' Standard Specifications for Construction Item No. 306, "Structural Excavation" or the most applicable approved equal provision. All references therein to density and/or compaction levels are superseded by those of SAWS, described elsewhere in these standard specifications.

307.6 MEASUREMENT: No direct measurement or payment will be made for the work to be done or the equipment to be furnished under this item, but shall be considered subsidiary to the particular items of work for which unit prices are required in the proposal.

307.7 PAYMENT: No direct payment will be made for the work to be done or the equipment to be furnished under this item, but shall be considered subsidiary to the particular items of work for which unit prices are required in the proposal.

-End of Specification-

ITEM NO. 550

Trench Excavation Safety Protection

550.1 DESCRIPTION: This item shall govern the trench excavation safety protection required for the construction of all trench excavation protection systems to be utilized in the project and including all additional excavation and backfill necessitated by the protection system.

550.2 REFERENCED STANDARDS: Reference standards cited in this Specification Item No. 550 refer to the current reference standard published at the time of the latest revision .

1. San Antonio Water System (SAWS):
   a. Specifications for Water and Sanitary Sewer Construction
   b. SAWS Materials Specifications
2. City Of San Antonio (COSA) Standard Specifications for Construction
3. Texas Commission of Environmental Quality (TCEQ)
   a. Chapter 217 Design Criteria for Domestic Wastewater Systems
   b. Chapter 213 Edwards Aquifer
   c. Chapter 290; Subchapter D – Rules and Regulations for Public Drinking Water
4. Occupational Safety and Health Administration (OSHA).
   a. Federal Regulations, 29 CFR, Part 1926, Standards – Safety and Health Regulations for Construction – Subpart P Excavation,

550.3 SUBMITTALS: Contractor shall submit manufacturer's product data, instructions recommendations, shop drawings, and certifications. All submittals shall be in accordance with Engineer's requirements and submittals shall be approved prior to delivery.

1. Submit a safety program specifically for the construction of trench excavation. Design the trench safety program to be in accordance with OSHA 29CFR standards governing the presence and activities of individuals working in and around trench excavations.
2. Construction and shop drawings containing deviations from OSHA standards or special designs shall be sealed by a Professional Engineer Licensed in the State of Texas retained and paid by Contractor.
3. Review of the safety program by Engineer will only be in regard to compliance with specification and will not constitute approval by Engineer nor relieve Contractor of obligations under State and Federal trench safety laws.
4. Submit certification that trench safety system will not be subjected to loads exceeding those which the system was designed to withstand according to the available construction and geotechnical information.
5. An excavation plan submittal signed and sealed by a Texas licensed professional engineer shall be submitted for review and acceptance by the SAWS' Representative, if applicable, prior to the delivery of materials and commencing

any portion of proposed construction activities where the planned excavation is 20 feet or greater.

550.4 CONSTRUCTION: Trench excavation safety protection shall be accomplished as required by the latest provision of Part 1926, Subpart P – Excavations, Trenching, and Shoring of the OSHA Standards and Interpretations, or the most approved equal provision.

1. A trench shall be defined as a narrow excavation made below the surface of the ground or pavement. In general, the depth is greater than the width, but the width of a trench is not greater than 15 feet.
2. If forms or other structures are installed or constructed in an excavation so as to reduce the dimension measured from the forms or structure to the side of the excavation to 15 feet or less (measure at the bottom of the excavation), the excavation is also considered to be a trench.
3. In addition, "Trench Excavation Protection" will not be limited to these applications, but may be used whenever deemed expedient and proper to ensuing work.

550.5 MEASUREMENT: Trench Excavation Safety Protection shall be measured by the linear foot along the centerline of any OSHA defined trench that may be entered by personnel and is not greater than 15 feet wide, including manholes and other structures.

550.6 PAYMENT: Payment for Trench Excavation Safety Protection, measured as described above, shall be made at the unit price bid per linear foot of Trench Excavation Safety Protection regardless of the depth of the trench.

1. Payment shall include all components of the Trench Excavation Safety Protection System which can include, but not be limited to, sloping, sheeting, trench boxes or trench shields, sheet piling, cribbing, bracing, shoring, dewatering or temporary diversion and proper recapture and transportation of water to provide adequate drainage.
2. Payment shall also include the additional excavation and backfill required, any jacking, jack removal, and removal of the trench supports after completion.
3. Payment of all work prescribed under this item shall be full compensation for all additional excavation and backfill associated with the item; for any retention by Contractor of structural design/geotechnical/safety/equipment consultant; for furnishing, placing and removing all shoring, sheeting, or bracing; for dewatering or temporary diversion and proper recapture and transportation of water; for all jacking and jack removal; and for all other labor, material, tools, equipment and incidentals necessary to complete this portion of the work.

- End of Specification -

ITEM NO. 804

Excavation, Trenching and Backfill

804.1 DESCRIPTION: This section shall govern the excavation, trenching, and backfilling for water, sanitary sewer, and recycled water construction, unless otherwise noted in the contract documents. The work shall include all necessary drainage, dewatering, pumping, bailing, sheeting, shoring and incidental construction.

804.2 REFERENCE STANDARDS: Reference standards cited in this Specification Item No. 804 refer to the current reference standard published at the time of the latest revision

1. San Antonio Water System (SAWS):
    a. Specifications for Water and Sanitary Sewer Construction
    b. SAWS Materials Specifications
2. City Of San Antonio (COSA) Standard Specifications for Construction
3. Texas Commission of Environmental Quality (TCEQ)
    a. Chapter 217 Design Criteria for Domestic Wastewater Systems
    b. Chapter 290; Subchapter D – Rules and Regulations for Public Drinking Water
4. American Society for Testing and Materials (ASTM) International:
    a. ASTM C 12 - Standard Practice for Installing Vitrified Clay Pipe Lines.
    b. ASTM C76- Standard Specification for Reinforced Concrete Culverts, Storm Drain, and Sewer Pipe.
    c. ASTM D 1556 - Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method.
    d. ASTM D 2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity Flow Applications.
    e. ASTM D 2487 - Standard Classification of Soils for Engineering Purposes.
    f. ASTM D 6938 - Test Method for in place Density and Water

Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

g. ASTM D 4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

h. ASTM D 558 - Standard Test Methods for Moisture-Density Relations of Soil Cement Mixtures.

i. ASTM D 698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600kN-m/m3)).

5. American Association of State Highway and Transportation Officials (AASHTO)

   a. AASHTO M306: Standard Specification for Drainage, Sewer, Utility, and Related Castings.

6. Occupational Safety and Health Administration (OSHA).

   a. Federal Regulations, 29 CFR, Part 1926, Standards – Safety and Health Regulations for Construction – Subpart P Excavation,

7. International Organization of Standardization (ISO)

   a. ISO9001 Standards

8. Texas Department of Transportation (TxDOT)

   a. TxDOT Tex-101-E - Preparing Soil and Flexible Base Materials for Testing.

   b. TxDOT Tex-110-E - Particle Size Analysis of Soils.

   c. TxDOT Tex-112-E – Test Procedure for admixing Lime to Reduce Plasticity Index of Soils

   d. TxDOT Tex-113-E - Laboratory Compaction Characteristics and Moisture-Density Relationship of Base Materials

   e. TxDOT Tex-114 -E- Laboratory Compaction Characteristics and Moisture-Density Relationship of Subgrade, Embankment Soils, and Backfill Material

   f. TxDOT Tex-142- E –Laboratory Classification of Soils for Engineering Purposes

804.3 SUBMITTALS: All submittals shall be in accordance with Engineer's requirements. All submittals shall be approved by the Owners' Representative prior to delivery of materials and commencing any portion of the proposed scope of work.

1. Contractor to submit cut sheets when applicable.
    a. No trenching will commence until cut sheets have been approved by SAWS' Representative.
    b. The depths of cuts indicated on the cut sheet, are from the center line hub elevation to the invert of the pipe.
2. Submit detailed trench plans, shoring system designs, installation sequences, and flowable fill mix designs.
3. Submit planned typical method of excavation, backfill placement and compaction including:
    a. Trench widths
    b. Procedures for foundation and pipe zone bedding placement, and trench backfill compaction
    c. Procedures for assuring compaction against undisturbed soil when pre-manufactured trench safety systems are proposed.
    d. An excavation plan submittal signed and sealed by a Texas licensed professional engineer shall be submitted for review and acceptance by the SAWS' Representative, if applicable, prior to the delivery of materials and commencing any portion of proposed construction activities where the planned excavation is 20 feet or greater.
4. Submit trench excavation safety program in accordance with requirements of Specification Item No. 550 Trench Excavation Safety Protection
5. Submit record of location of utilities as installed, referenced to survey control points. Include:
    a. Locations of utilities encountered or rerouted.
    b. Give stations, horizontal dimensions, elevations, inverts, and gradients.
6. Submit detailed drawing with plotted utility or obstruction location to SAWS' Representative.
7. Submit Emergency Action Plan (EAP) to address contingency plans in the event of damage to utilities. Include the following:

a. Contact personnel and agencies including primary and secondary telephone, numbers,

b. Contractor's hierarchy of responsible personnel,

c. Traffic control measures, and

d. Identification of resources to be available on or near project site in event of damage to utilities.

8. Submit backfill material sources and product quality information in accordance with requirements of this specification.

804.4 MATERIALS: The Contractor shall procure, store, and place materials from either onsite or offsite sources which comply with the specified requirements.

1. The use of sand backfill is not allowed, unless sand is native soil to trenchline, is clean, and is approved by SAWS' Engineer.

2. Backfilling for pipelines is divided into three (3) separate zones:

a. Bedding: the material in the trench bottom in direct contact with the bottom of the pipe;

b. Initial backfill: is defined as backfill having a thickness in its compacted state from the surface of the bedding to a point 1 foot above the top of the pipe.

c. Secondary backfill: the backfill zone extending from the initial backfill surface to the top of the trench.

d. Materials and placement for each of the zones shall be as described herein

3. Trench Bottom Materials:

a. Stable Material: Existing stable material present during excavation includes:

(1) Trench bottom (free of water, muck, debris);

(2) Rock in boulder, ledge or coarse gravel (particle size not larger than 1- ¾ inch) formations;

(3) Coarse sand and gravels with maximum particle size of 1- ¾ inch, various graded sands and gravels containing small percentages of fines, generally granular and non-cohesive either wet or dry; and

(4) Fine sands and clayey gravels; fine sand, sand-clay mixtures, clay and gravel-clay mixtures.

b. Unstable Material: Existing unstable materials are silt, muck, trash or debris in the trench bottom bearing level; rock on boulder ledge or coarse gravel (particle size larger than 1- ¾ inch) formations.

4. See Table 1 for an outline of the bedding and initial backfill requirements for various pipe materials.

TABLE 1

BEDDING AND INITIAL BACKFILL REQUIREMENTS

	UNSTABLE		**STABLE***		**ROCK**	
	Bedding	**Initial Backfill**	**Bedding**	**Initial Backfill**	**Bedding**	**Initial Backfill**
WATER	6" or D/8	1.0' above	6" or D/8	1.0' above pipe	6" or D/8	1.0' above pipe
CSC	Modified Grade 5	Modified Grade 5	Modified Grade 5	Modified Grade 5	Modified Grade 5	Modified Grade 5
DI	Modified Grade 5	Modified Grade 5	Modified Grade 5	Modified Grade 5	Modified Grade 5	Modified Grade 5
PVC	Modified Grade 5	Modified Grade 5	Modified Grade 5	Modified Grade 5	Modified Grade 5	Modified Grade 5
HDPE	Modified Grade 5	Modified Grade 5	Modified Grade 5	Modified Grade 5	Modified Grade 5	Modified Grade 5
WSP	Modified Grade 5	Modified Grade 5	Modified Grade 5	Modified Grade 5	Modified Grade 5	Modified Grade 5
SEWER	6" or D/8	1.0' above pipe	6" or D/8	1.0' above pipe	6" or D/8	1.0' above pipe
RIGID	sewer gravel	sewer gravel	sewer gravel	sewer gravel	sewer gravel	sewer gravel
FLEXIBLE	sewer gravel	sewer gravel	sewer gravel	sewer gravel	sewer gravel	sewer gravel

NOTE: The use of sand backfill is not allowed, except as secondary backfill if sand is native soil to trenchline, is clean, and is approved by SAWS' Engineer.

CSC = Concrete Steel Cylinder

DI = Ductile Iron

HDPE = High Density Polyethylene Pipe.

PVC = Polyvinyl Chloride

WSP = Tape Wrapped Steel Pipe.

D = Outside Diameter of Pipe

5. Sanitary Sewer Backfill**:**

   a. Bedding Material:

      (1) The existing material at the bearing level shall be removed and replaced to a minimum depth of 6 inches or 1/8 of the outside diameter of the pipe, whichever is greater, with bedding material.

      (2) The bedding material shall extend up the sides of the pipe sufficient to embed the lower quadrant of the pipe.

      (3) The bedding material shall be composed of well-graded, crushed stone or gravel conforming to the requirements of Table 2 unless modified by the Engineer in writing.

Table 2

Sanitary Sewer Backfill Materials

Sewer Gravel	**Percent**
Passing 1- ½ inch sieve	100
Passing 1 inch sieve	95 to 100
Passing 1/2 inch sieve	25 to 60
Passing No. 4 sieve	0 to 10
Passing No. 8 sieve	0 to 5

6. Potable Water and Recycle Mains Backfill

   a. Bedding Material:

      (1) The existing material at the bearing level shall be removed and replaced to a minimum depth of 6 inches or 1/8 of the outside diameter of the pipe, whichever is greater, with bedding material.

      (2) The bedding and initial backfill materials for concrete steel cylinder pipe (CSC), ductile iron pipe (DI), Wrapped Steel (WS) Pipe, High Density Polyethylene Pipe (HDPE) and Polyvinyl Chloride Pipe (PVC) in all nominal diameters shall be composed of well graded crushed stone or gravel conforming to the requirements of Table 3 unless modified by the Engineer in writing.

Table 3

Modified Grade 5 Backfill Materials

Modified Grade 5	Percent
Passing ½ inch sieve	100
Passing 3/8 inch sieve	95 to 100
Passing No. 4 sieve	20 to 80
Passing No. 10 sieve	0 to 25
Passing No. 20 sieve	0 to 2

   b. Where copper or HDPE services (¾" – 2") are installed, initial backfill shall be sand conforming to the following requirements:

      (1) Natural sand or sand produced from crushed gravel or crushed rock maximum ¼ inch free from clay and organic material conforming to the requirements of Table 4 unless modified by the Engineer.

      (2) Larger services utilizing DI pipe or PVC (C-900) pipe shall be backfilled the same as mains and conform to the

requirements of Table 3 unless modified by the Engineer in writing.

Table 4 **Sand Backfill- For Services**	
Sand No.	**Percent**
Passing No. 4 Sieve	95
Passing No. 200 sieve	8

804.5 CONSTRUCTION: All existing utilities shall be protected from damage during the excavation and backfilling of trenches and, if damaged, shall be replaced by the Contractor at their own expense.

1. General:

   a. Unless otherwise shown in the contract documents, **all excavation shall be unclassified and shall include all materials encountered regardless of their nature or the manner in which they are removed, to include but not limited to groundwater, water, rock, stone, sand, concrete, organic material, existing abandoned utility lines whether shown on the plans or not, or any kind of material that is encountered.**

   b. Trenches shall not be backfilled until constructed structures or appurtenances, as installed, conform to all requirements specified.

      (1) Failure to comply will require Contractor to re-excavate trench at no expense to SAWS.

   c. Where pipe is specially coated or sleeve/tape wrapped for protection against corrosion, care shall be taken not to damage the coating or sleeve/tape wrap.

      (1) Damage to be assessed by Manufacturer and repaired to manufacture's recommendation at no expense to SAWS.

   d. Where a trench has been improperly backfilled, or settlement occurs, the identified section shall be excavated to the trench depth and a length 50 feet in both directions of the failed area, then refilled and compacted to the grade and compaction level required.

e. Safety Devices: The Contractor shall provide and maintain barricades, flags, road flares, and other safety devices as required by local, state, and federal codes and ordinances and conduct work to create a minimum inconvenience to the public.

f. Temporary suspension of work does not relieve Contractors' responsibility of the above requirements.

g. Safety and Health Regulations: The Contractor shall at all times conform to all of the latest applicable regulations of 29 CFR Part 1926 Subpart "P" entitled Excavation, of OSHA Safety and Health Regulations for Construction," or most applicable approved equal provisions, and all other applicable state and local rules and regulations.

h. Archaeological (Unidentified Archaeological Sites): If the Contractor should encounter a section of an archeological feature, such as a acequia (early Spanish irrigation ditch) or any other archaeological deposits during construction operations, the Contractor must stop excavation immediately and contact the SAWS' Engineer and SAWS' Inspector, who will call the City of San Antonio Historic Preservation Officer at (210) 207-0035 for an archaeological investigation as per Section 35-432.3 of the City Code, "Unidentified Sites Archaeological."

(1) The Contractor cannot begin excavation again without written permission from SAWS.

(2) If more than three days are required for investigation (not including holidays and weekends) and the Contractor cannot work on other project scope items, the Contractor will be permitted to negotiate for additional construction time through a Request for Information (RFI).

i. The RFI shall be submitted within ten days after date of the first notice, additional standby time will not be considered.

(3) If the time required for investigation does not exceed three days for each event, contract duration will not be extended.

2. Excavation: The Contractor shall perform all excavation of every description and of all substances, including rock, encountered to the lines and grades shown in the contract documents or as determined by the Engineer.

a. During excavation, material suitable for backfilling shall be stockpiled in an orderly manner a safe distance from the banks of the trench to avoid overloading and to prevent slides or cave-ins as per 29 CFR Part 1926 Subpart "P" entitled Excavation, of OSHA Safety and Health Regulations for Construction,"

b. All excavated materials not required or suitable for backfill shall be removed and properly disposed of by the Contractor or as directed by the Inspector at no additional cost to SAWS.

c. Grading shall be done as may be necessary to prevent surface water from flowing into trenches or other excavations, and any water accumulating therein shall be removed by pumping or by other approved methods.

d. Sheeting and shoring shall be installed in accordance with all applicable safety requirements for the protection of the work, adjoining property, and for the safety of all personnel.

e. Unless otherwise indicated, excavation shall be by open cut, hand, backhoe, hoe-ram, rock saw, or other approved method.

f. Short sections of a trench may be tunneled, if the pipe or structure can be safely and properly installed or constructed, and backfill can be properly compacted in such tunnel sections**.**

g. Tunneled section must be authorized by SAWS' Engineer prior to start of Construction.

h. Where over-excavation occurs and when not as directed by the Engineer or Inspector, the under-cut trench shall be restored to grade at no cost to SAWS by replacement with a material conforming to the requirements of the bedding material or a material approved by the Engineer.

3. Trenching

a. Trench walls shall be vertical

b. Open trenches are limited to 200 ft. open at one time.

c. Contractor shall compact trench and install an all-weather surface on any paved surface, roadway or trench as directed by SAWS' inspector, prior to proceeding to the next section. Sections are limited to 200 ft. of open trench.

d. Projects under 500 ft. must be completely restored at the end of

each day.

e. Where the trench bottom has been over excavated in excess both vertically and horizontally, beyond the limits as defined in contract documents, the pipe shall be concrete-encased or encased as directed by the engineer.

(1) Encasement shall extend from the trench wall to trench wall and be a minimum of 6 inches above the top of pipe. No separate pay item (See Specification Item No. 858, Concrete Encasement.)

f. Where the trench bottom is not excavated in accordance with this specification due to rock or other hard under lying materials, then the pipe shall be concrete encased as defined in Specification Item No. 858, Concrete Encasement.

g. The practice of undercutting at the bottom or flaring at the top will not be permitted except where it is justified for safety or at the Engineer's and/or Inspector's direction.

h. In special cases, where trench flaring is required, the trench walls shall remain vertical to a depth of at least 1 foot above the top of the pipe.

i. The trench bottom shall be square or slightly curved to the shape of the trenching machine cutters.

j. The trench shall be accurately graded along its entire length to provide uniform bearing and support for each section of pipe installed upon the bedding material.

k. Bell holes and depressions for joints shall be dug after the trench bottom has been graded and bedding installed.

l. The pipe shall rest upon the new bedding material for its full length.

m. The minimum allowable base width of the trench shall be not less than 12 inches greater than the exterior diameter of the pipe, not less than 6 inches on each side.

n. Trench supports are exclusive of the minimum trench width.

o. The maximum allowable base width of trench shall be not greater than 24 inches than the exterior diameter of the pipe, not more than 12 inches on each side.

p. Trench supports are exclusive of the maximum trench width.

q. Whenever such maximum allowable width of trench is exceeded, except as provided for in the contract documents, or by written approval of the Engineer, the Contractor, at his sole expense, shall encase the pipe in concrete from trench wall to trench wall.

r. Any additional trench restoration required as a result of an excavation wider than this maximum width or subsequent surface or paving work, will be done at the Contractor's sole expense.

s. When unsuitable bearing materials such as water, silt, muck, trash, debris or rock in ledge, boulder or coarse gravel (particle size larger than 1- ¾ inch) is encountered at the bearing level, the Contractor shall over- excavate and remove such materials to a depth no less than 6 inches below the bottom of the pipe and replace it with a material conforming to the requirements of this Specification or as approved by the Engineer and/or Inspector.

4. Dewatering: Prevent surface water and subsurface or groundwater from flowing into excavations and from flooding project site and surrounding area.

a. The Contractor shall not allow water to accumulate in excavations or at subgrade level.

b. Remove water to prevent softening of foundation bottoms and soil changes detrimental to stability of subgrades and foundations.

c. Provide and maintain dewatering system components necessary to convey water from excavations.

d. Convey water removed from excavation and rainwater to collecting or runoff areas away from buildings and other structures.

e. Establish and maintain temporary drainage ditches and other diversions outside excavation limits.

f. Do not use trench excavations as temporary drainage ditches.

g. Dewatering devices shall be provided by the Contractor with filters to prevent the removal of fines from the soil.

h. Should the pumping system draw fines from the soil, the Inspector shall order immediate shutdown, and remedial measures will be the responsibility of the Contractor.

i. Upon completion of the dewatering work, the Contractor shall remove all equipment and leave the construction area in a neat,

clean, condition that is acceptable to the Inspector.

j. The Contractor shall maintain a groundwater table at least 12 inches below the finished excavated trench depth.

k. Performances of the dewatering system for lowering groundwater shall be measured by observation wells on piezometers installed in conjunction with the dewatering system, and these shall be documented at least daily.

l. The Contractor shall maintain a daily log of these readings and submit them to the Inspector before payment.

m. No direct payment shall be made for costs associated with dewatering.

n. All costs in connection therewith shall be included in the applicable contract price for the item to which the work pertains.

5. Backfilling**:** Trenches shall not be backfilled until the construction structures or appurtenances, as installed, conform to the requirements specified.

a. Initial backfill is defined as backfill having a thickness in its compacted state from the surface of the bedding to a point 1 foot above the top of the pipe.

b. Initial Bedding material shall be consolidated to assure it is incorporated from the bottom of the trench up to the pipe centerline.

(1) A hand-held vibrator, commonly used for concrete work, can be used for this purpose. The vibrator shall be inserted every 3 feet on each side of the pipe.

c. For pipelines up to 24 inches in diameter initial backfill material shall be placed in two separate lifts above the bedding material the pipe is set on.

(1) The first lift shall be spread uniformly and simultaneously on each side and under the bottom quadrant of the pipe to the mid-point or spring line of the pipe.

d. For diameters larger than 24 inches, initial backfill material shall be evenly and simultaneously spread alongside, under the lower quadrant of the pipe and over the pipe in 18 (first lift) or 12 inch lifts to a point sufficient to a minimum of 1 foot above the top of the pipe (See Drawing Series DD-804).

e. Placement of the first lift of initial backfill shall be subject to inspection and approval prior to placement of second lift, which shall extend from the spring line of the pipe to a minimum of 1 foot above the top of the pipe.

f. Secondary backfill is defined as backfill from 1 foot above the top of the pipe to the top of the trench or bottom of pavement section.

g. Secondary backfill shall generally consist of materials removed from the trench and shall be free of brush, debris and trash.

(1) Rock or stones having a dimension larger than 6 inches at the largest dimension shall be sifted out and removed before the material is used in the secondary backfilling zone.

(2) Secondary backfill material shall be primarily composed of compactible soil materials. The secondary backfill material shall be placed in maximum 12 inch loose lifts or as directed by the Engineer and/or Inspector.

h. Secondary backfill shall be constructed in accordance with details shown in the construction documents.

i. All compaction within the secondary backfill zone shall be such that the relative dry density of each layer shall be not less than 98% compaction from the top of the initial backfill to the bottom of pavement section as outlined in TxDOT Testing Methods Tex-113 or Tex-114.

j. For native sand backfill and non-cohesive soils, Engineer will specify compaction requirements.

k. The second lift shall be evenly spread in a similar manner as the first lift.

l. Where specified, by Engineer, only the secondary backfilling may incorporate native excavated materials approved, by Engineer, for backfilling, consisting of earth, loam, sandy clay, sand and gravel, soft shale or other approved materials, free from large clods of earth or stones.

m. Where pipe is specially coated or sleeve/tape wrapped for protection against corrosion, care shall be taken not to damage the coating or sleeve/tape wrap.

n. Damaged wrap will be replaced at Contractor's expense.

o. Where a trench has been improperly backfilled, or where settlement occurs, the identified section shall be excavated to the trench depth and a length 50 feet in both directions of the failed

area, then refilled and compacted to the grade and compaction level required at the Contractor's expense.

p. The use of sand backfill shall not be allowed, except as secondary backfill if the native soil is sand. Compaction and moisture-density relationship to be determined by TxDOT Testing Methods Tex-113 or Tex-114.

q. Soil Characteristic determined by TxDOT-142e.

r. The pavement (asphalt) section shall have 95% compaction density with a maximum dry density at + or – 1% optimum moisture content as determined by tests on samples as outlined in the latest provisions of TX-DOT Testing Method Tex 113-E or Tex-114, unless otherwise shown on the contract documents.

s. At the time of compaction, the water content shall be at optimum moisture content, + or - 1% points as outlined in the latest provisions of TX-DOT Testing Method Tex 113-E or Tex-114.

6. Trench Surface Restoration: The surface of the backfilled trench shall be restored to match the previous existing conditions.

a. This shall include final grading, placement of topsoil and seeding, placement of sod (such as at homes or businesses that had maintained grass), or other unprepared and prepared surfaces.

b. Contractor shall compact trench and install an all-weather surface on any paved surface, roadway or trench as directed by SAWS inspector, prior to proceeding to next section. Sections limited to 200 ft. of open trench.

c. Trenches in alleys actively being used by vehicles (such as trash pickup, vehicle parking, etc.) shall be restored by grading and compacting to 98% (per TxDOT Tex-113 or Tex - 114) or higher with a minimum of 4 inches of flex- base materials for the entire width of the alley.

d. Asphaltic materials shall have a compaction density of 95%.

e. Alleys not actively used by vehicles shall be graded and compacted to 98% (per TxDOT Tex-113 or Tex - 114) or higher from the top of the initial backfill to the bottom of the pavement section, then spread grass seed for entire width of the alley.

f. Trenches in paved streets shall be covered with a temporary all-weather surface to allow for vehicular traffic and protect trench from weather, water infiltration and runoff until the final

asphalt/concrete paving is complete.

(1) This surface shall be a minimum of 4 inches hot-mix cold lay compacted and rolled asphaltic black base, either hot-mix or cold-mix applied, or plates with cold mix asphalt installed around the edges.

(2) It is the Contractor's responsibility to maintain this surface until the final street restoration is complete.

(3) Sections limited to 200 ft. of open trench at a time.

(4) Temporary street striping may also be required.

(5) This surface must be removed prior to final asphalting.

g. All street work shall be done in accordance with the latest City of San Antonio Public Works' (or other city as applicable) construction specifications.

h. Included in this requirement is replacement of any curbs or sidewalks damaged or removed during the construction.

i. No separate payment for the surface restoration is permitted. The cost for this work must be included in the appropriate bid item.

804.6 DISPOSAL OF EXCAVATED MATERIALS: Any excess excavated material, not utilized after all fill requirements have been met, shall become the responsibility of the Contractor.

1. The Contractor shall dispose of it by hauling and wasting outside the limits of the rights-of-way or easements of this project and of public thoroughfares and water courses, in conformity with pertinent City, County, State and Federal codes and ordinances and in a manner meeting the approval of the Engineer or Inspector.

804.7 QUALITY CONTROL:

1. All testing to be coordinated 48 hours in advance with SAWS Inspector.
2. Samples to be taken in conjunction with SAWS samples at same time and location.
3. Contractor to be prepared to test if coordinated with Inspector.
4. Quality Assurance Testing: The Owner shall have such tests and inspections as he may desire performed by a nationally-accredited,

independent testing laboratory for his guidance and control of the work.

a. The Owner will determine in-place density and moisture content by anyone or combination of the following methods:

   (1) TxDOT Tex-113-E - Laboratory Compaction Characteristics and Moisture-Density Relationship of Base Materials

   (2) TxDOT Tex-114 -E- Laboratory Compaction Characteristics and Moisture-Density Relationship of Subgrade, Embankment Soils, and Backfill Material

   (3) ASTM D2922 (density of soil and soil aggregate in-place by nuclear methods – shallow depth),

   (4) ASTM D1556 (density and unit weight of soil in-place by sand cone method),

   (5) ASTM D2216 (lab density of water content of soil and rock),

   (6) ASTM D3017 (water content of soil and rock – shallow depth in-place by nuclear methods) or most applicable approved equal provisions.

b. Payment for such tests shall be the responsibility of the Owner, including the material proctor tests and density tests.

c. The Contractor shall request testing work performed by the Owner by notifying the Owner of the areas available by Station Numbers or Dimensions and Lift Numbers.

d. The Contractor shall provide access to SAWS and to lab to the test area, backfilling test areas and provide associated trench excavation safety protection at the Contractor's expense for all depths and lifts.

e. The frequency and location of testing shall be determined solely by the SAWS. Or at a minimum tests will be done at location points randomly selected as indicated by the Inspector/Test Administrator, per each 18 (first lift from bottom) and 12 inch loose lift per 100 linear feet, at a probe depth of six (6) inches. One per lift per 100 ft.

f. The Owner may test any lift of fill at any time, location, or elevation.

5. Quality Control Testing: The Contractor shall be responsible for compaction in accordance with the appropriate Specification.

    a. Compaction tests will be done at location points randomly selected or as indicated by the SAWS' Inspector/Test Administrator, per each 18 (first lift from bottom) and 12 inch loose lift per 100 linear feet, at a probe depth of six (6) inches. One per lift per 100 ft.

    b. The inspector shall determine the depth at which the density test shall be taken.

    c. All depths shall be considered for testing without a predetermined maximum or minimum

    d. Test requirements above are indicated as a minimum requirement, but maybe subjected to follow more stringent requirements as established by other appropriate agencies (such as COSA Public Works Right of Way Management Plan, etc.)

    e. Any failed test shall require the Contractor to remove and replace that layer of backfill in the identified section of the failed test location to the trench depth and a length 50 feet in both directions, then refilled and compacted to the grade and compaction level required.

        1) The Contractor will also be required at no cost to SAWS to provide two additional tests at the replaced location where the initial test failed and at one location point, randomly selected or as indicated by the SAWS Inspector/Test Administrator.

    f. Sanitary Sewer Laterals will be subject to compaction tests at the discretion of the SAWS' Inspector/Test Administrator within 100 linear foot segments.

        1) Any failed test shall require the Contractor to remove and replace that layer of backfill in the identified section of the failed test location to the trench depth and a length 50 feet in both directions, then refilled and compacted to the grade and compaction level required.

        2) The Contractor will also be required at no cost to SAWS to provide two additional tests at the replaced location where the initial test failed and at one location point, randomly selected or as indicated by the SAWS' Inspector/Test Administrator.

g. The Contractor shall be responsible for all costs associated with the proctor and density tests, and for providing to SAWS and Consultant, if applicable, verification that necessary compaction levels were achieved.

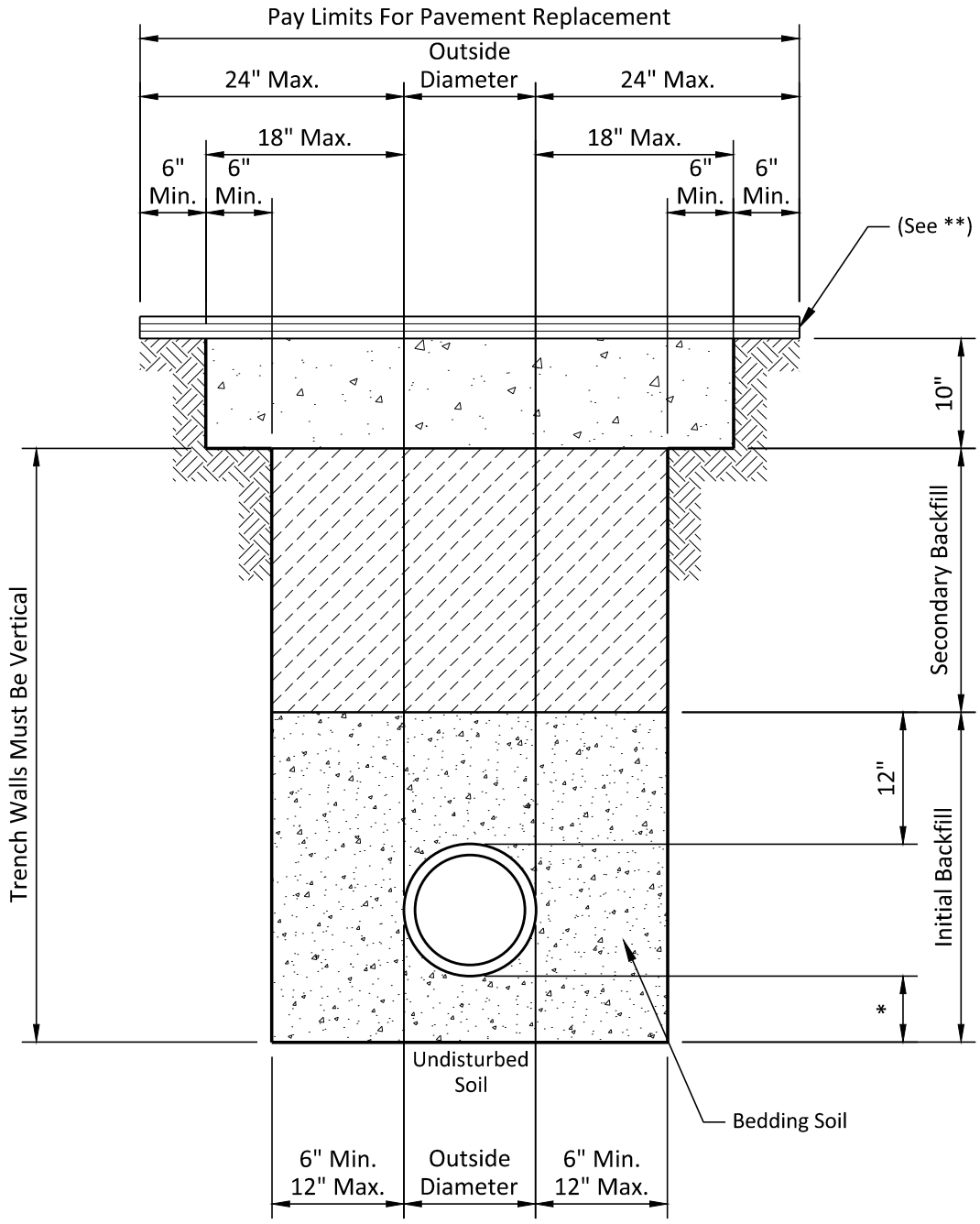
h. These tests shall be performed by a nationally-accredited, independent testing laboratory.

i. The Contractor shall provide access to SAWS and to lab to the test area, backfilling test areas and provide associated trench excavation safety protection at the Contractor's expense for all depths and lifts.

804.8 MEASUREMENT: Excavation, Trenching and Backfill will not be measured for payment

804.9 PAYMENT: No direct payment shall be made for incidental costs associated with quality control testing, excavation, trenching backfilling for water mains and sanitary sewers, and placement of all-weather material and all costs in connection therewith shall be included in the applicable contract price for the item to which the work pertains.

-End of Specification-



The Existing Material at the Bearing Level shall be Removed and Replaced to a Minimum Depth of 6-Inches or ⅛ of the Outside Diameter of the Pipe, whichever is greater, with Bedding Material.

In Areas of over Excavation, Encasement shall extend from Trench Wall. Pay Limits shall not Exceed 12" Max. as shown on Detail. Additional Encasement shall be incidental.

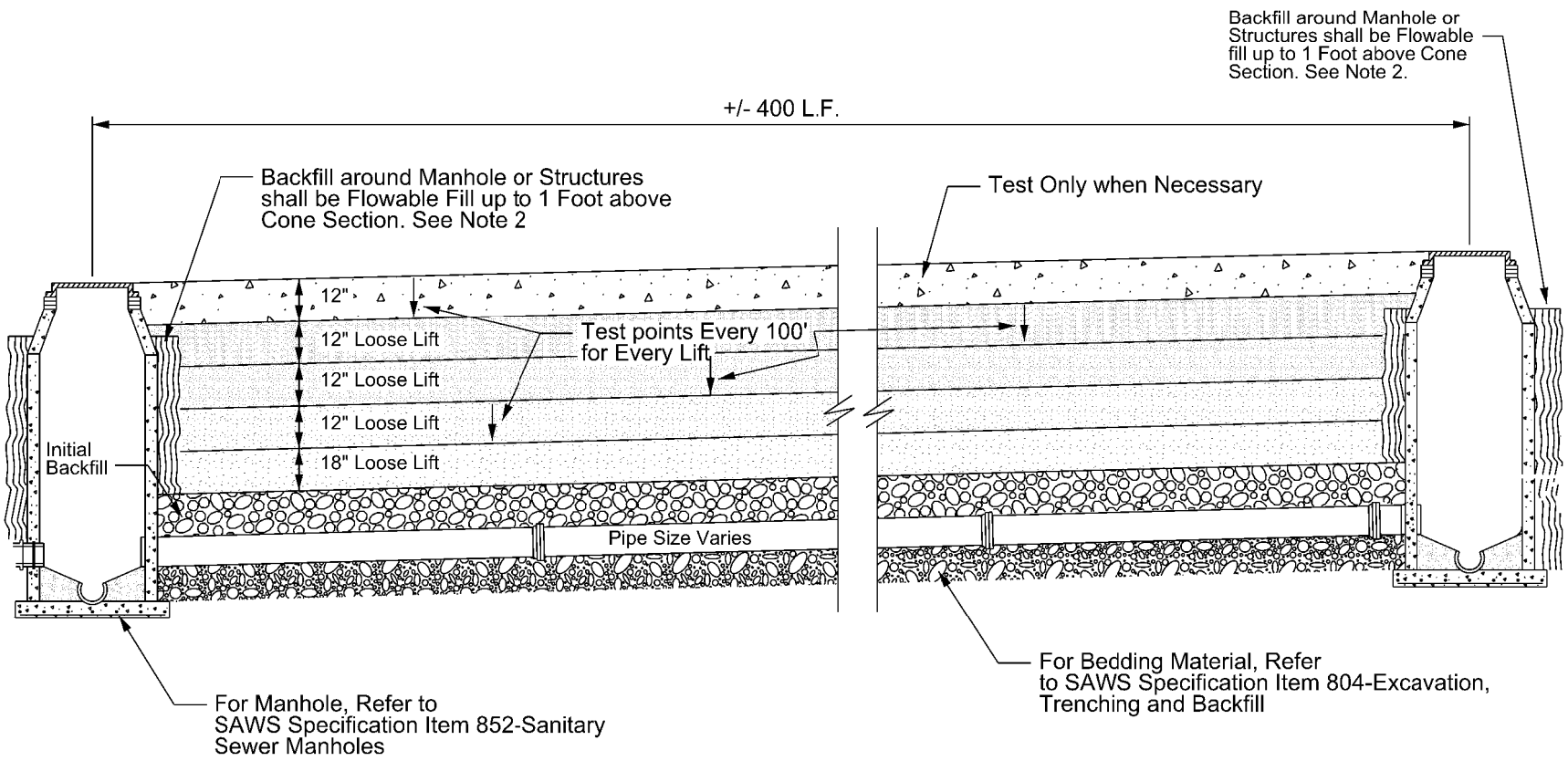
* Sewer Gravel 6" Min. or ⅛ O.D. of the Pipe, whichever is greater.
** Minimum 2" HMAC Type "D" for Trench Repair in Local/Residential Streets.
** Minimum 3" HMAC Type "C" for Trench Repair in Collector/Arterial Streets.

- Hot Mix Asphalt Concrete (HMAC)
- Asphalt Treated Base (A.T.B.)

PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	SANITARY SEWER PIPE LAID IN TRENCH	APPROVED MARCH 2008	REVISED AUG 2019
		DD-804-01	SHEET 1 OF 1

PROPERTY OF
SAN ANTONIO WATER SYSTEM
SAN ANTONIO, TEXAS

TRENCH COMPACTION DETAIL



NOTES:
1. The Compaction Report will indicate the Station and the Depth of each Test Point.
2. When Contractor opts to backfill, all work will be subject to sections 804.3 and 804.4 of this specification
3. Insure Compaction Probe Penetrates to same Depth as Lift.

APPROVED
MARCH 2018

REVISED
AUG 2019

DD 804-02

SHEET 1 OF 1

ITEM NO. 812

Water Main Installation

812.1 DESCRIPTION: This item shall consist of water main installation in accordance with these specifications and as directed by the Engineer.

812.2 REFERENCE STANDARDS: Reference standards cited in this Specification Item No. 812 refer to the current reference standard published at the time of the latest logged revision date.

1. San Antonio Water System (SAWS):
   a. Specifications for Water and Sanitary Sewer Construction
   b. SAWS Materials Specifications
2. City Of San Antonio (COSA) Standard Specifications for Construction
3. Texas Commission of Environmental Quality (TCEQ) Chapter 290 Public Water Supply
4. American National Standrads Institute (ANSI)/American Water Works Association (AWWA)
   a. ANSI A 21.11/AWWA C111 - Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   b. ANSI/NSF Standard 61 - Drinking Water System - Health Components.
   c. ANSI/AWWA C151/A21.51—Ductile-Iron Pipe, Centrifugally Cast.
   d. ANSI/AWWA C515—Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service (5.5 lb) Rammon and a 305 mm (12 in.) Drop.
   e. ANSI†/AWWA C105/A21.5—Polyethylene Encasement for Ductile-Iron
   f. Pipe Systems.
   g. ANSI/AWWA C111/A21.11—Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   h. ANSI/AWWA C150/A21.50—Thickness Design of Ductile-Iron Pipe.
   i. ANSI/AWWA C500—Metal-Seated Gate Valves for Water Supply Service.
   j. ANSI/AWWA C509—Resilient-Seated Gate Valves for Water Supply Service.
   k. ANSI/AWWA C651—Disinfecting Water Mains.
5. American Society for Testing and Materials (ASTM) International:
   a. ASTM A 36 - Standard Specification for Carbon Structural Steel.
   b. ASTM A 536 - Standard Specification for Ductile Iron Castings.
   c. ASTM A 126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
   d. ASTM B 21 - Standard Specification for Naval Brass Rod, Bar, and Shapes.
   e. ASTM B 98 - Standard Specification for Copper-Silicon Alloy Rod, Bar, and Shapes.

f. ASTM B 301 - Standard Specification for Free-Cutting Copper Rod and Bar.
g. ASTM B 584 - Standard Specification for Copper Alloy Sand Casting for General Application.
h. ASTM E 165 - Standard Test Method for Liquid Penetrant Examination.
i. ASTM E 709 - Standard Guide for Magnetic Particle Examination.
j. ASTM F 1674 - Standard Test Method for Joint Restraint Products for Use with PVC Pipe.
k. ASTM D2241, "Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR PR Series)"

6. American Water Works Association (AWWA)
   a. AWWA C 206 - Standard for Field Welding of Steel Water Pipe.
   b. AWWA C 207 - Standard for Steel Pipe Flanges for Waterworks Service - Sizes 4 Inches through 144 Inches.
   c. AWWA C605, "Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water
   d. AWWA C651-05 Disinfecting Water Mains
   e. AWWA C900, "Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 in. through 60in. (100 mm through mm) for Water Distribution"
   f. AWWA C907, "Polyvinyl Chloride (PVC) Pressure Fittings for Water –4 in. through 8 In (100 mm Through 200 mm)
   g. AWWA Manual M27, External Corrosion: Introduction to Chemistry and Control
   h. AWWA M28 Rehabilitation of Water MainsAWWA Manual M41— Ductile-Iron Pipe and Fittings.
   i. AWWA Manual M17, Installation, Field Testing, and Maintenance of Fire Hydrants.
7. International Organization of Standardization (ISO)
   a. ISO9001

812.3 SUBMITTALS: All submittals shall be in accordance with most recent version of SAWS's General Conditions requirements. Submit the following prior to performing any work.

1. Certifications:
   a. Per General Conditions section 5.12.2 all Contractor submittals for all pipe and other products or materials furnished under this specification shall be marked as reviewed and approved by Contractor for compliance with Contract Documents and the referenced standards.
   b. The Manufacturer shall provide ISO 9001 Certificate by a third party.
   c. Submit written verification that the pipe Manufacturer has been manufacturing pipe per required ASTM with similar design pressure and size as this Project.
   d. Submit written verification from the pipe Manufacturer demonstrating compliance with the production and delivery schedule of the pipe as

indicated in the Contractor's schedule.

e. Submit written verification from mechanical fitting Manufacturer that fittings are compatible with proposed pipe and meets the requirements of this section.

2. Contractor shall submit Manufacturer's product data, installation recommendations, allowable deflection, shop drawings, and certifications.

3. Shop Drawings:

   a. Catalog Data Sheets for all materials confirming pipe, fittings, and other materials conform to requirements of this specification.

   b. Pipe Supplier Information. Submit company name, contact name, and contact number.

   c. Details of all piping systems components confirming that the pipe and fittings conform to the specified requirements.

   d. The Contractor shall submit shop drawings of pipe, fittings, gaskets, hardware, flanges, appurtenances, special details sufficient to demonstrate compliance with these Specifications and applicable pipe installation Specification.

   e. Fabrication drawings showing:

      1) Wall thickness.

      2) Pipe length.

      3) Pipe joint (i.e. mechanical, flanged. fused)

4. Testing Plan: Submit at least prior to start of construction and at minimum, include the following:

   a. Testing dates.

   b. Piping systems and section(s) to be tested.

   c. Method of isolation. Method of isolation to be approved by SAWS Inspector.
   Method of conveying water from source to system being tested.

   d. Hydrostatic leak testing.

      i. Submit a hydrostatic leak testing plan which includes equipment (pump, water meter, pressure regulating valve, pressure gauges, etc.), water handling procedures (supply and disposal), sequence and schedule by test section, and pressure test data

      ii. Certifications of Calibration: Approved testing laboratory certificate if pressure gauge for hydrostatic test has been previously used. If pressure gauge is new, no certificate is required.

5. Testing Reports:

   a. Furnish affidavit certified that all pipe meet the provisions of the specification and has been tested and submit reports in accordance with the applicable ASTMs and AWWA Standards. Reports to include the following:

i. Hydrostatic proof test reports.
ii. Sustained pressure test reports.
iii. Burst strength test reports.
iv. Stress Regression Testing
v. Additional reports may be requested by SAWS Inspector

6. Fusion information as required by Specification Item No. 815 HDPE Installation.
7. The Contractor shall also submit details of welding/fusing procedures and equipment to be used.
8. Detail drawings indicating type, number, and other pertinent details of the slings and/or other methods proposed for pipe support and handling during manufacturing, transport, and installation. All pipe handling equipment and methods shall be acceptable to Owner.
9. Pipe Manufacturer's Written Quality Assurance/Quality Control Program.
10. Field Service Representative Resume.

812.4 MATERIALS: The materials for water main installation shall conform to the specifications contained within the latest revision of SAWS Material Specifications:

1. Material Specification Item No. 113-03: Specifications Ductile-Iron Restrained Joint Fittings for Use on Ductile Iron and Poly-Vinyl Chloride Pipe
2. Material Specification Item No. 05-11: Specifications Ductile Iron Pipe
3. Material Specification Item No. 05-12: Specifications for C-900 Polyvinyl Chloride (PVC) Pressure Pipe, 4-inch Through 12-Inch
4. Material Specification Item No. 05-13: Specifications for C909 Oriented Polyvinyl Chloride (PVC) Pressure Pipe, 4-Inch Through 12-Inch
5. Material Specification Item No. 05-20: Specifications for Prestressed Concrete Pressure Pipe Steel Cylinder Type
6. Material Specification Item No. 05-30: Specifications for Steel Water Pipe Specification Item No. 815: Specifications for High Density Polyethylene Pipe
7. The pressure rating for pipe materials apply to any work performed in SAWS Pressure Zones. Minimum pressure rating for all pipes shall be 235 psi, or as identified in plans and bid documents.
8. PVC water pipe shall be blue in color. **White PVC pipe is not permitted.**
9. PVC Water pipe sizes greater than 24" shall not be allowed. PVC pipe markings shall include:
   a. Manufacturer's name or trademark;
   b. Standard to which it conforms;
   c. Pipe size;
   d. Material designation code;
   e. Pressure rating;
   f. SDR number or schedule number;

g. Potable water laboratory seal or mark attesting to suitability for potable water;
h. A certifier's mark may be added; and
i. Manufactured date (installation shall not exceed one year from this date)

812.5 CONSTRUCTION:

1. The Contractor shall start his work near a tie-in or point designated by the Inspector.
2. Pipe shall be laid with bell ends facing in the direction of pipe laying, unless otherwise authorized or directed by the Inspector.
3. All valves and fire hydrants must be installed as soon as pipe laying reaches their established location.
4. All pipe shall be installed to the required lines and grades with fittings, valves, and hydrants placed at the required locations.
5. Spigots shall be centered in bells or collars, all valves and hydrant stems shall be set plumb, and fire hydrant nozzles shall face as per SAWS standard details..
6. No valve or other control on the existing system shall be operated for any purpose by the Contractor unless a representative of SAWS is present.
7. New water mains crossing any other utility shall have a minimum of 5 feet of cover over the top of the pipe, unless otherwise waived or modified by the Engineer.
8. Excavation around other utilities shall be done by hand for at least 12 inches all around.
9. Any remedial measures for damages will be at Contractors expense.
10. Any damage to the protective wrap on gas lines or electrodes shall be reported immediately to the CPS Energy, phone (210) 353-4357.
11. Any damage to other utilities shall be reported to their proper governing entity.
12. In any case of utility damage, the Contractor shall also promptly notify the Inspector.
13. Any remedial measures for damages will be at Contractor's expense.
14. New waterline installation and separation shall comply with TCEQ Chapter 290; Subchapter D – Rules and Regulations for Public Drinking Water criteria for the location and installation of waterlines. See Drawings series DD-812.
15. All separation distances shall be measured from the outside surfaces of each of the respective pieces.
16. The bedding and backfill of the existing wastewater mains or laterals shall not be disturbed.
17. All water mains shall have a minimum of 5 feet of cover from the proposed final finish ground/street/elevation unless otherwise adjusted by the Engineer.
18. Pipe grades shall be as required by the contract documents or as directed by the Engineer.
19. Precaution shall be taken to ensure that the pipe barrel has uniform contact with the cushion material for its full length except at couplings.
20. The couplings shall not be in contact with the original trench bottom prior to

backfilling.

21. Cushion material shall be placed under the coupling and compacted by hand prior to backfilling so as to provide an even bearing surface under the coupling and pipe.
22. Prior to placing pipe in a trench, the trench shall have been excavated to the proper depth as required in plans and Specification Item No. 804 "Excavation, Trenching, and Backfilling."
23. Approved imported materials or Engineer-approved native materials, as per Specification Item No. 804 "Excavation, Trenching, and Backfilling," shall be smoothly worked across the entire width of the trench bottom to provide a supporting cushion.
24. When either the Inspector or Engineer note that the material at the bottom of a trench is unstable or unsuitable, it shall be removed and replaced with approved material which may be properly compacted in place to support the pipe. See Specification Item No. 804 "Excavation, Trenching, and Backfilling,"
25. If required the Contractor shall also construct a foundation for the pipe consisting of piling, concrete beams, or other supports in accordance with contract documents prepared by the Engineer.
26. Proper implements, tools, and facilities satisfactory to the Inspector shall be provided and used by the Contractor for the safe and convenient completion of work.
27. All pipe, fittings, valves, and hydrants shall be carefully lowered into the trench piece by piece, by means of a derrick, ropes, or other suitable tools or equipment in such a manner as to prevent damage to water main materials and protective coatings, polywrap sleeving, and linings.
28. Under no circumstances shall water main materials, pipes, fittings, etc., be dropped or dumped into the trench.
29. Extreme care shall be taken to avoid damaging polywrap films. No chains or slings shall be allowed unless the entire sling is wrapped with a protective nylon web sock.
30. To prevent pipe damage, proper implements, tools, and equipment should be used for placement of the pipe in the trench; pipe and/or accessories should never be dropped into the trench.
31. After placing a length of pipe in the trench, the jointed end shall be centered on the pipe already in place, forced into place, brought to correct line and grade, and completed in accordance with requirements.
32. The pipe shall be secured in place with approved initial backfill material tamped around it.
33. Precautions shall be taken to prevent dirt or other foreign matter from entering the joint space.
    a. Under adverse trenching conditions, work stoppage for more than 24 hours and/or as otherwise required by the Inspector, a manufactured water tight cap/plug is to be used at each end to prevent any foreign type material entering the pipe and to make the pipe watertight.

b. This provision shall apply during all periods when pipe laying is not in progress.
c. Should water enter the trench, the seal shall remain in place until the trench is pumped completely dry.
d. The Contractor shall provide all plugs and caps of the various sizes required.
e. The cap/plug shall be left in place until the pipe is connected to an adjacent pipe.
f. The interior of each pipe shall be inspected for foreign material or defects, and the pipe shall be cleaned or rejected if any defects are found.

34. Deviations in Alignment
a. Wherever obstructions not shown in the contract documents, to include changes in depth and/or alignment, are encountered during the progress of the work and interfere to an extent that an alteration in the plan is required, the Engineer shall have the authority to change the contract documents and direct a deviation from the alignment or to arrange with the owners of the structures for the removal, relocation, or reconstruction of the obstructions.
b. Any deviation from the alignment shall be accomplished by the use of appropriate bends unless such requirement is specifically waived by the Engineer.
c. These deviations shall clearly and accurately be reflected in the Contractor's submittal of their redline drawings for permanent recording purposes.
d. Whenever it is necessary to deflect pipe from a straight line, the deflection shall be as directed by the Engineer.
e. In no case shall the amounts shown in Table 1, Maximum Deflections of Ductile Iron Pipe, or Table 2, Maximum Deflections of Concrete Steel Cylinder Pipe, or as per manufacture's recommendation for pipe deflection be exceeded.
f. If deflection is exceeded, bends must be incorporated.
g. Deflection of PVC (C-900, and C-909) shall be limited to 1 degree of the manufacturers recommended deflection as noted in specification 818 Water Pipe Installation PVC (C-900, and C-909) Pipe 4 inch to 24 in Pipe
   i. Changes in direction of PVC pipe shall only be use of fittings or by deflecting straight pipe sections at joints.
   ii. Longitudinal bending of pipe is not allowed
   iii. Deflection of pipe fittings is not allowed
   iv. Deflection of straight pipe sections shall not exceed 1 degree at each joint (even if joint restraint devices are installed), which corresponds to the following in pipe alignment:
      1) Length of pipe, feet offset, inches allowable radius of cuvarture, feet 204 maxium, feet 1,1146 minimum

TABLE 1					
MAXIMUM DEFLECTIONS OF DUCTILE-IRON					
Nominal Pipe Diameter	**Maximum Deflection Angle**	**Maximum Deflection In Inches**		**Approximate Radius Of Curve In Inches**	
		18 Ft.	**20 Ft.**	**18 Ft.**	**20 Ft.**
6"	4°25'	16.7	18.5	234	260
8"	3°51'	14.6	16.2	268	297
10"	3°42'	14.0	15.5	279	310
12"	3°08'	11.9	13.2	327	363
16"	2°21'	8.8	9.7	440	488
20"	1°55'	7.2	8.0	540	600
24”	1°35'	6.0	6.7	648	720

TABLE 2					
MAXIMUM DEFLECTIONS OF CONCRETE STEEL CYLINDER					
Nominal Pipe Diameter	**Maximum Deflection Angle**	**Maximum Deflection In Inches**		**Approximate Radius Of Curve In Inches**	
		16 Ft.	**20 Ft.**	**16 Ft.**	**20 Ft.**
16"	2°20'	--	9.8	--	500
20"	1°52'	--	7.8	--	600
24"	1°34'	--	6.6	--	750
30"	1°16'	--	5.3	--	900
36"	1°02'	--	4.3	--	1100
42"	0°54'	--	3.8	--	1300
48"	0°47'	2.6	--	1170	--
54"	0°44'	2.5	----	1237	--
60"	0°54'	3.0		1024	-

35. Cutting Pipe:
    a. The cutting of pipe for inserting valves, fittings, or closure pieces shall be accomplished in a neat and workmanlike manner so as to produce a smooth end at right angles to the axis of the pipe.
    b. The recommendations of the pipe manufacturer shall be strictly followed by the Contractor.
    c. Only qualified and experienced workmen shall be allowed to cut pipe and, under no circumstances, shall a workman not equipped with proper safety goggles, helmet and all other required safety attire be permitted to engage in this work.
    d. All cuts made on ductile-iron pipe shall be done with a power saw.
        i. The cuts shall be made at right angles to the pipe axis and shall

be smooth.

ii. The edges of the cut shall be finished smoothly with a hand or machine tool to remove all rough edges.

iii. The outside edge of pipe should be finished with a small taper at an angle of about 30 degrees.

iv. Solid sleeves or cast couplings shall be allowed on precast/prefab vaults only.

v. All fire line services shall be installed with full joints of pipe.

e. **Tapping of CSC pipe is only allowed by CSC Manufacturer of pipe brand being tapped or CSC Manufacturer approved by SAWS. See Specification Item No. 820 Concrete Steel Cyclinder Pipe Installation.**

f. To facilitate future repair work on water mains, no sections less than 3 feet in length between fittings shall be allowed.

g. Asbestos Cement (AC): No field cutting, breaking, or crushing will be allowed on AC pipe.

i. Repairs to AC pipe shall be accomplished by removing one full joint of AC pipe and replacing with appropriate PVC, Ductile Iron pipe, CSC, or HDPE pipe and fittings.

ii. All work associated with removing and disposing of AC pipe shall conform to the provisions of Item No. 3000, "Handling of Asbestos Cement Pipe."

36. Joint Assembly:

b. Rubber Gasketed Joints: The installation of pipe and the assembly of rubber gasketed joints for ductile iron pipe, PVC, HDPE, CSC pipe shall conform to the pipe manufacturer's assembly instructions.

c. The method of inserting spigot ends of pipe in bells or collars known as "stabbing" shall not be permitted with pipe larger than 6 inches in size.

d. Spigot ends of pipe larger than 6 inches in size must be properly inserted in the joint by means of suitable pushing/pulling devices or an approved manufacture's method.

e. PVC spigot ends shall be pushed in until the lip of the bell is between the reference marks on the spigot end.

i. If the spigot is inserted beyond the insertion point, the pipe will have to be pulled out and reinserted.

ii. Pipe should be inspected to ensure pipe has not been damaged prior to reinsertion.

iii. Any damaged pipe shall be replaced at Contractors expense.

f. Mechanical couplings shall be assembled and installed according to the standards recommended by the manufacturer.

i. Prior to the installation of the mechanical coupling, the pipe ends shall be cleaned by wire brush or other acceptable method to provide a smooth bearing surface for the rubber compression gasket.

ii. The pipe shall be marked to align the end of the coupling which will center it over the joint.

iii. After positioning, the nuts shall be drawn up finger tight.
iv. Uniform pressure on the gaskets shall be applied by tightening alternate bolts on the opposite side of the circle in incremental amounts.
v. Final tensioning shall be accomplished with a torque wrench and in a manner similar to the tightening procedure.
vi. Final torque check shall then be made prior to coating and wrapping the joint.
vii. Refer to manufacturer's recommendations for proper torque.

g. Restraint Joints shall be installed as shown on the contract documents or as directed by the Engineer.
   a. Installation shall conform to the manufacturer's recommendation.
   b. Refer to Specification Item No. 839 Anchorage/Thrust Blocking and Joint Restraints.

37. Abandonment/Removal of Existing Mains:
   a. The Contractor shall accomplish all cutting, capping, plugging, and blocking necessary to isolate existing mains retained in service from abandoned mains.
   b. The open ends of abandoned mains and all other openings or holes in such mains occasioned by cutting or removal of outlets shall be blocked off by pressure forcing cement grout or concrete into and around the openings in sufficient quantity to provide a permanent substantially watertight seal.
   c. Abandonment of existing water mains will be considered subsidiary to the work required, and no direct payment will be made.
   d. Capping or plugging of main is prefered over grouting. For mains 12'' and larger, under major thoroughfare or highways, grouting will be required.
   e. When specified or shown otherwise in the contract documents, Contractor shall remove the main and all related appurtenances that are to replaced, or will no longer be in service, and all effort to accomplish this requirement will be considered subsidiary to the work required, and no direct payment will be made.
   f. Removed AC pipe shall be manifested and disposed of in accordance with Item No. 3000, "Handling Asbestos Cement Pipe."

38. Valves abandoned in the execution of the work shall have the valve box and extension removed in its entirety and filled with flowable fill to within 12" inches of the surface.
   a. The remaining 12" inches shall be filled with required asphaltic pavement or top soil and sod and finished flush with the adjacent pavement or ground surface as required (N.S.P.I.).

39. At no time during the project work shall any valves be covered or rendered inaccessible for operation due to any activities by the Contractor.

40. Any work during construction activities will be suspended until this requirement is met. No claims for cost or schedule delays will be accepted.

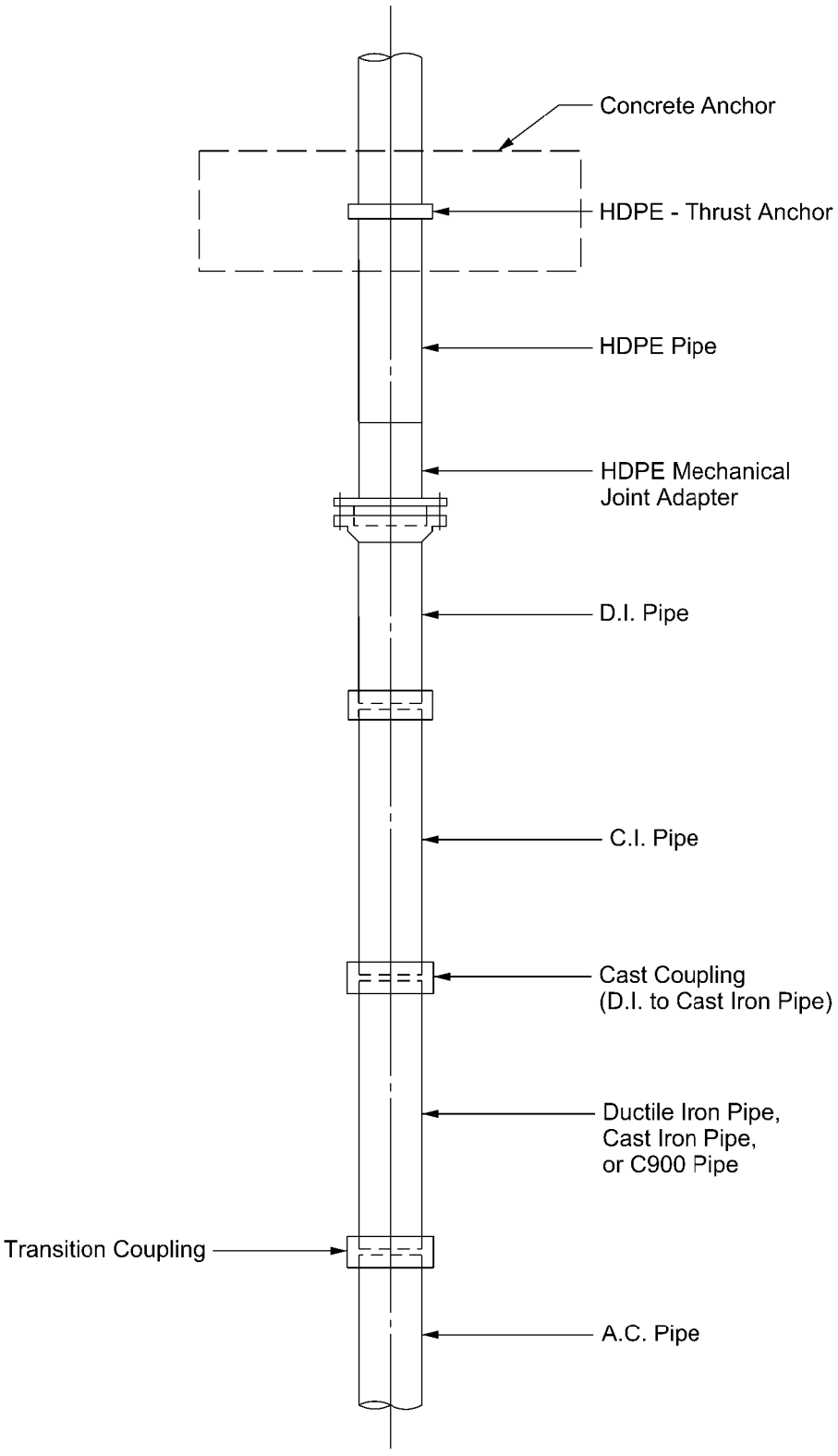
812.6 MEASUREMENT:

1. Water main installed will be measured by the linear foot for each size and type as follows:
   a. Measurements will be from the center line intersection of runs and branches of tees to the end of the valve of a dead end run.
   b. Measurements will also be between the center line intersection of runs and branches of tees.
   c. Where the branch is plugged for future connection, the measurement will include the entire laying length of the branch or branches of the fitting.
   d. The measurement of each line of pipe of each size will be continuous and shall include the full laying lengths of all fittings and valves installed between the end of such line except that the laying length of reducers will be divided equally between the connected pipe sizes.
   e. Lines leading to a tapping connection with an existing main will be measured to the center of the tapped main.

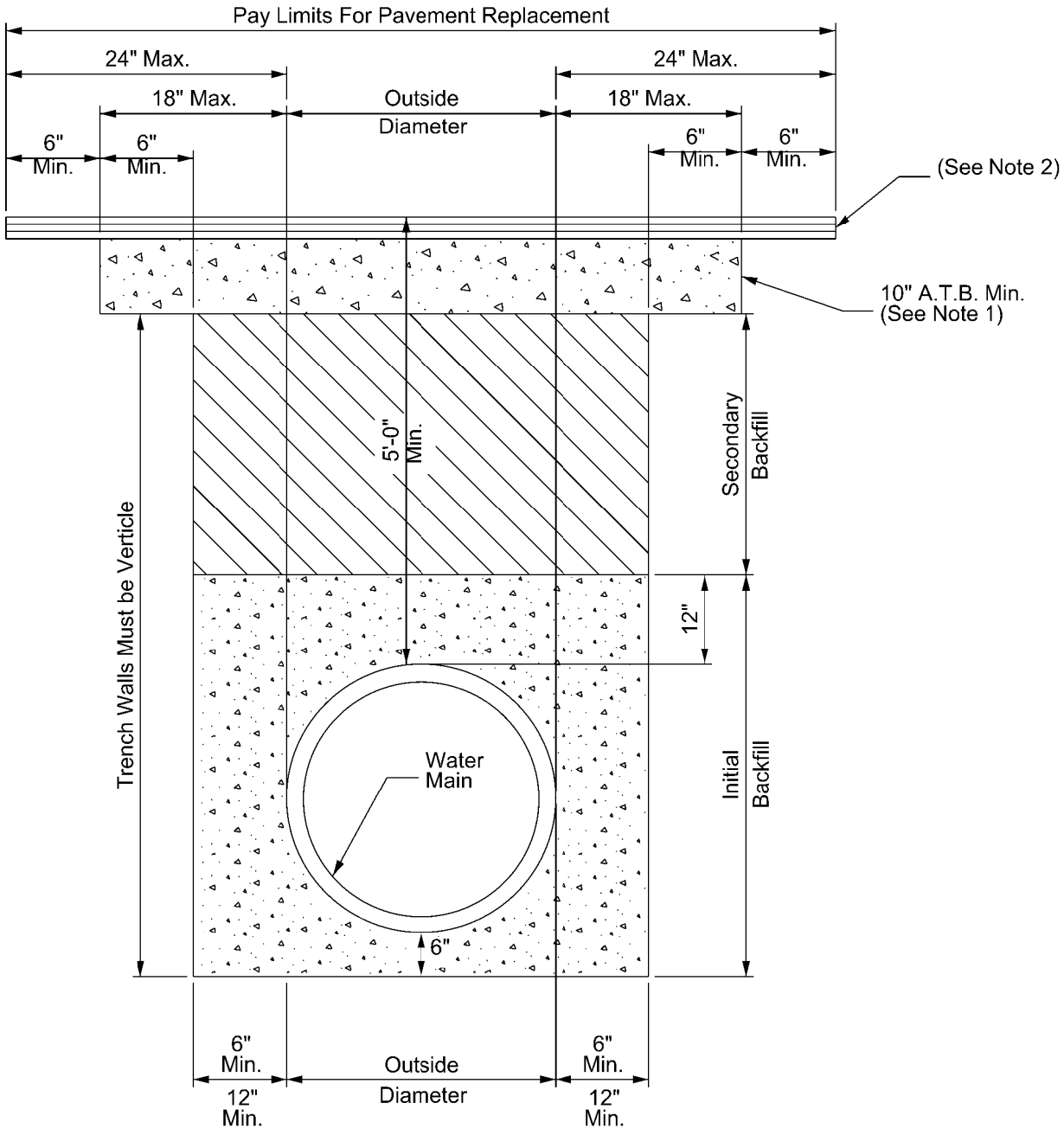
812.7 PAYMENT: Payment for water main installed will be made at the unit price bid per linear foot of pipe of the various sizes installed by the open cut method.

1. Such payment shall also include excavation, concrete encasement, pipe encasement, spacers, grout, selected embedment material, backfill, compaction, compaction testing, polyethylene sleeve, fittings, adapters, couplings, anchors, cathodic protection if required, tracer wire and detection tape if required, hauling and disposition of surplus excavated material, including all existing pipe, fittings, appurtenances to be abandoned or removed, installation of all weather surface, and other required testing as per Specification Item No. 804, "Excavation, Trenching, and Backfilling,"
2. Materials paid on site will be in accordance with Table 1 of Specification Item No. 100 Mobilization.

-End of Specification-



PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	PIPE COUPLINGS	APPROVED MARCH 2008	REVISED AUG 2019
		DD-812-01	SHEET 1 OF 9



1. Asphalt Treated Base - As Specified COSA ROW - 10" Min. or Greater.

2. Replacement of Surface Layer Shall be of the Type and Thickness Base On Functional Classification.
   a. Min 2" HMAC Type "D" for Trench Repair in Local / Residential Streets.
   b. Min. 3" HMAC Type "C" for Trench Repair in Collector / Arterial Streets.

- Asphalt Treated Base (ATB)
- Hot Mix Asphalt Concrete (HMAC)

PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	POTABLE AND RECYCLED WATER MAIN DETAIL	APPROVED MARCH 2008	REVISED AUG 2019
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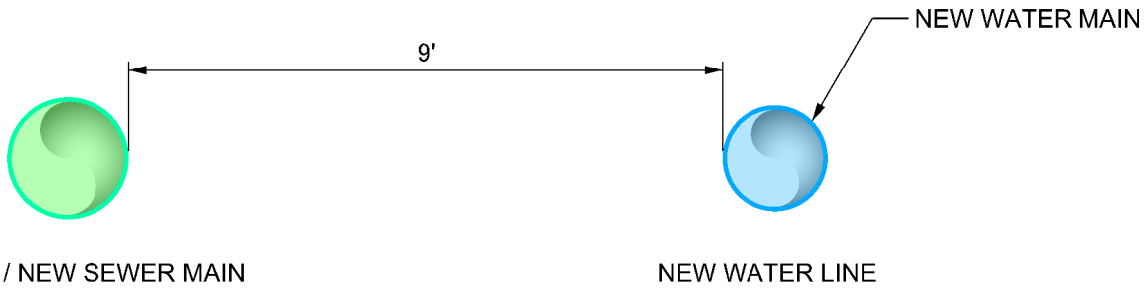
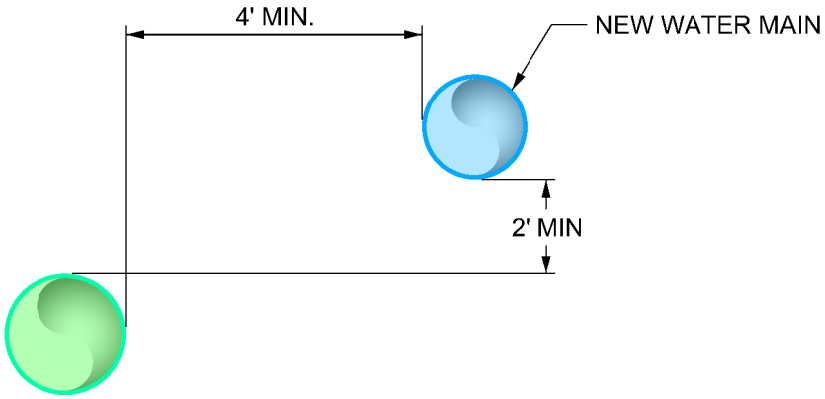
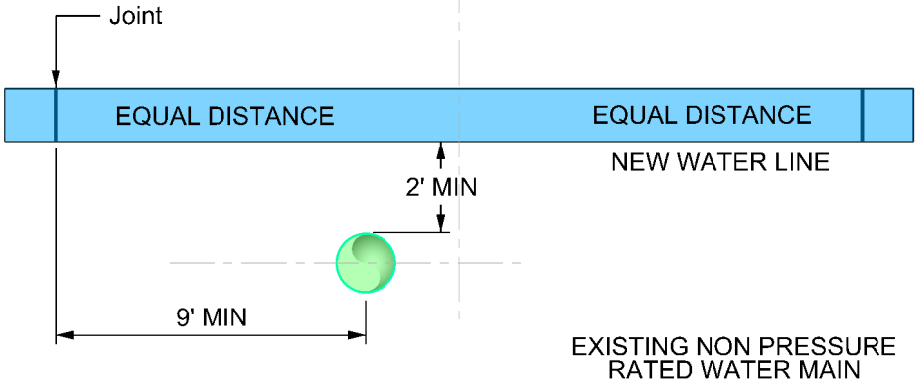
EXISTING / NEW WATER LINES CONSTRUCTED
LOCATION OF WATER LINES

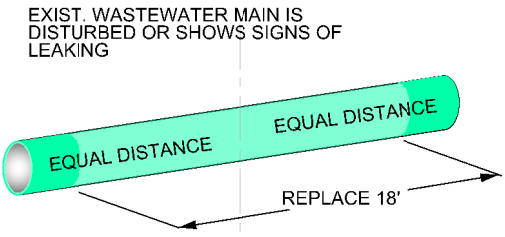


Where the nine foot separation distance can not be achieved, the following criteria shall apply: LOCATION OF WATER LINES - PARRALLEL LINE



NEW WATER LINE CROSSES AN EXISTING NON-PRESSURE RATED WASTEWATER MAIN: NEW WATERLINE INSTALLATION - CROSSING LINES





PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	WATER LINES	APPROVED MARCH 2008	REVISED AUG 2019
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PROPERTY OF
SAN ANTONIO WATER SYSTEM
SAN ANTONIO, TEXAS

DETAIL

DD 812-01

APPROVED
MARCH 2018

REVISED
AUG 2019

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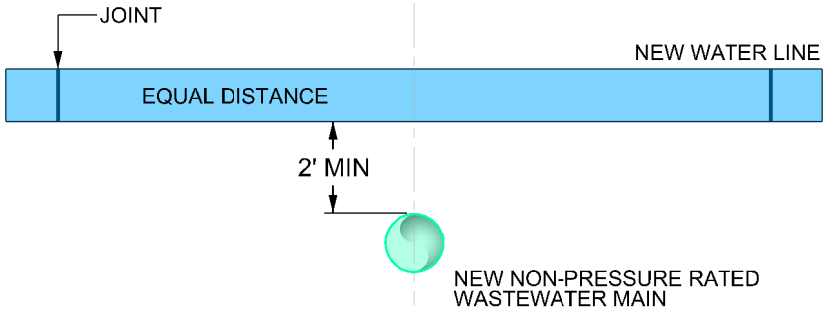
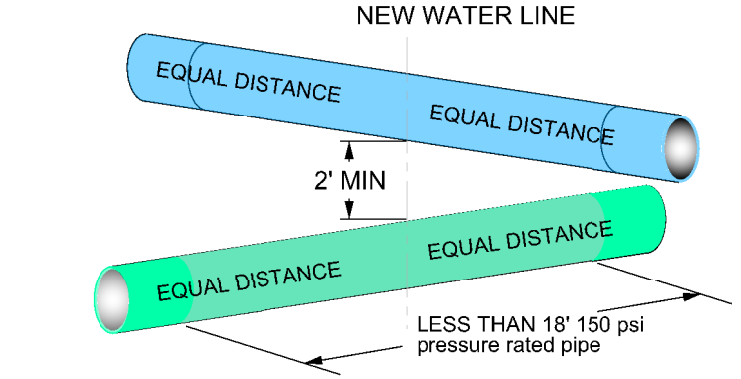
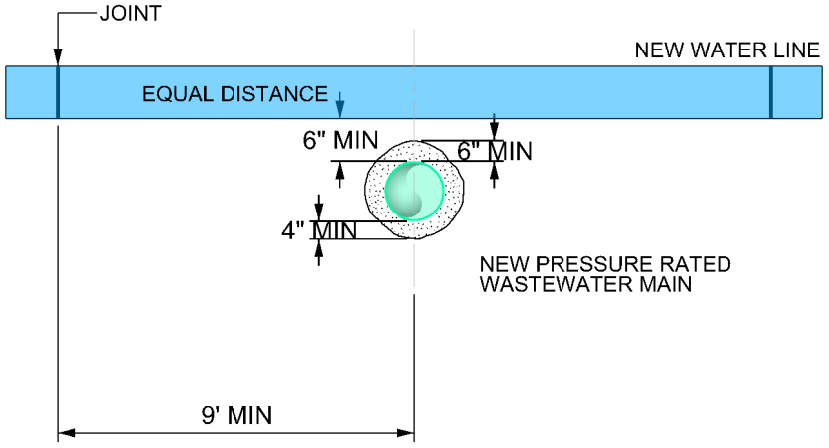
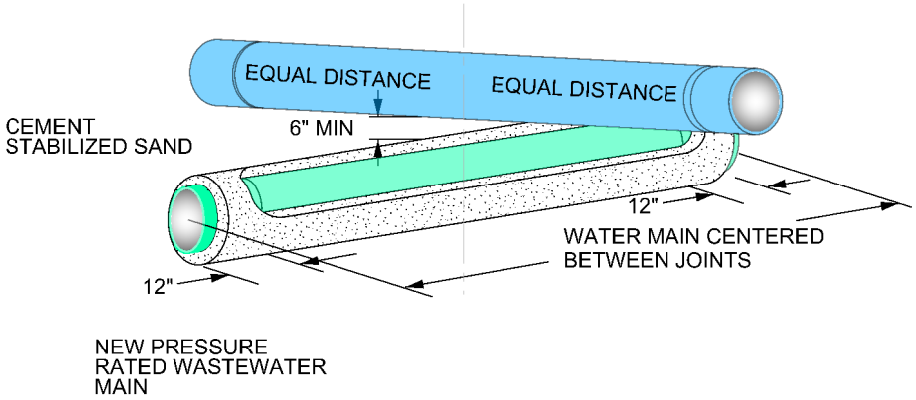
NEW WATER LINE CROSSES AN EXISTING PRESSURE RATED WASTEWATER MAIN
LOCATION OF WATER LINES - CROSSING LINES





NEW WATERLINE CROSSES A NEW PRESSURE RATED WASTEWATER MAIN
LOCATION OF WATER LINES - CROSSING LINES





PROPERTY OF
SAN ANTONIO WATER SYSTEM
SAN ANTONIO, TEXAS

DETAIL

APPROVED MARCH 2008
REVISED AUG 2019

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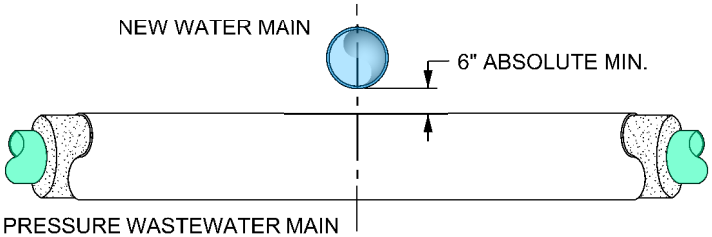
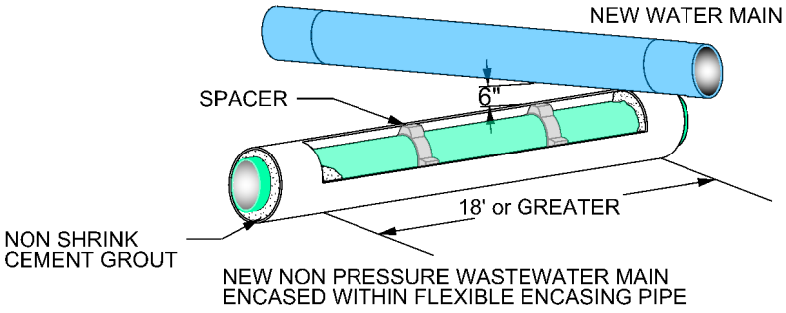
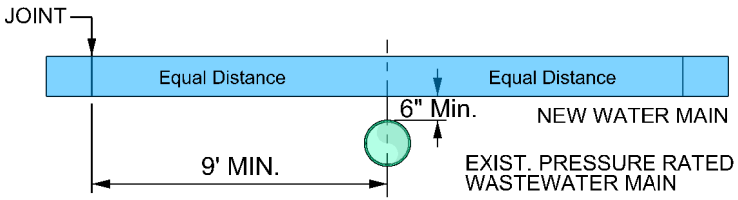
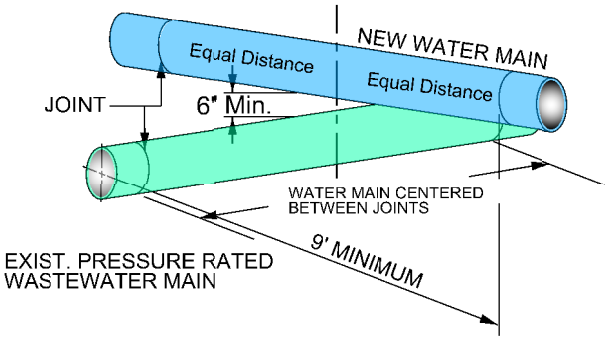
NEW WATER LINE CROSSES A NEW NON PRESSURE RATED WASTEWATER MAIN
LOCATION OF WATER LINES - CROSSING LINES



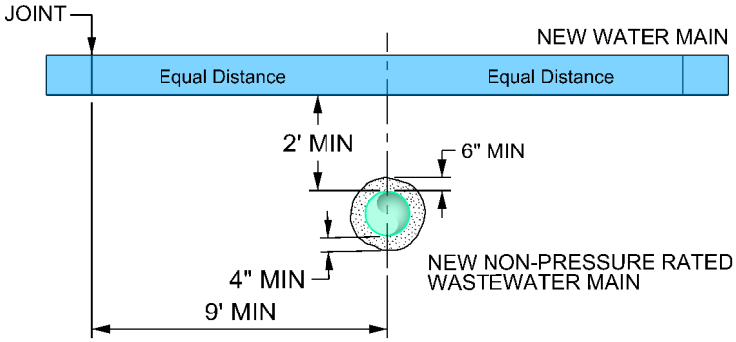


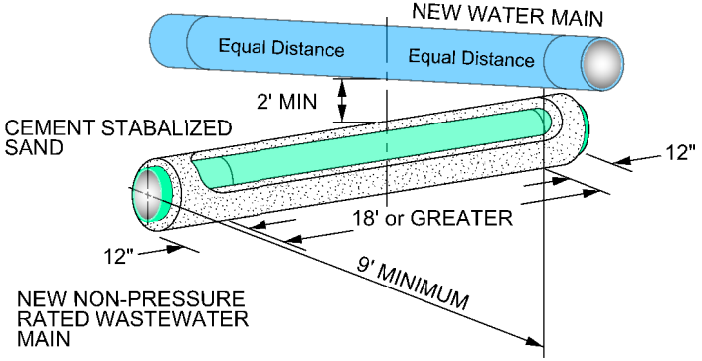
LOCATION OF WATER LINES - CROSSING LINES

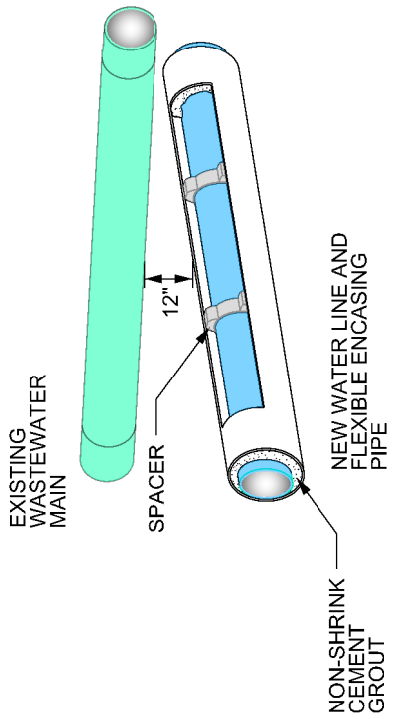




NEW WATER LINE CROSSES A NEW NON-PRESSURE RATED WASTEWATER MAIN

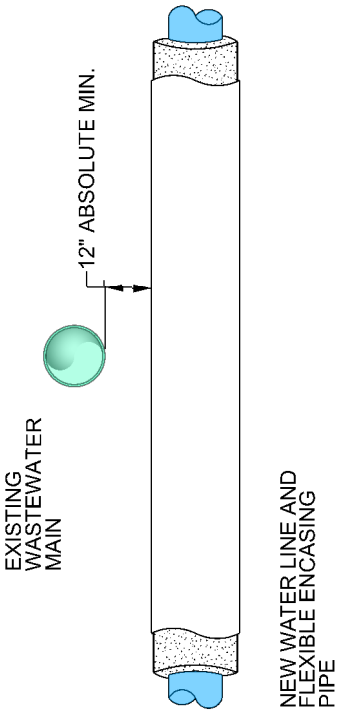






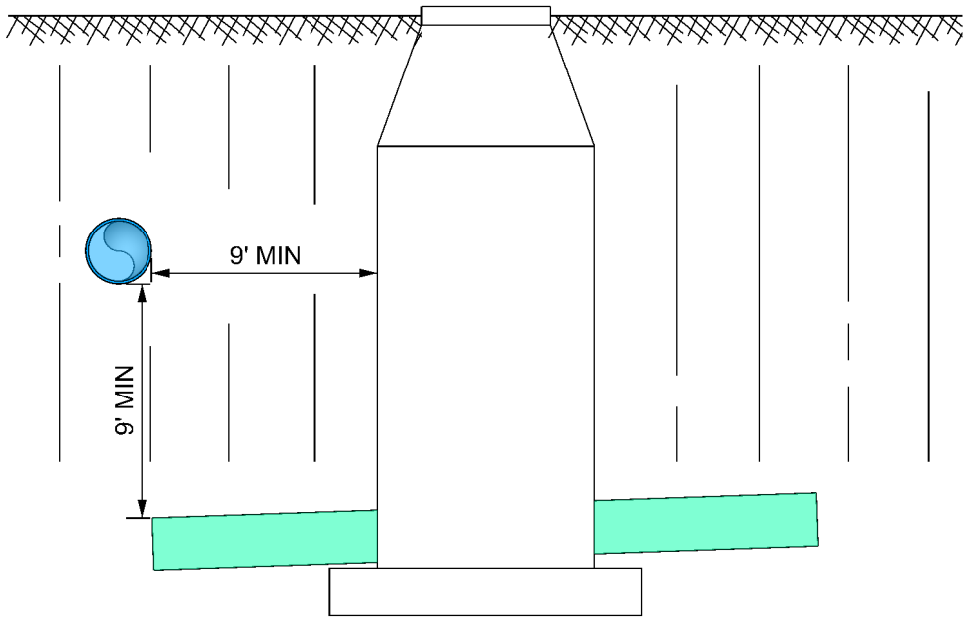
NEW WATER LINE CROSSES UNDER A WASTEWATER MAIN

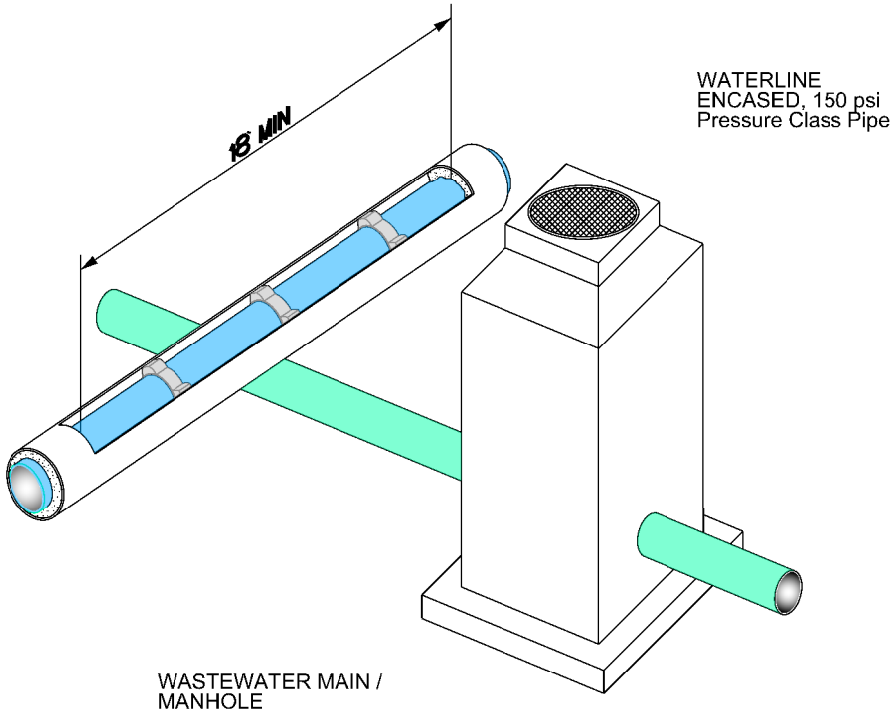
LOCATION OF WATER LINES - CROSSING LINES



PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	DETAIL	APPROVED MAY 2013	REVISED AUG 2019
		DD-812-01	SHEET 6 OF 9

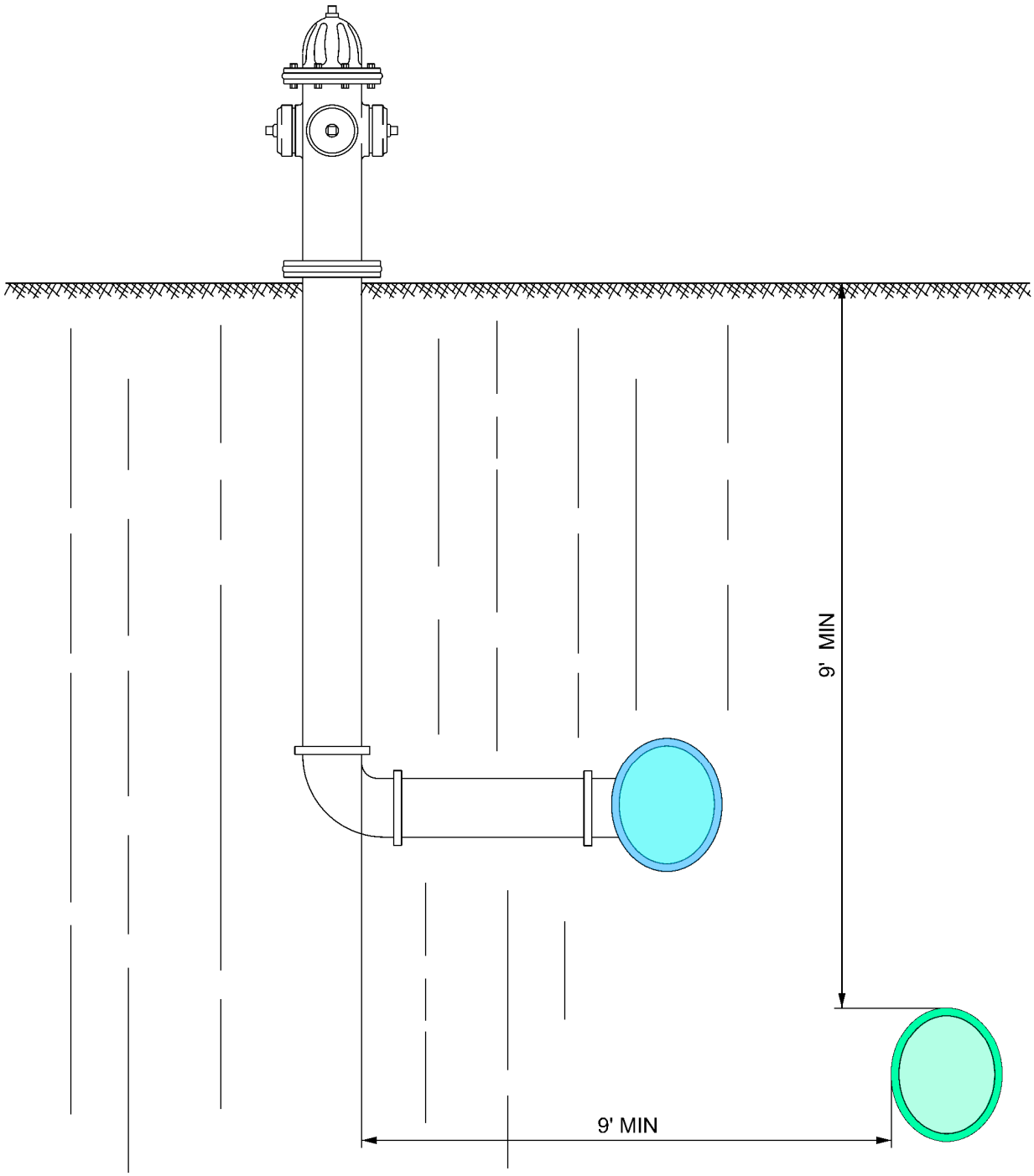
WATERLINE AND WASTEWATER MAIN OR LATERAL MANHOLE OR CLEANOUT SEPARATION
CLEANOUT SEPARATION





PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	CLEANOUT SEPARATION	APPROVED MAY 2013	REVISED AUG 2019
		DD-812-01	SHEET 7 OF 9

WATERLINE AND WASTEWATER MAIN OR LATERAL MANHOLE OR CLEANOUT SEPARATION
LOCATION OF FIRE HYDRANTS



PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	FIRE HYDRANT WITH MAIN GREATER THAN 6 FOOT DEPTH	APPROVED	REVISED AUG 2019
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PROPERTY OF
SAN ANTONIO WATER SYSTEM
SAN ANTONIO, TEXAS

SANITARY SEWER
RELIEF LINE

APPROVED

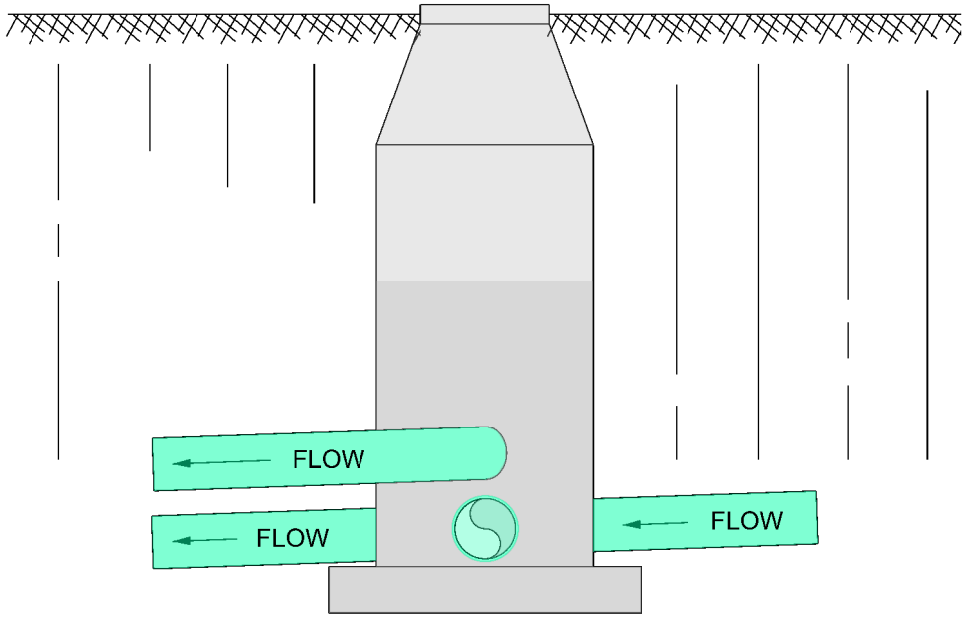
REVISED
AUG 2019

DD-812-01

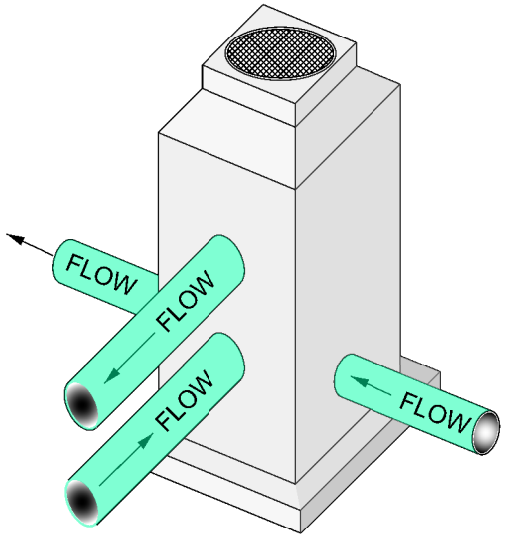
SHEET 9 OF 9

SANITARY SEWER RELIEF LINE

RELIEF SEWERS - AN OVERLOADED EXISTING SANITARY SEWER MAY REQUIRE RELIEF, WITH THE RELIEF SEWER CONSTRUCTED PARALLEL TO THE EXISTING LINE TO DIVERT FLOWS TO ALTERNATE OUTLETS.



ELEVATION VIEW - SEWER RELIEF LINE



ISOMETRIC VIEW - SEWER RELIEF LINE

San Antonio Water System Standard Specifications for Construction

ITEM NO. 824

Water Service Supply Lines
New Services

824.1 DESCRIPTION: This item shall consist of New Water Service Supply Lines installation in accordance with these specifications and as directed by the Engineer.

824.2 REFERENCED STANDARDS: Reference standards cited in this Specification Item No. 824 refer to the current reference standard published at the time of the latest revision date.

1. San Antonio Water System (SAWS):
   a. Specifications for Water and Sanitary Sewer Construction
   b. SAWS Materials Specifications
2. City of San Antonio (COSA) Standard Specification for Construction
3. Texas Commission of Environmental Quality (TCEQ)
   a. Chapter 290; Subchapter D – Rules and Regulations for Public Drinking Water
4. American National Standards Institute (ANSI)/American Water Works Association (AWWA)
   a. ANSI†/AWWA C105/A21.5—Polyethylene Encasement for Ductile-Iron Pipe Systems.
   b. ANSI A 21.11/AWWA C111 - Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   c. ANSI/AWWA C150/A21.50—Thickness Design of Ductile-Iron Pipe.
   d. ANSI/AWWA C151/A21.51—Ductile-Iron Pipe, Centrifugally Cast.
   e. ANSI/AWWA C500—Metal-Seated Gate Valves for Water Supply Service.
   f. ANSI/AWWA C515—Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service.
   g. ANSI/NSF Standard 61 - Drinking Water System - Health Components
   h. AWWA C 206 - Standard for Field Welding of Steel Water Pipe.
   i. AWWA C 207 - Standard for Steel Pipe Flanges for Waterworks Service - Sizes 4 Inches through 144 Inches.
   j. ANSI/AWWA C509—Resilient-Seated Gate Valves for Water Supply Service.
   k. AWWA C605, "Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water
   l. AWWA C651 Disinfecting Water Mains
   m. AWWA C900, "Polyvinyl Chloride (PVC) Pressure Pipe And Fabricated Fittings, 4 In. Through 60 In. (100 Mm Through 1,500 Mmfor Water Distribution"

n. AWWA C907, "Polyvinyl Chloride (PVC) Pressure Fittings for Water –4 in. through 8 In (100 mm Through 200 mm)
o. AWWA Manual M27, External Corrosion: Introduction to Chemistry and Control.
p. AWWA M28 Rehabilitation of Water Mains
q. AWWA Manual M41—Ductile-Iron Pipe and Fittings

5. American Society for Testing and Materials (ASTM) International:
   a. ASTM A 36 - Standard Specification for Carbon Structural Steel.
   b. ASTM A 536 - Standard Specification for Ductile Iron Castings.
   c. ASTM A 126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and
   d. Pipe Fittings.
   e. ASTM B 21 - Standard Specification for Naval Brass Rod, Bar, and Shapes.
   f. ASTM B 98 - Standard Specification for Copper-Silicon Alloy Rod, Bar, and Shapes.
   g. ASTM B 301 - Standard Specification for Free-Cutting Copper Rod and Bar.
   h. ASTM B 584 - Standard Specification for Copper Alloy Sand Casting for General Application.
   i. ASTM E 165 - Standard Test Method for Liquid Penetrant Examination.
   j. ASTM E 709 - Standard Guide for Magnetic Particle Examination.
   k. ASTM F 1674 - Standard Test Method for Joint Restraint Products for Use with PVC Pipe.
6. International Organization of Standardization (ISO)
   a. ISO9001

824.3 SUBMITTALS: All submittals shall be in accordance with most recent version of SAWS's General Conditions requirements. Submit the following for approval prior to performing any work.

1. Certifications:
   a. Per General Conditions section 5.12.2 all Contractor submittals for all pipe and other products or materials furnished under this specification shall be marked as reviewed and approved by Contractor for compliance with Contract Documents and the referenced standards.
   b. The Manufacturer shall provide ISO 9001 Certificate by a third party.
   c. Submit written verification from the pipe Manufacturer demonstrating compliance with the production and delivery schedule of the pipe as indicated in the Contractor's schedule.
   d. Contractor shall submit Manufacturer's product data, installation recommendations, shop drawings, and certifications.
   e. Shop Drawings

f. Catalog Data Sheets for all materials confirming pipe, fittings, and other materials conform to requirements of this specification.

g. Pipe Supplier Information. Submit company name, contact name, and contact number.

h. Details of all piping systems components confirming that the pipe and fittings conform to the specified requirements.

824.4 MATERIALS: The materials for water service supply lines installation and adjustment shall conform to the specifications contained within the latest revision of SAWS' Material Specification Item Nos. 21-10, "Brass Gate Valves,"15-40, "Brass Goods, 19-01 HDPE Tubing and 100-30, "Service Saddles," 10-30 Water Meter Boxes (5/8", 3/4", 1", 1-1/2" AND 2" Meters).

824.5 CONSTRUCTION:

1. General: Service supply lines and fittings, meter boxes and appurtenances shall conform to the Material Specifications and shall be installed by the Contractor as specified herein, or as directed by the Engineer and in accordance with the DD-824 Standard Drawing Series.
   a. All services shall be in line with meter box location, any variance requires prior approval from SAWS' Inspector.
   b. Tracer wire shall be utilized for location and taped directly to the pipe.
      i. Tracer wire shall be properly spliced at each end connection and each service connection.
      ii. Tracer wire shall be adequately wrapped and protected at each splice location in accordance with manufacturer recommendations.
      iii. No bare tracer wire shall be accepted.
      iv. Wire shall also come up to the top of valve extensions and fire hydrant stems, as directed by the Inspector.
      v. Tracer wire shall be utilized for location purposes and taped directly to the top of pipe.
      vi. Tracer wire shall be of solid core (14 gauge insulated), and shall be taped to the main in minimum of 10 inch increments.
      vii. Detection tape cannot be used in lieu of tracer wire.
2. Designation of Service Supply Lines: A service supply line located between the water main and the inlet side of the water meter is designated as a "water service line."
   a. A service supply line located between the outlet side of the water meter to the point of connection within the limits of the Customer's lot or property is designated as the "Customer's yard piping" and is covered under Specification Item No. 822 "Customer's Water Yard Piping" of these specifications.
   b. Services 2 inches and smaller are designated "small services."

c. Services 4 inches and larger are designated "large services."

3. New Services: If a new main is required to be extended to provide water service for new Customers, the service lines laid to the new main shall be designated as "new services."
   a. New laid main(s) to which new services are on the same side of the street as the Customer's new meter box location, are designated as "new short services."
   b. New laid main(s) to which new services on the opposite side of the street from the Customer's new meter box location, are designated as "new long services."
4. New Unmetered Services: New unmetered services are defined as services that are installed on existing or new mains to provide service to platted vacant lots.
   a. Where the new or existing main to which new unmetered services are being installed, is on the same side of the street as the Customer's new meter box location (Inspector is to set location of new meter box), the services to be laid are designated "new unmetered short services."
   b. Where the new or existing water main to which new unmetered services are installed, is on the opposite side of the street from the Customer's new meter box location (Inspector is to set location of new meter box), the services to be laid are designated "new unmetered long service."
   c. New unmetered long services and new unmetered short services will not include "Customer's yard piping," and no meter will be set.
   d. New meter box will be included with unmetered service, and is inclusive to the unmetered service. See material specifications.
5. Service Line Installation: Unless otherwise notified new services shall be installed as described herein, and in the DD-824 Standard Drawing Series.
   a. Unless otherwise indicated, existing meter and meter box relocation shall be included in the service line installation.
   b. All service lines longer than 60 ft. in length in concrete pavement or major thoroughfares crossings shall be installed in Schedule 80 PVC conduit, or rigid pipe.
   c. Cutting, excavation, backfill and replacement of pavement shall be done as specified herein and in accordance with applicable sections of the City of San Antonio Specification Item No. 511, "Cutting and Replacing Pavements (Trench Repair), and Specification Item No. 804, "Excavation, Trenching, and Backfill."
   d. The minimum trench width for small service lines shall be 8 inches, while the minimum trench width for large service lines shall be the nominal pipe diameter plus 16 inches, except when specified otherwise by the Engineer.
   e. For ¾ inch to 2 inch service lines, the minimum bury depth shall be 3 feet.
   f. For services greater than 2 inches, the minimum depth of bury shall be 4 feet.
   g. All service lines shall be installed in accordance with the DD-824 Standard Drawing Series, SAWS' Standard Material Specification Item No. 100-30

"Service Saddles," with two strap service saddle clamps for all taps services.

h. The Contractor shall use precaution to protect and preserve the polyethylene wrap around ductile-iron water mains when installing service saddles and service corporations.

i. The required method is wrap pipe tape around the pipe, over the polywrap, after the service saddle and service corporation has been installed.

j. HDPE shall have stiffners installed per manufactures' recommendation.

k. The tap shall be made through the tape and polywrap. It is not necessary to remove and replace polywrap.

l. All exposed pipe, corporation, and the first three feet of the service, shall be wrapped and taped to achieve a complete seal.

m. In addition, a sand envelope shall extend over and around the connection to a depth of 8 inches above the main.

n. Small service lines shall be embedded in sand in accordance with Specification Item No. 804, "Excavation, Trenching and Backfill."

o. When approved by the Inspector, the Contractor may lay the new service line from the corporation stop to the curb stop or angle valve.

p. Upon completion, the Contractor shall isolate the new service line by closing the curb stop or angle valve until the meter box is set.

6. Splicing: A long service line single slice may be permitted only when approved in advance by the Inspector, provided the location of the splice is not under pavement, concrete, or roadways.

   a. The segment added is required to be the same material as the existing service line, unless otherwise directed by the Inspector.

   b. Splicing short service lines will not be permitted.

7. Directional Boring/Drilling: Service lines which cross paved streets may be installed at the Contractor's option by boring or jacking operations at no additional cost to SAWS. PVC schedule 80 shall be used for casing (2" and 3"), Certa-T lock or steel pipe shall be used for larger casing 4" and up.

8. Tapping Asbestos Cement (AC) Pipe: Direct tapping will not be allowed. Service saddles must be used when tapping AC pipe.

   a. Shell cutters with pilot bit type shall be used for services less than 2 inches.

   b. Shell cutters with pilot bit type shall be used for all services 2 inches and greater.

   c. The tapping of AC pipe must be done in accordance with manufacturers' recommendations and done only with tap machine having a built in flush valve and the flush valve must be open during the entire procedure.

9. Abandonment of Service Lines: The Contractor shall accomplish all cutting, capping, and plugging necessary to isolate new service lines transferred to new and existing mains from those abandoned, including service lines designated in the contract documents as "tap plug".

   a. The corporation stop for an abandoned service line tapped on a ferrous main shall be removed, and the tap at the main shall be plugged with an appropriately sized brass plug.

   b. For a non-ferrous main, the corporation stop shall not be removed from the

main. Instead, the corporation stop shall be closed and the flared nut shall be removed from the corporation stop.

c. After the appropriately sized copper disc is inserted inside the flared nut, replace the flared nut on the corporation stop.

10. Tapping PVC (C-900) Pipe: Tapping of PVC pipe must be done in accordance with Uni-Bell procedures.
    a. Direct tapping will not be allowed. All drill cutting tools must be the "shell type" with internal teeth or double slots which will retain the coupon.
    b. The shell cutters must be designed for C-900 pipe, thus having sufficient root depth to handle the heavier walled pipe.
    c. Direct tapping will not be allowed. Service saddles must be used when tapping C-900 pipe
11. Tapping Ductile Iron Main:
    a. Direct tapping will not be allowed. All drill cutting tools must be the "shell type" with internal teeth or double slots which will retain the coupon.
    b. The shell cutters must be designed for DI pipe, thus having sufficient root depth to handle the heavier walled pipe.
    c. Direct tapping will not be allowed. Service saddles must be used when tapping DI pipe.
12. Small Service Lines:
    a. HDPE tubing shall be used for ¾ inch through 2 inch service lines.
    b. Brass fittings for ¾ inch and 1 inch service lines shall be of compression type for the use with HDPE tubing.
    c. Brass fittings for 1½ inch and 2 inch lines shall be of compression type for use with or HDPE tubing, except as modified in this specification. Stiffner verbage
    d. Tubing shall be cut squarely by using an approved cutting tool and by avoiding excessive pressure on the cutting wheels which might bend or flatten the pipe walls.
    e. Tubing shall be cut squarely and burred.
    f. Pipe adjacent to the fittings shall be straight for at least 10 inches.
    g. Bending of tubing shall be accomplished by using an appropriate sized bending tool. No kinks, dents, flats, or crimps will be permitted, and should such occur, the damaged section shall be replaced.
    h. Final assembly shall be in accordance with the manufacturer's recommendations.
13. Small Service Lines on New Mains: Installation of new service lines shall consist of all excavation through miscellaneous material encountered; trench excavation protection; drilling and tapping the new main with an approved tapping machine; setting the curb stop or angle valve at the meter; laying the new service line at the specified depth between the main and the meter and its tie-in at the corporation and the curb stop or the angle valve; "Meter and Meter Box Installation."; backfilling the trench with approved selected material and disposal of surplus excavated material; capping the tap hole with asphalt treated base, including the outer limits of the main trench line with service line trench; cutting and replacing pavements,

curbing and sidewalks of all types over the limits of the main line trench and the completed service line trench.

14. Single Service Line - Dual Meters: The single service line - dual meter installation shall consist of a 1" service line reducing to two ¾ inch service lines at a tee which shall be set in line with the front edge of meter boxes for ⅝ inch and ¾ inch meters.
    a. A single service line with dual meters shall be installed in those new residential developments where new ⅝ inch and ¾ inch meters are required and in main replacement work, where it is necessary to change the location of existing ⅝ inch and ¾ inch meters.
    b. Single service line - dual meter materials and installation requirements shall conform to requirements established herein See DD-824 Drawing Series.
    c. No branching will be allowed on services that require pressure reducing valves (PRVs).
    d. Dual Meters will be allowed for new development only.
15. Small Service Lines on Existing Mains: The work involved in the installation of new service lines on existing mains shall consist of jacking, boring, tunneling, and, open trench operations; all excavation through any material encountered; trench excavation protection; using the existing corporation when approved by the Inspector; tapping the existing main and installing the new corporation and setting the curb stop or angle valve at the meter; abandoning the existing corporation stop, removing the existing flared nut, inserting inside the existing flared nut an appropriately-sized copper disc and replacing the existing flared nut on the corporation stop, if the main is non-ferrous, or plugging the existing service line at the main if the main is ferrous; installing the new service line at the same grade as the existing service line or at the specified grade between the main and the existing meter and its tie-in at the corporation and the curb stop; disposal of surplus excavated material; capping the tap hole with asphalt treated base including the outer limits of the main line trench and the service line trench; cutting and replacing all surfaces of all type encountered over the completed service line trench; restoration of the site.
16. Large Service Lines: Ductile iron pipe, HDPE, and PVC fittings used for metered service lines and non-metered fire service lines larger than 2 inch shall be installed in accordance with the applicable provisions of Specification Item No. 812, "Water Main Installation," except where otherwise approved by the Engineer.
17. Large Service Lines on New Mains: Work involved in the installation of a new metered service lines and non-metered fire service lines shall consist of all excavation through all material encountered, trench excavation protection, installing tees, pipe and fittings of various sizes including main line and service line valves, valve boxes, ductile iron pipe, PVC, HDPE, fittings, in accordance with the associated DD-824 Drawing Series, and reaction block, backfilling with approved selected material, cutting and replacing pavements, curbing, and sidewalks of all types over the limits of the main line trench and the completed service line.
18. Large Service Lines on Existing Mains: The work involved in the installation of

the new metered service lines and non-metered fire service lines shall consist of all excavation through all material encountered, trench excavation protection, cutting-in tees and installing tapping sleeves and valves, pipe and fittings of various sizes including main line and service valves, valves boxes, ductile iron pipe, PVC, HDPE, fittings and reaction block required, backfilling with approved selected material, cutting and replacing pavements, curbing, and sidewalks of all types over the limits of the main line trench and the completed service line.

824.6 MEASUREMENT:

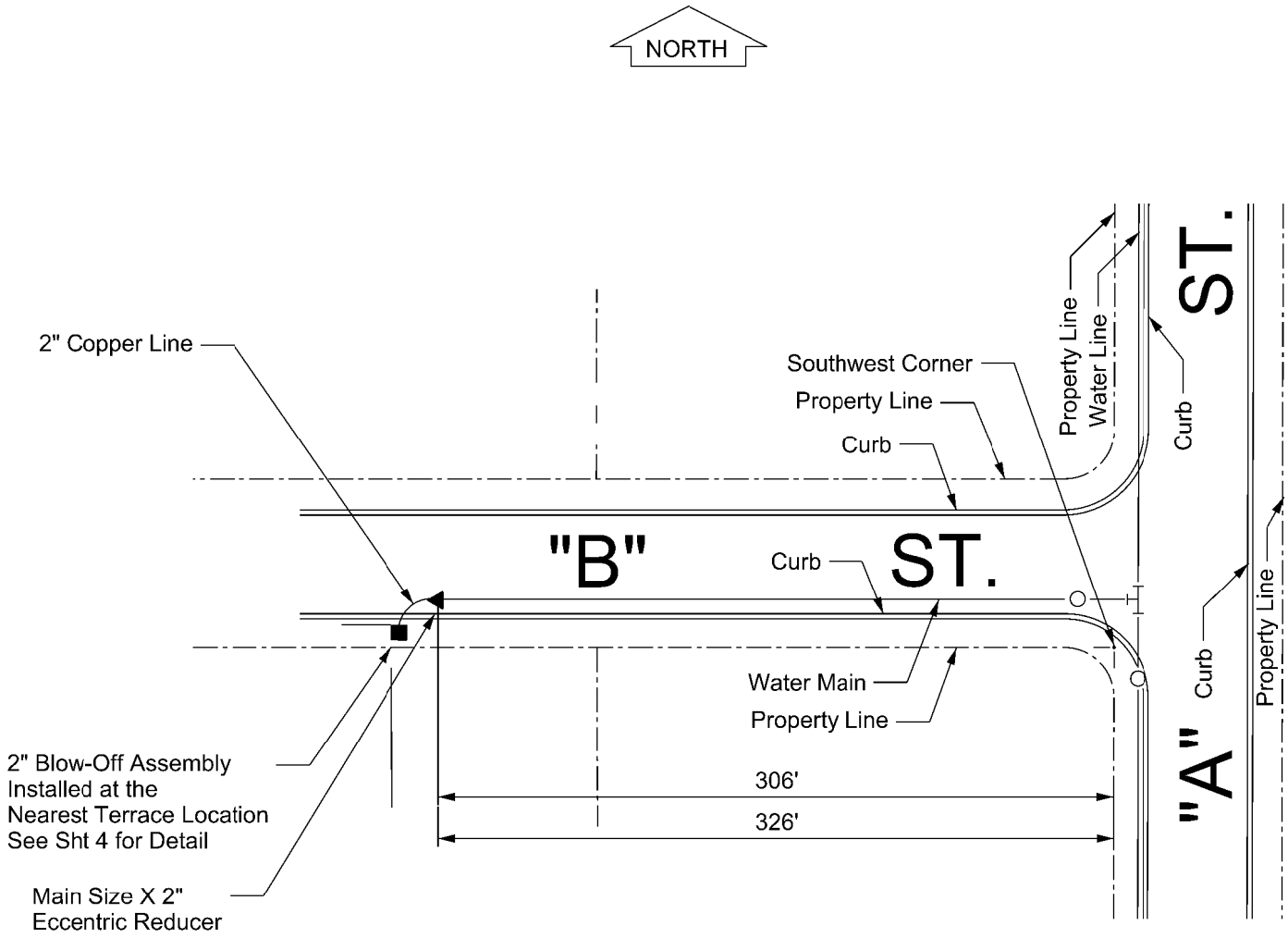
1. New Short Service will be measured by the unit of the various types and sizes of each new service line installed.
2. New Long Service will be measured by the unit of the various types and sizes of each new service line installed.
3. New Un-metered Short Service will be measured by the unit of the various type and sizes of each new un-metered service line installed.
4. New Un-metered Long Service will be measured by the unit of the various type and sizes of each new un-metered service line installed.

824.7 PAYMENT:

1. Payment for New Short Service will be made at the unit of the various types and sizes of each new service line installed.
   a. Such payment shall also include excavation, new meter box trench excavation protection, hauling and disposition of surplus excavated materials, sand backfill, cutting pavement and surface structures of all type encountered and replacement with all type specified, and tubing and fittings of the various sizes used in the service line reconnection.
2. Payment for New Long Service will be made at the unit of the various types and sizes of each new service line installed.
   a. Such payment shall also include excavation, trench excavation protection, hauling and disposition of surplus excavated materials, sand backfill, cutting pavement and surface structures of all type encountered and replacement with all type specified, and tubing and fittings of the various sizes used in the new service line reconnection.
   b. New Meter box template.
3. Payment for New Un-metered Short Service will be made at the unit of the various type and sizes of each new un-metered service line installed.
   a. Such payment shall also include excavation, trench excavation protection, hauling and disposition of surplus excavated materials, sand backfill, cutting pavement and surface structures of all type encountered and replacement with all type specified, and tubing and fittings of the various sizes used in the un-metered service line reconnection.
   b. New Meter box template.

4. Payment for New Un-metered Long Service will be made at the unit of the various type and sizes of each new un-metered service line installed.
   a. Such payment shall also include excavation, trench excavation protection, hauling and disposition of surplus excavated materials, sand backfill, cutting pavement and surface structures of all type encountered and replacement with all type specified, and tubing and fittings of the various sizes used in the un-metered service line reconnection.
   b. New Meter box template.

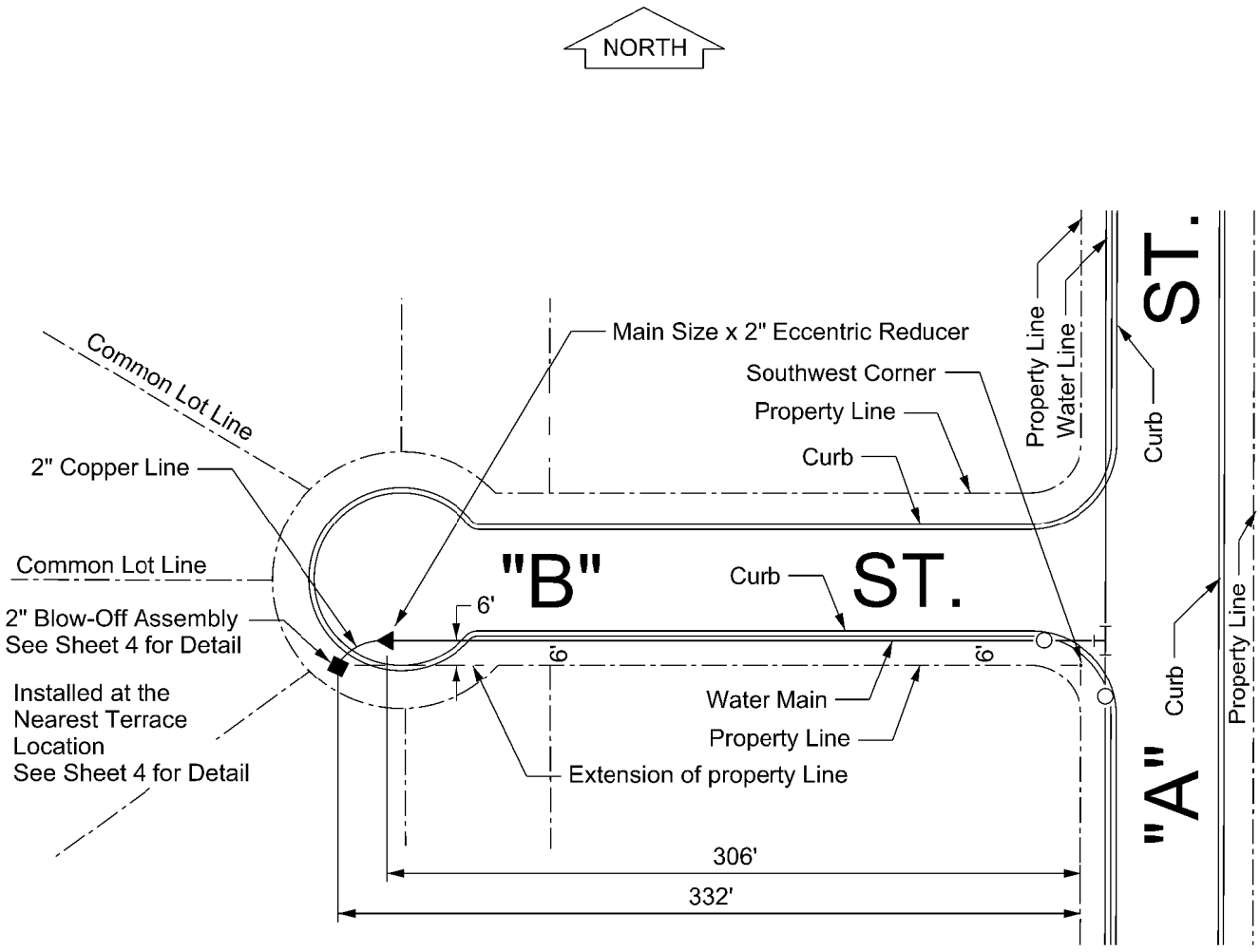
-End of Specification-



EXAMPLE BLOW-OFF MEASUREMENT:

From the Southwest Corner of "A" St. and "B" St. West 306'
and North 13' to Eccentric Reducer
West 326' and North 8' to Blow-Off Assembly Box

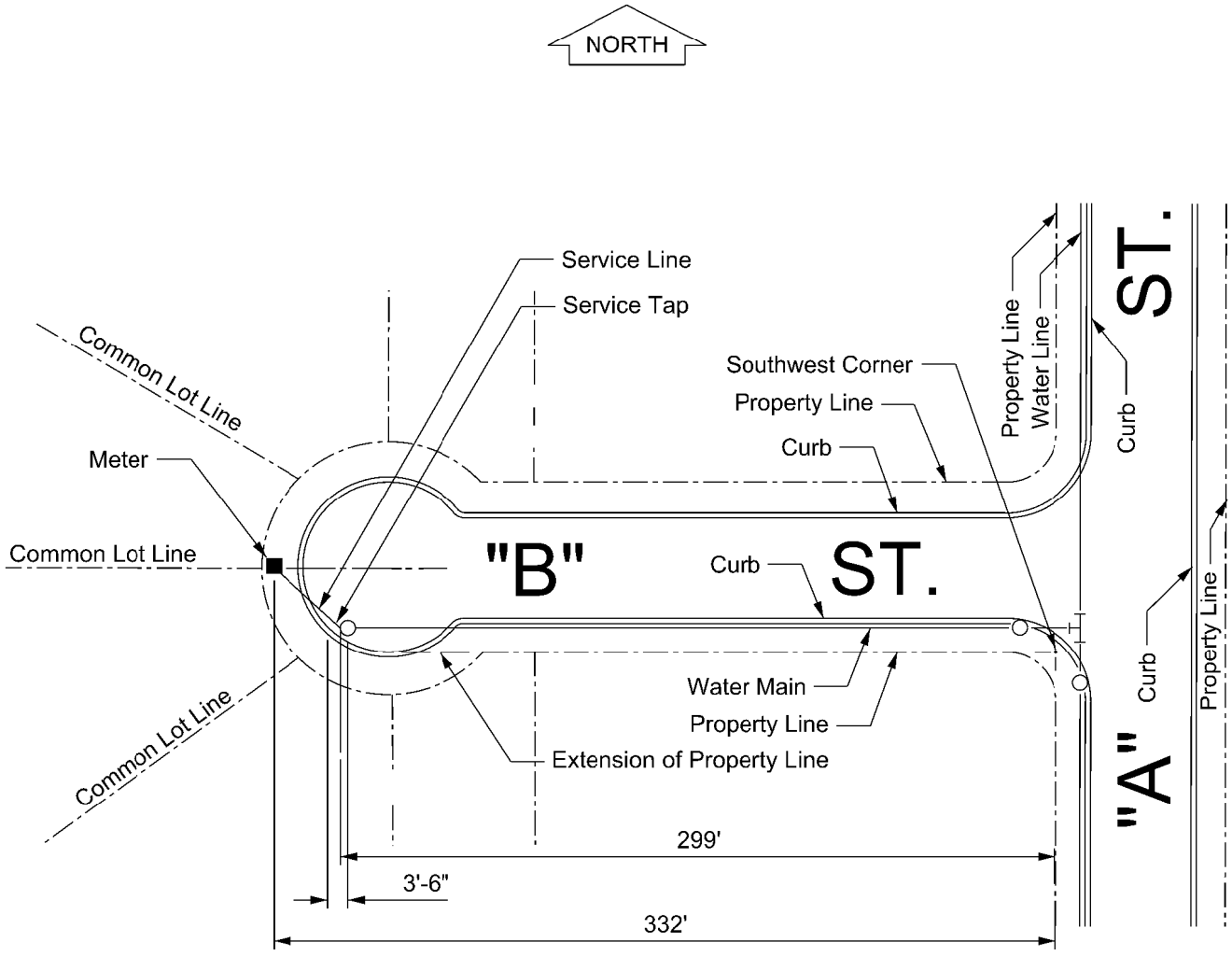
PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	TYPICAL BLOW-OFF ARRANGEMENT ON DEAD END MAINS	APPROVED MARCH 2008	REVISED AUG 2019
		DD-824-04	SHEET 1 OF 4



EXAMPLE BLOW-OFF MEASUREMENT:

- From the Southwest Corner of "A" St. and "B" St. West 306' and North 6' to Eccentric Reducer,
- West 332' and North 0' to Blow-Off Assembly Box.

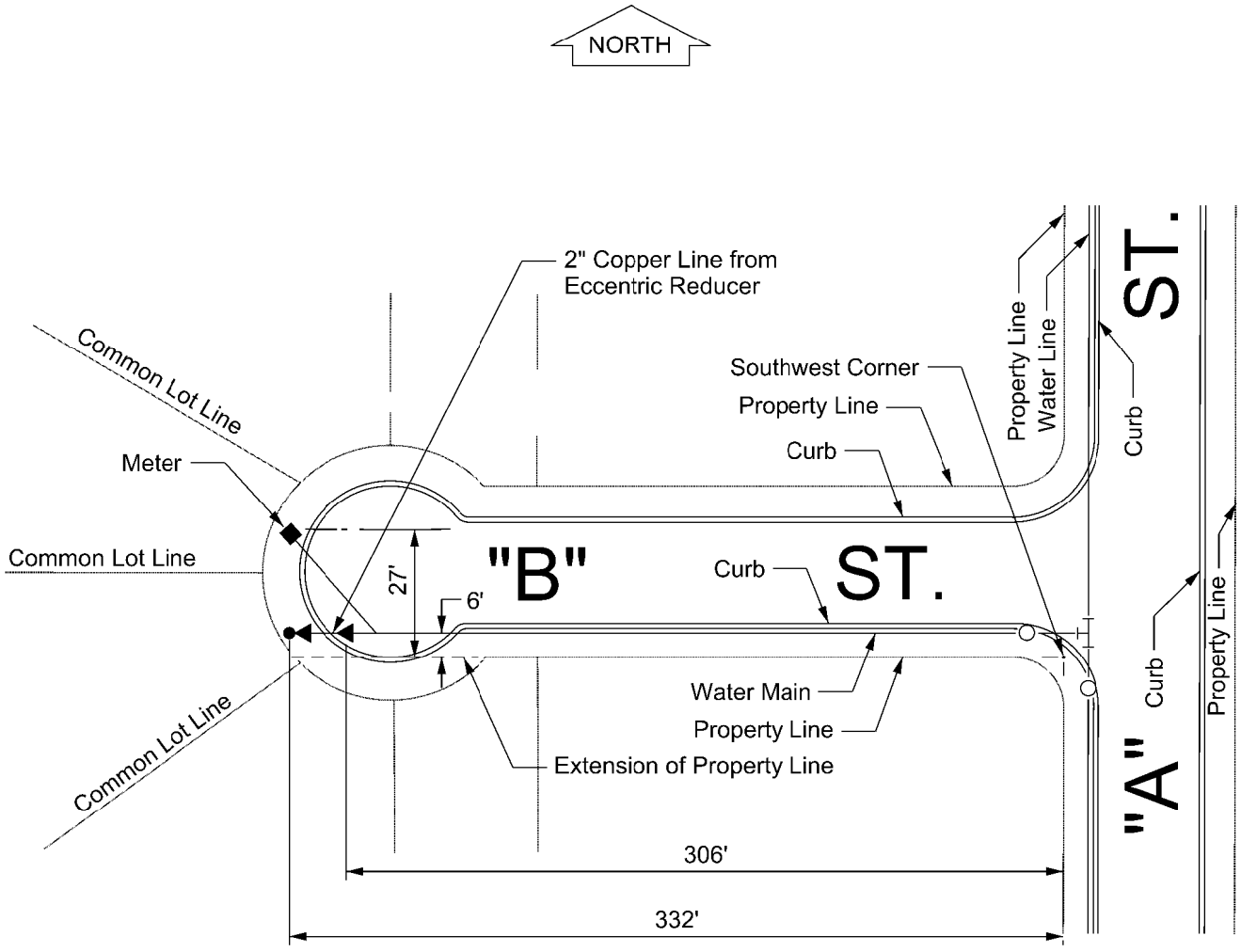
PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	TYPICAL BLOW-OFF ARRANGEMENT IN CUL-DE-SAC	APPROVED MARCH 2008	REVISED AUG 2019
		DD-824-04	SHEET 2 OF 4



EXAMPLE SERVICE MEASUREMENT:

- From the Southwest Corner of "A" St. and "B" St. West 299' and North 6' to Tap, and West 332' and North 17' to Meter.

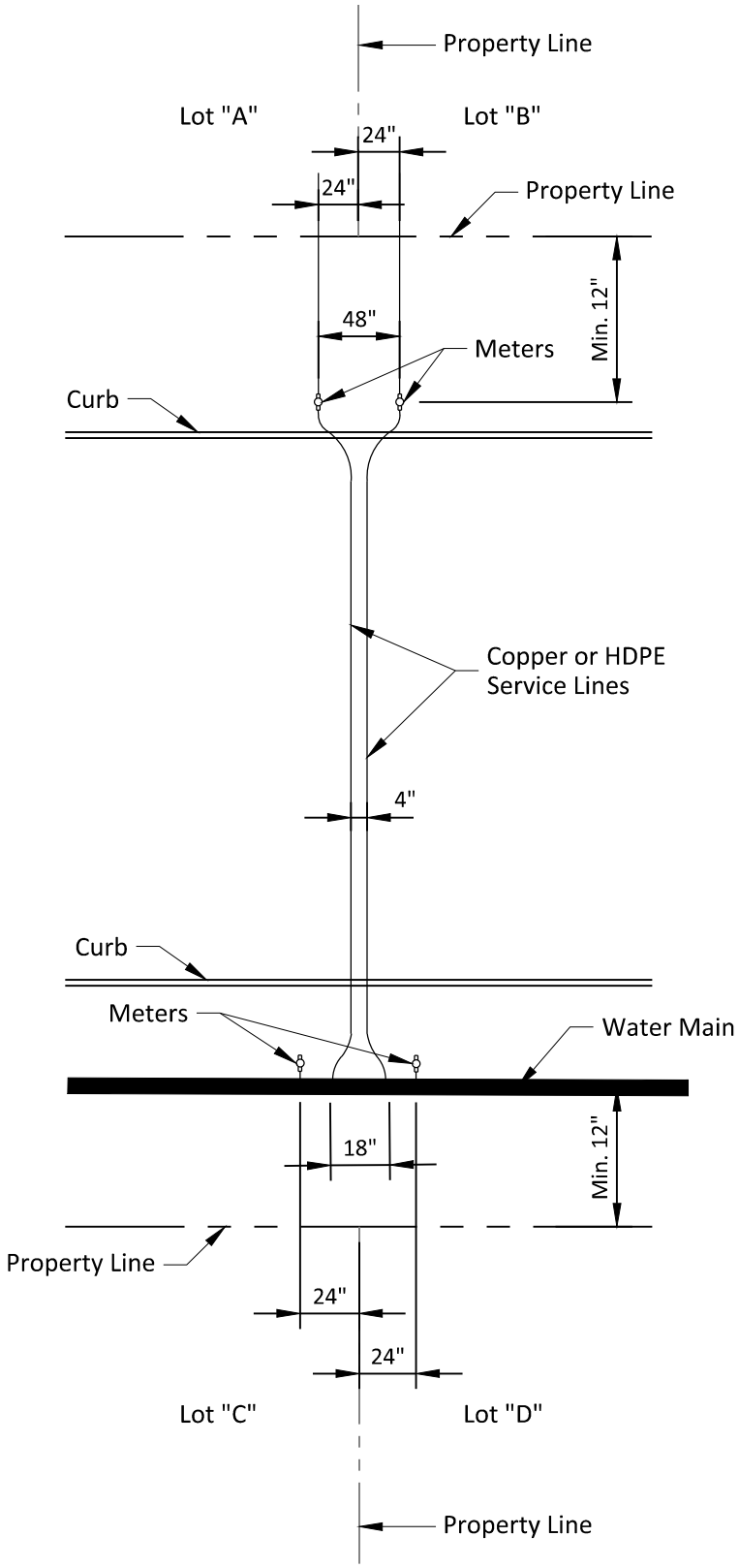
PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	TYPICAL SERVICE ARRANGEMENT IN CUL-DE-SAC	APPROVED MARCH 2008	REVISED AUG 2019
		DD-824-04	SHEET 3 OF 4



EXAMPLE BLOW-OFF MEASUREMENT:

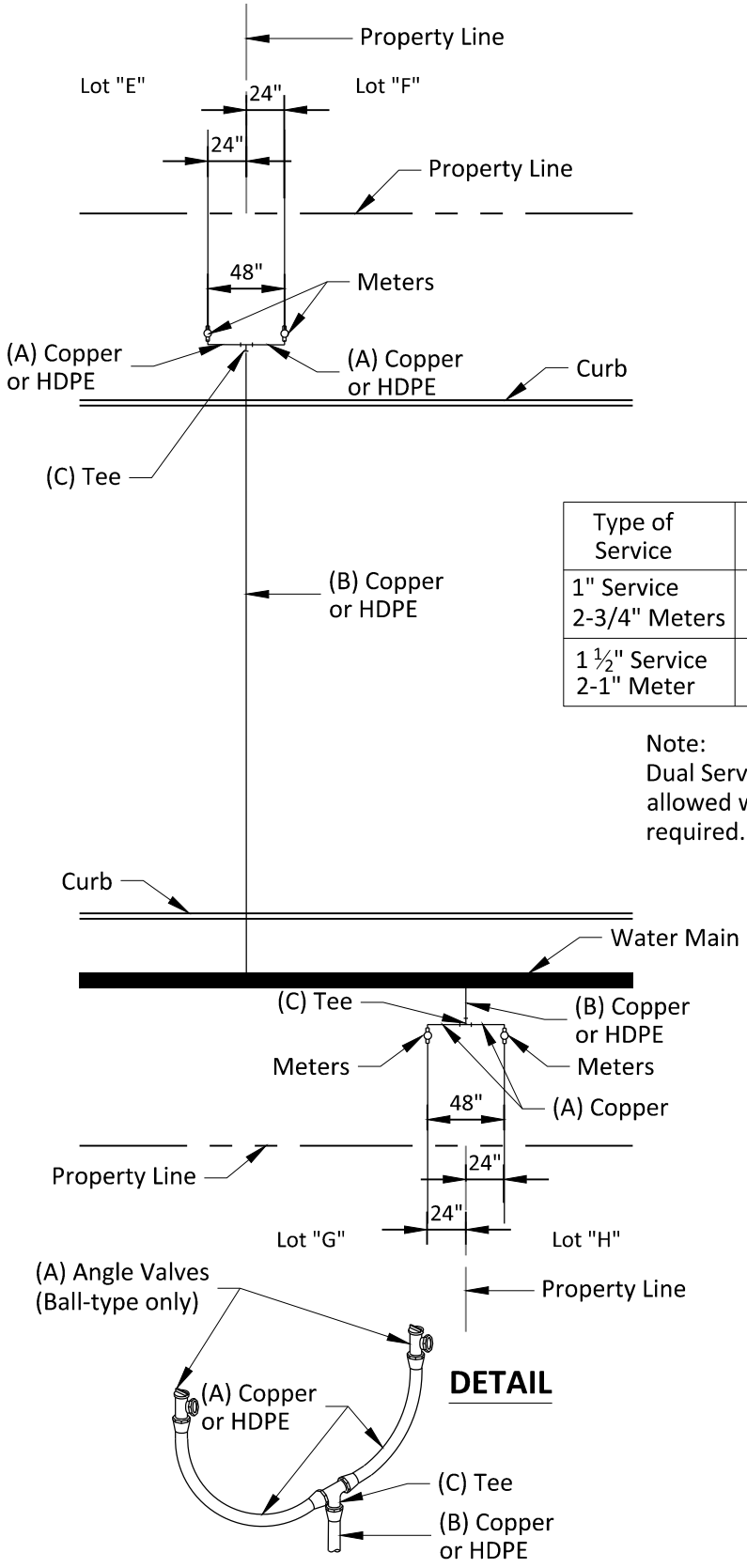
- From the Southwest Corner of "A" St. and "B" St. West 306' and North 6' to End of Eccentric Reducer and West 332' and North 6' Blow-Off Assembly.

PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	TYPICAL 2" BLOW-OFF ASSEMBLY ON DEAD END MAINS	APPROVED MARCH 2008	REVISED AUG 2019
		DD-824-04	SHEET 4 OF 4



SINGLE SERVICE LINE - SINGLE METER

PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	TYPICAL NEW DEVELOPMENT SERVICE ARRANGEMENT	APPROVED March 2008	REVISED December 2018
		DD-824-05	SHEET 1 OF 3



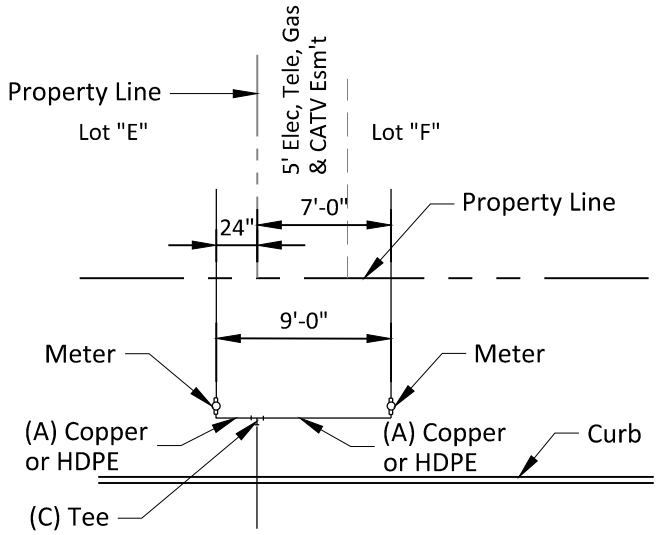
DETAIL

Type of Service	A	B	C
1" Service 2-3/4" Meters	¾"	1"	¾" x ¾" x 1"
1 ½" Service 2-1" Meter	1"	1 ½"	1" x 1" x 1 ½"

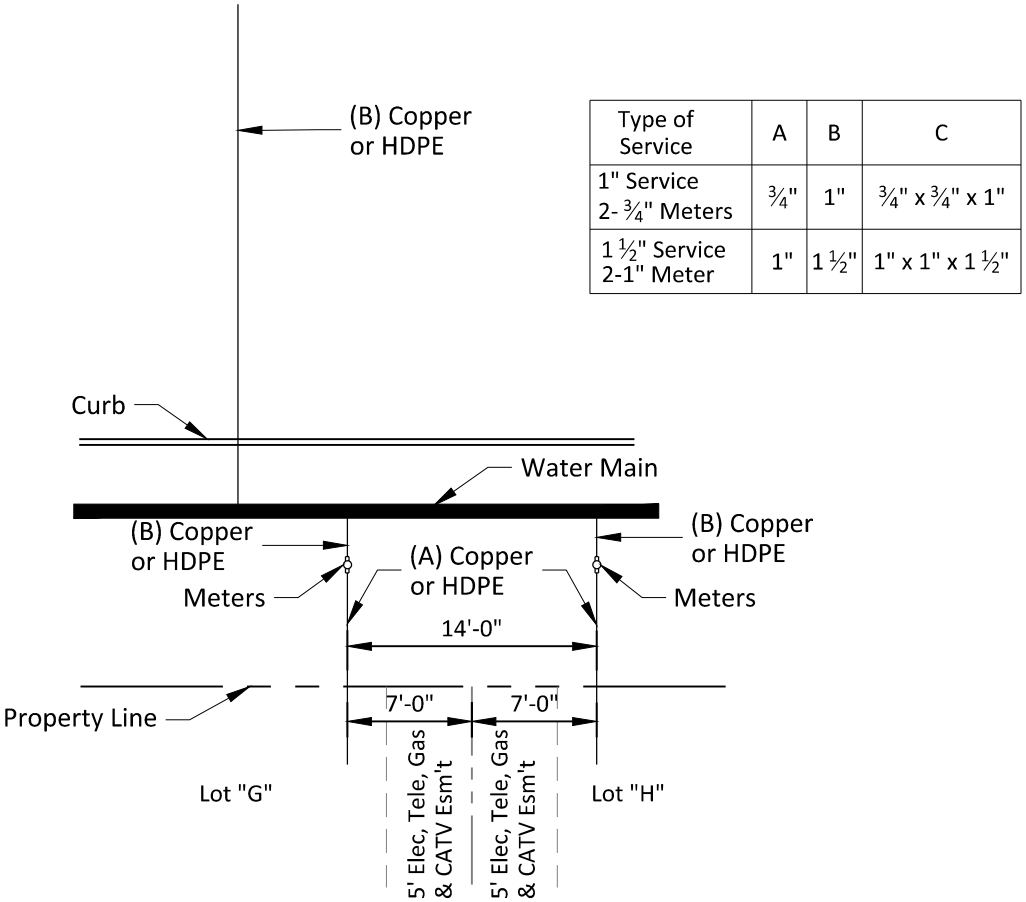
Note:
Dual Services not allowed when PRVs are required.

SINGLE SERVICE LINE - DUAL METER

PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	TYPICAL SERVICE ARRANGEMENT	APPROVED March 2008	REVISED December 2018
		DD-824-05	SHEET 2 OF 3



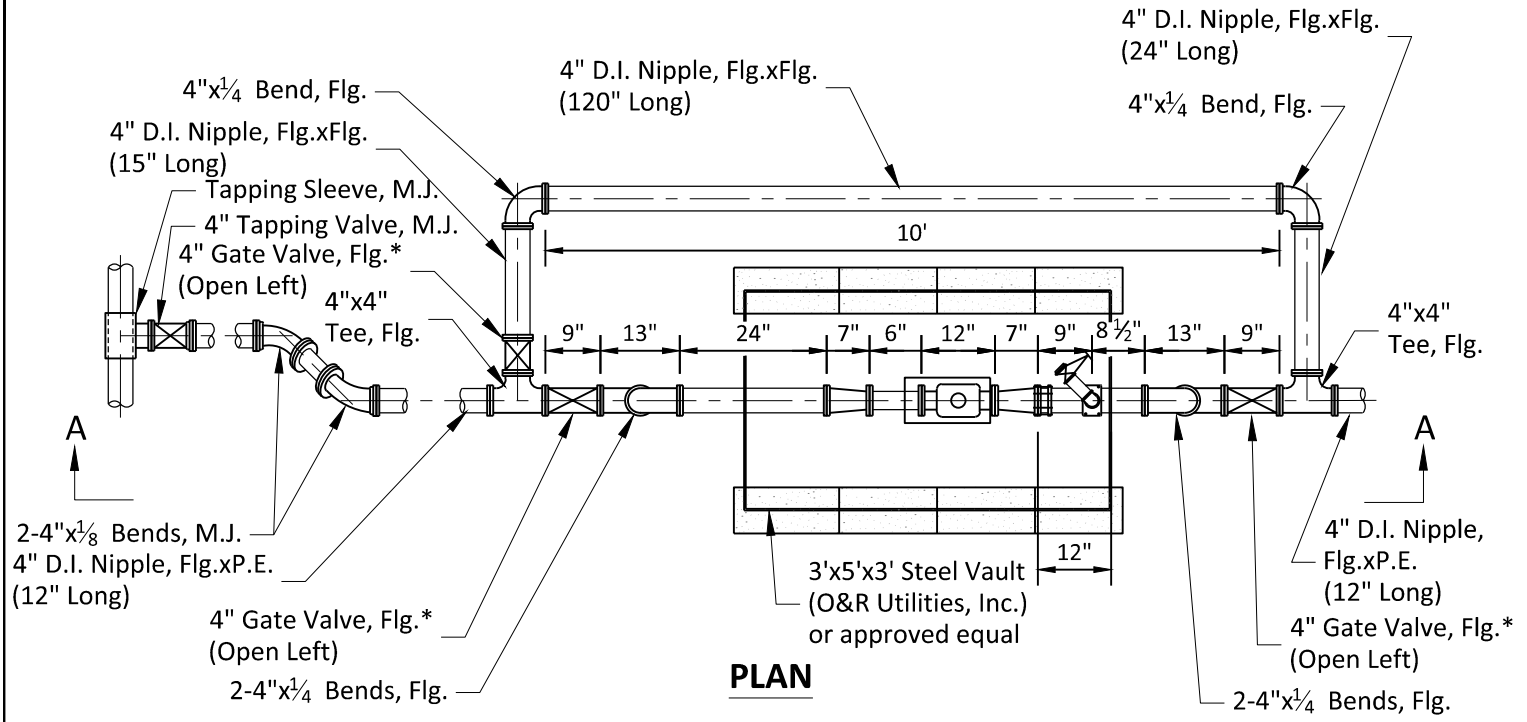
SINGLE SERVICE LINE - DUAL METER W/ EASEMENT



Type of Service	A	B	C
1" Service 2- ¾" Meters	¾"	1"	¾" x ¾" x 1"
1 ½" Service 2-1" Meter	1"	1 ½"	1" x 1" x 1 ½"

SINGLE SERVICE LINE W/ EASEMENT

PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	ALTERNATE SERVICE ARRANGEMENT	APPROVED March 2008	REVISED December 2018
		DD-824-05	SHEET 3 OF 3



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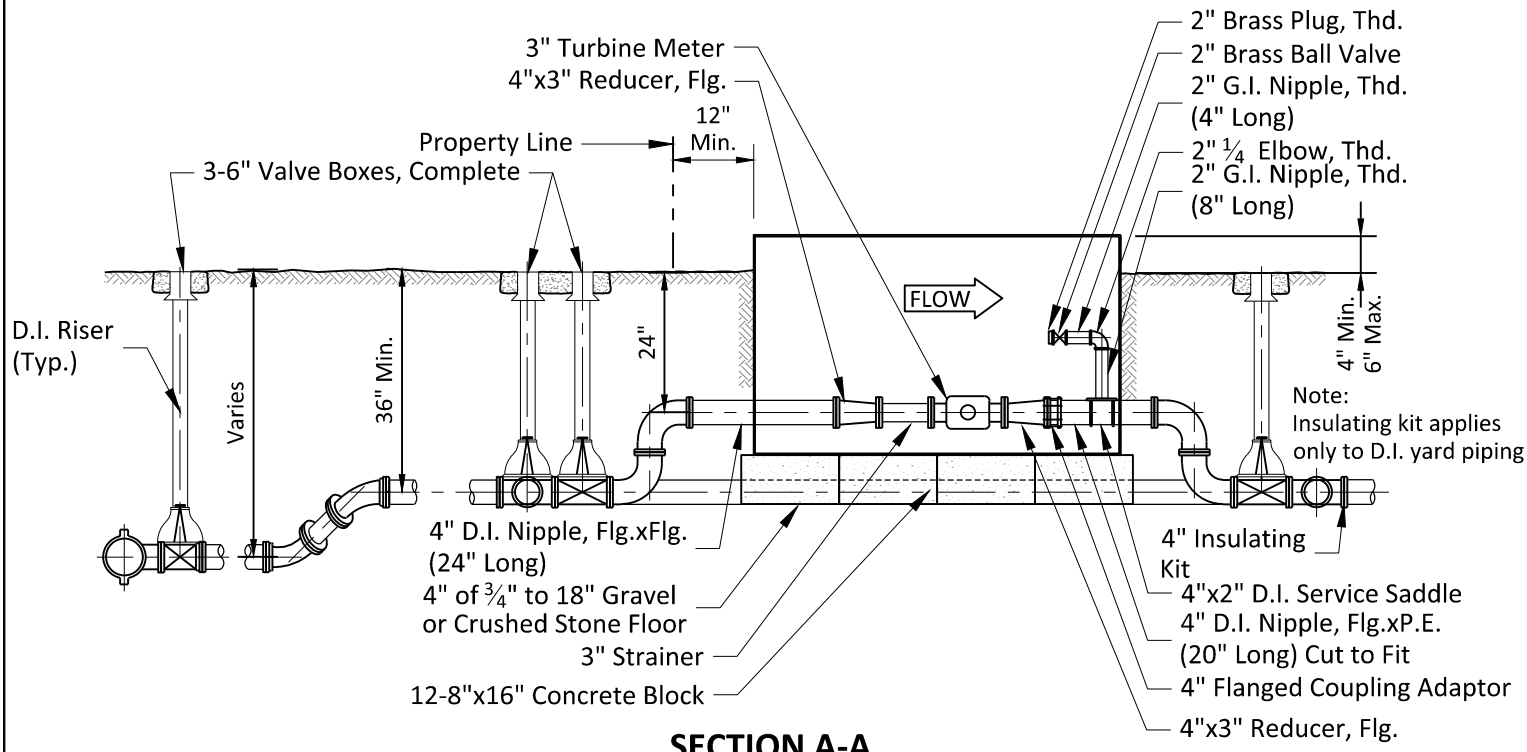
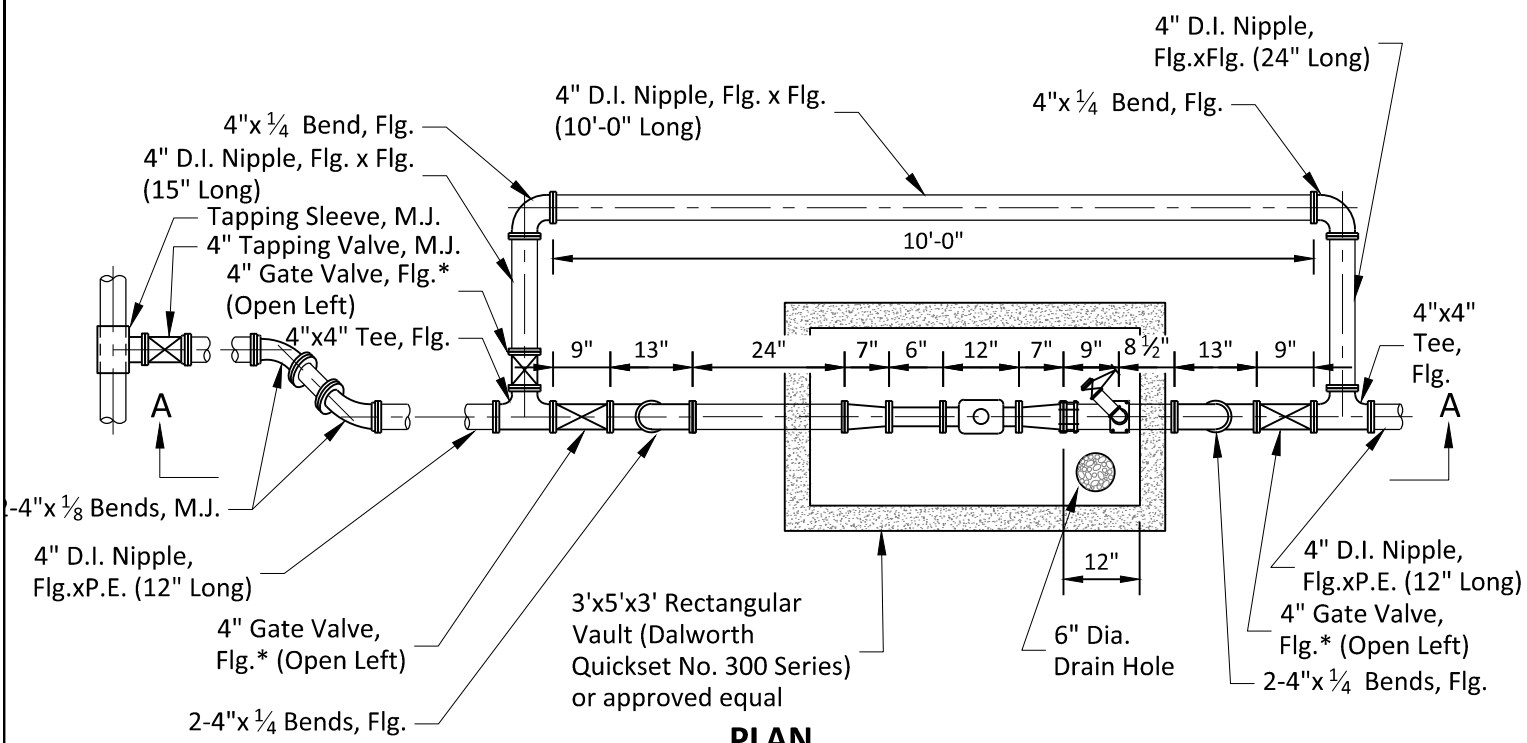


SECTION A-A

3'x5'x3' STEEL VAULT
(NON-TRAFFIC BEARING LOCATION)

*Resilient Seat

PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	3" TURBINE METER INSTALLATION	APPROVED March 2008	REVISED December 2018
		DD-824-06	SHEET 1 OF 2



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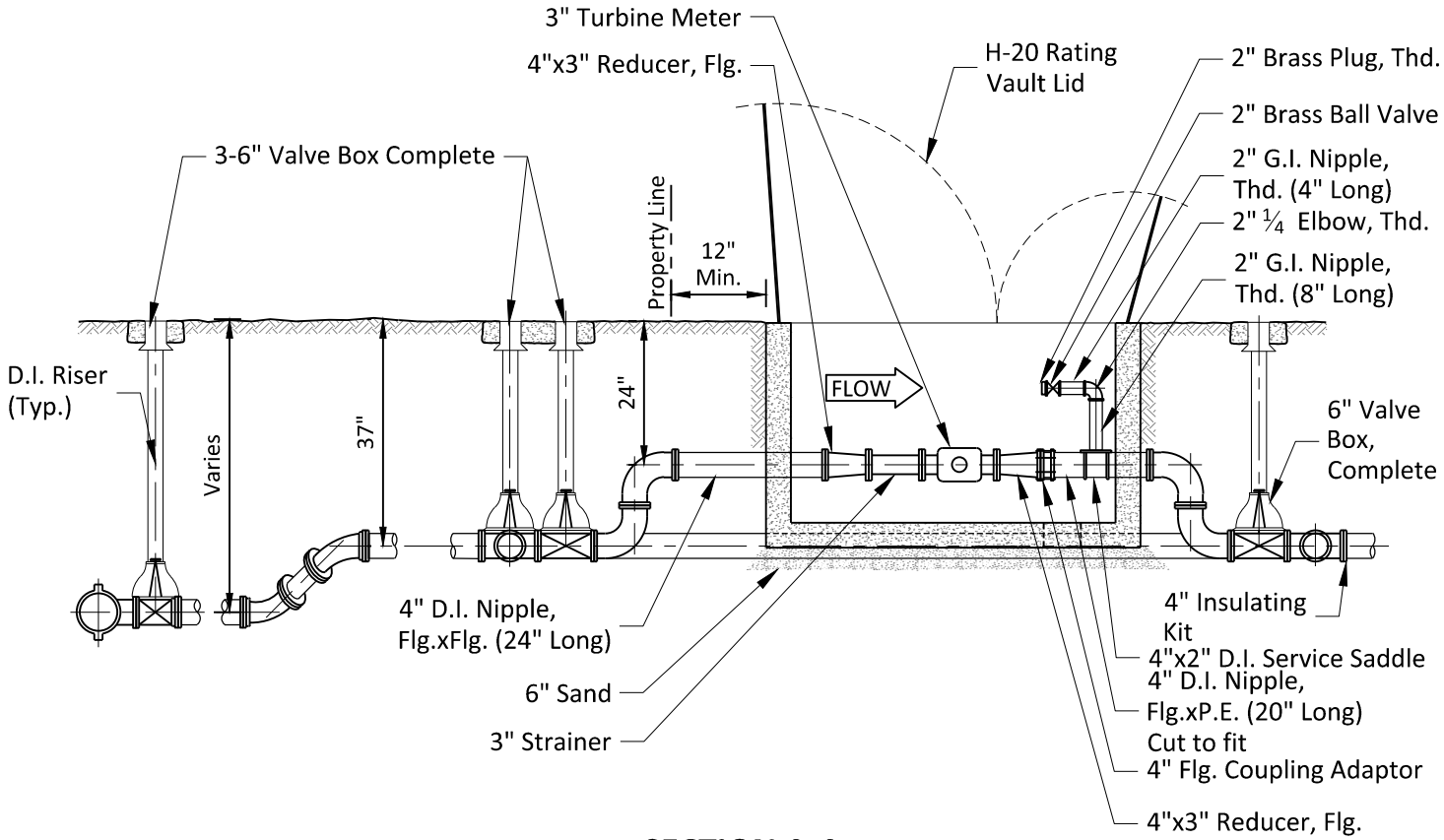


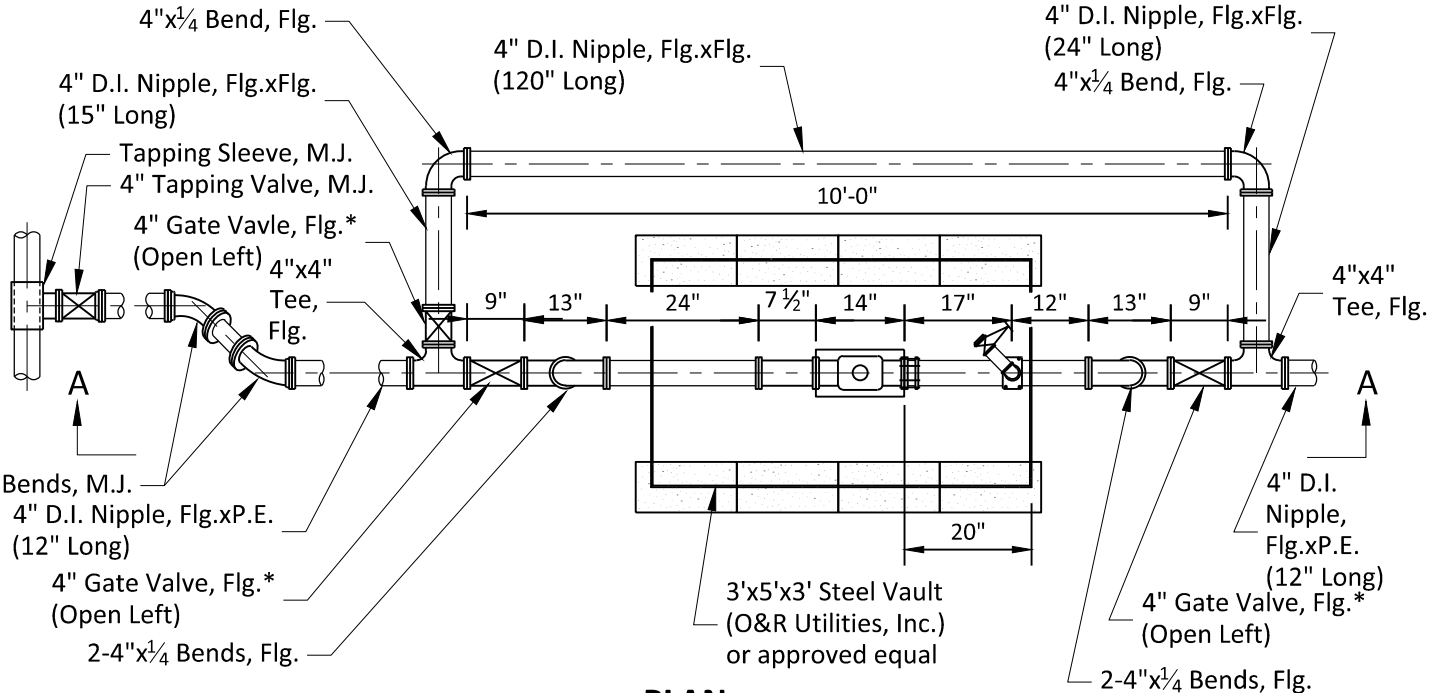
SECTION A-A

3'x5'x3' CONCRETE VAULT (TRAFFIC BEARING LOCATION)

* Resilient Seat

Note:
Insulating kit applies only to D.I. yard piping

PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	3" TURBINE METER INSTALLATION	APPROVED March 2008	REVISED December 2018
		DD-824-06	SHEET 2 OF 2



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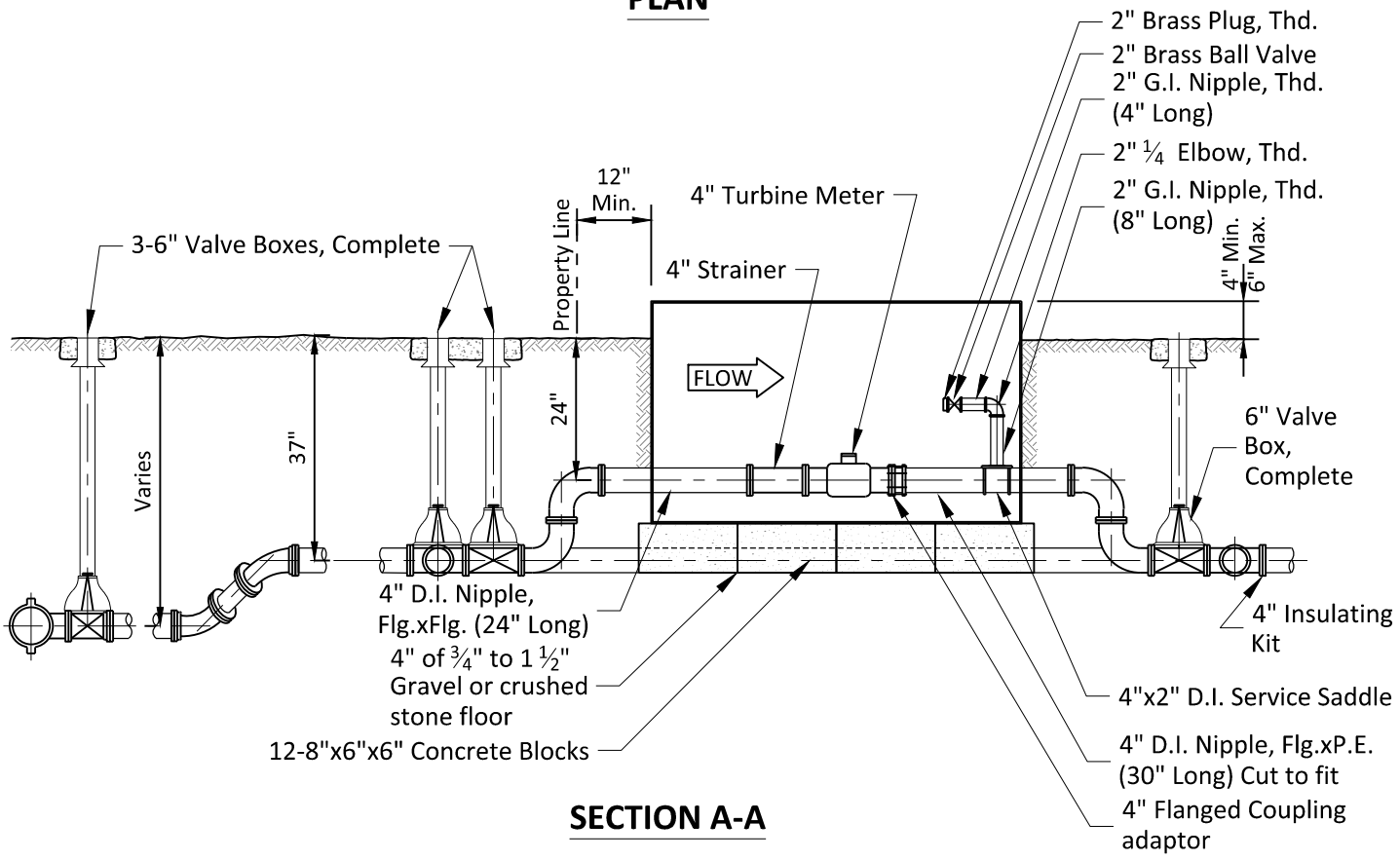


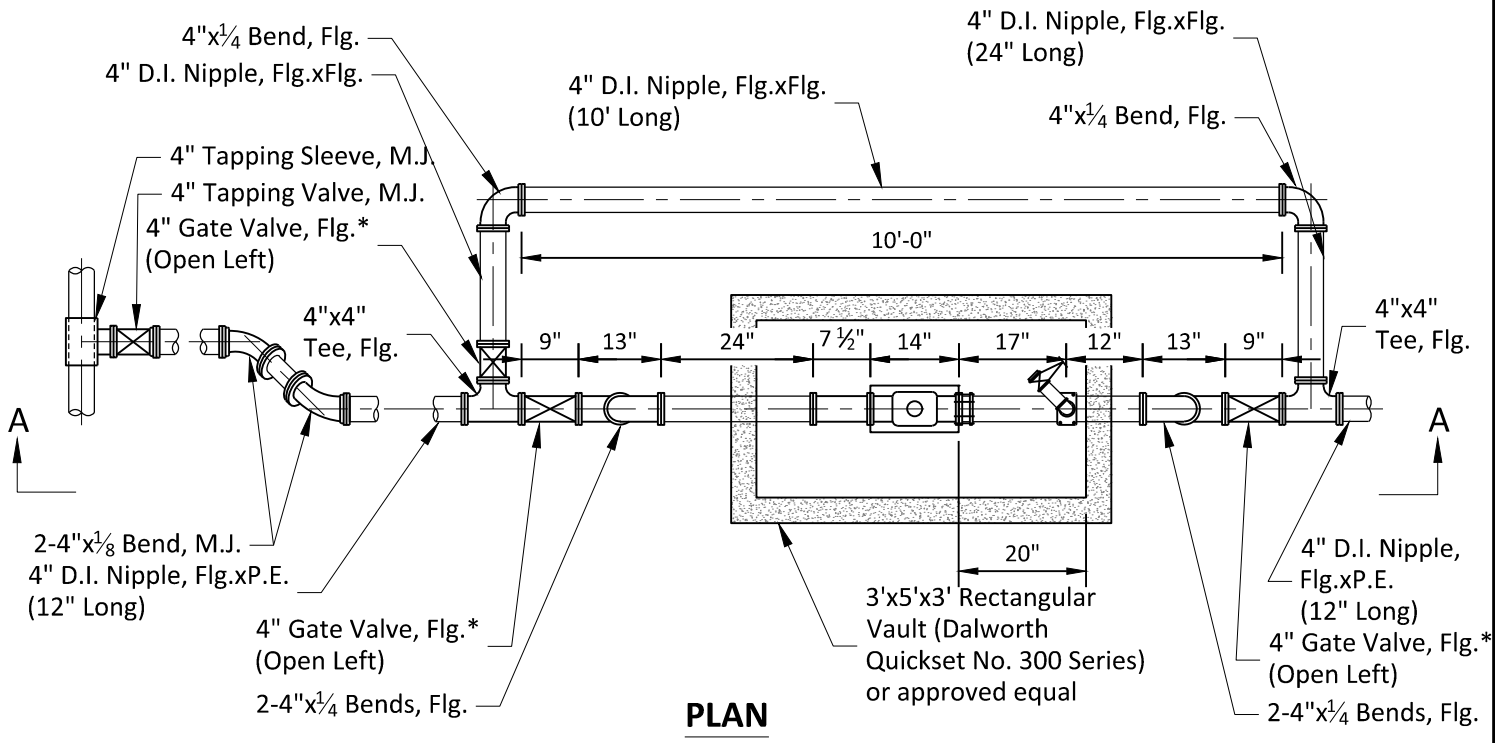
SECTION A-A

3'x5'x3' STEEL VAULT
(NON-TRAFFIC BEARING LOCATION)

Note:
Insulating kit applies only to D.I. yard piping

* Resilient Seat

PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	3" TURBINE METER INSTALLATION	APPROVED March 2008	REVISED December 2018
		DD-824-07	SHEET 1 OF 2



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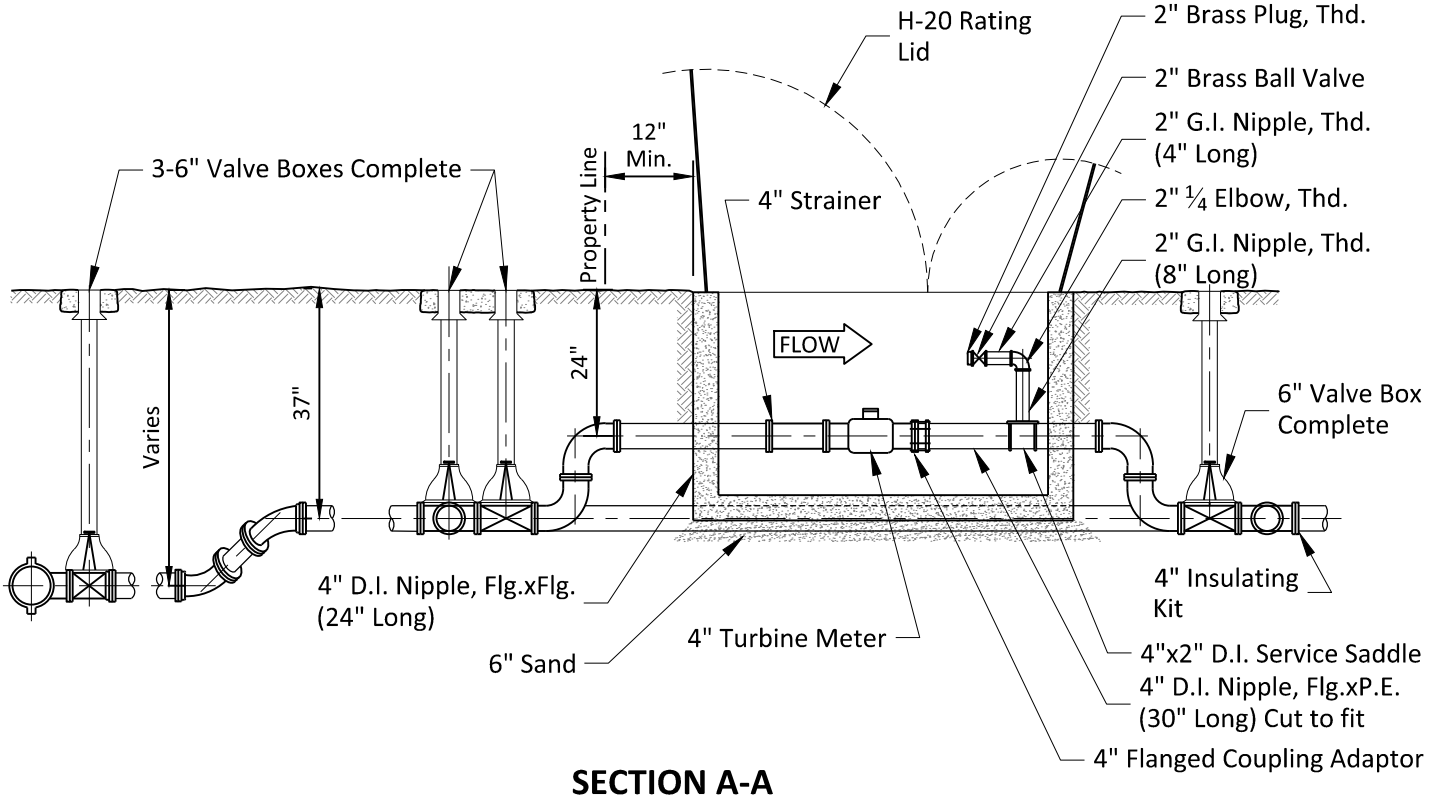


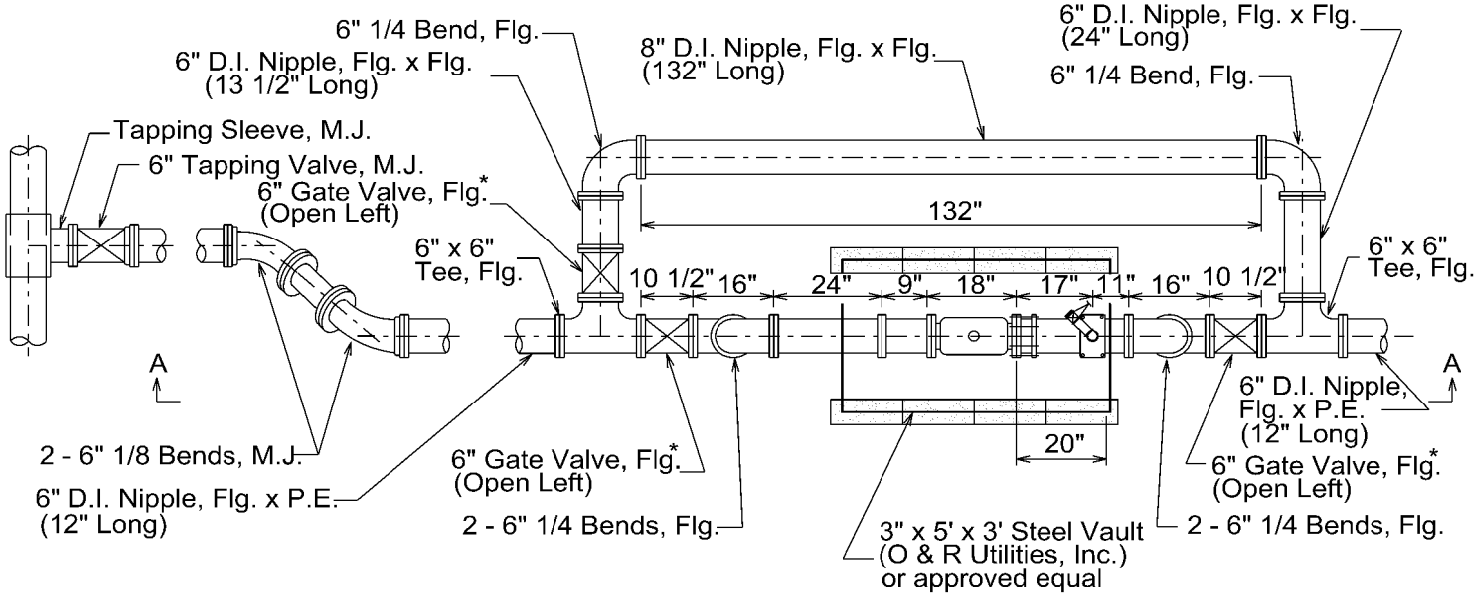
SECTION A-A

3'x5'x3' RECTANGULAR CONCRETE VAULT (TRAFFIC BEARING LOCATION)

Note:
Insulating kit applies
only to D.I. yard piping

* Resilient Seat

PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	4" TURBINE METER INSTALLATION	APPROVED March 2008	REVISED December 2018
		DD-824-07	SHEET 2 OF 2



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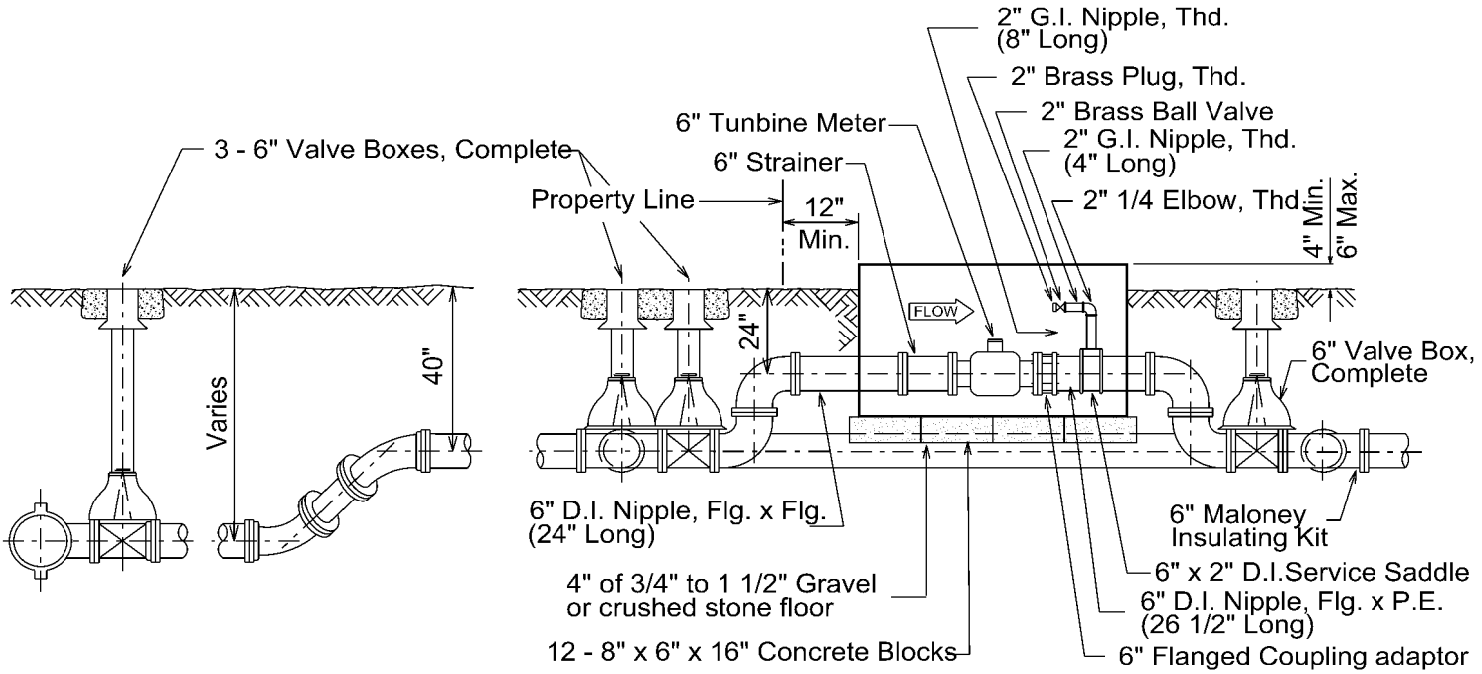
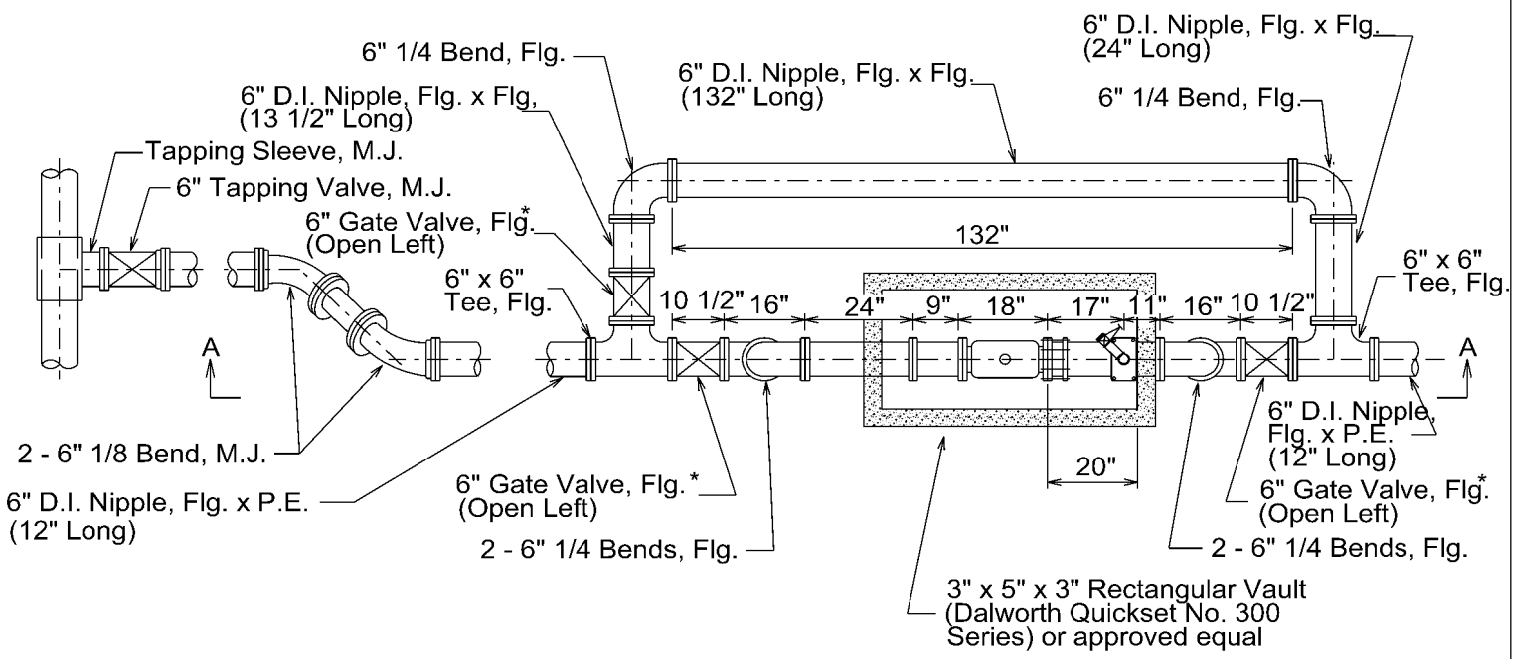


SECTION A-A

* Resilient Seat

3' x 5' x 3' STEEL VAULT
(NON-TRAFFIC BEARING LOCATION)

PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	6" TURBINE METER INSTALLATION	APPROVED March 2008	REVISED AUG 2019
		DD-824-09	SHEET 1 OF 2



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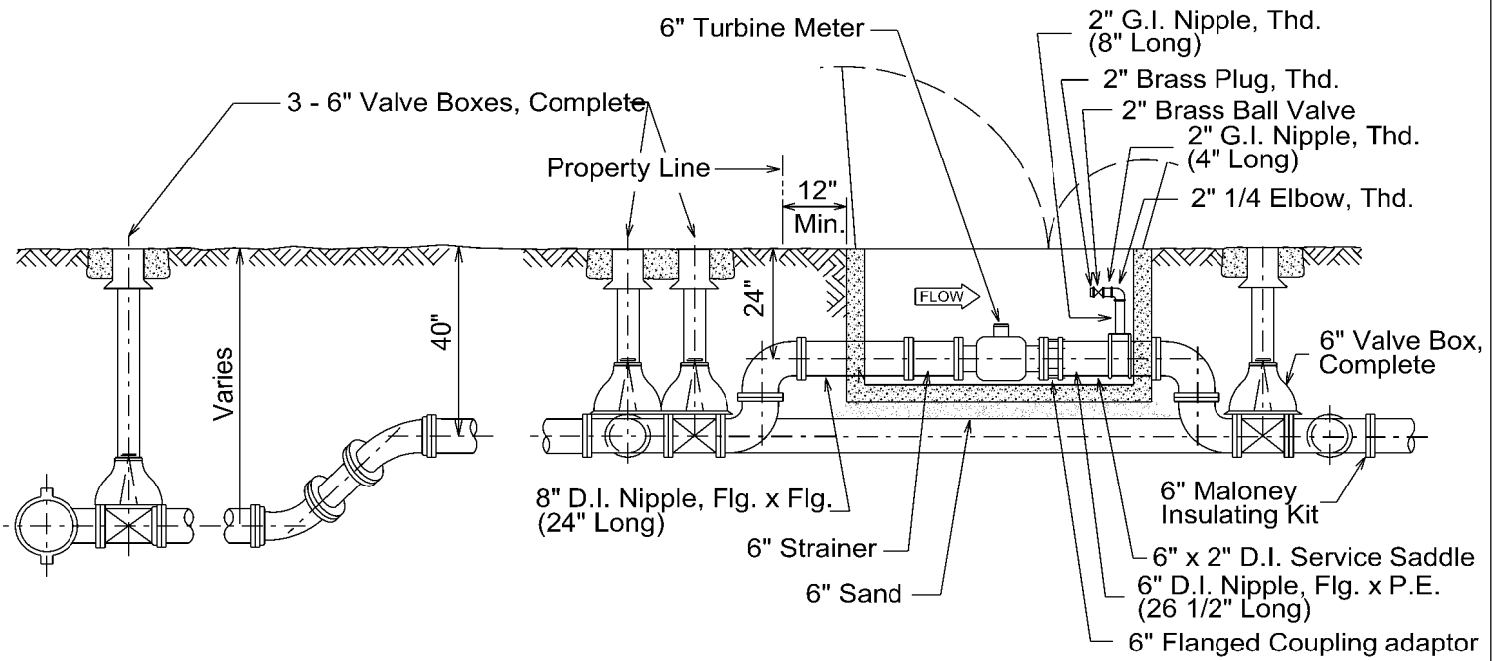
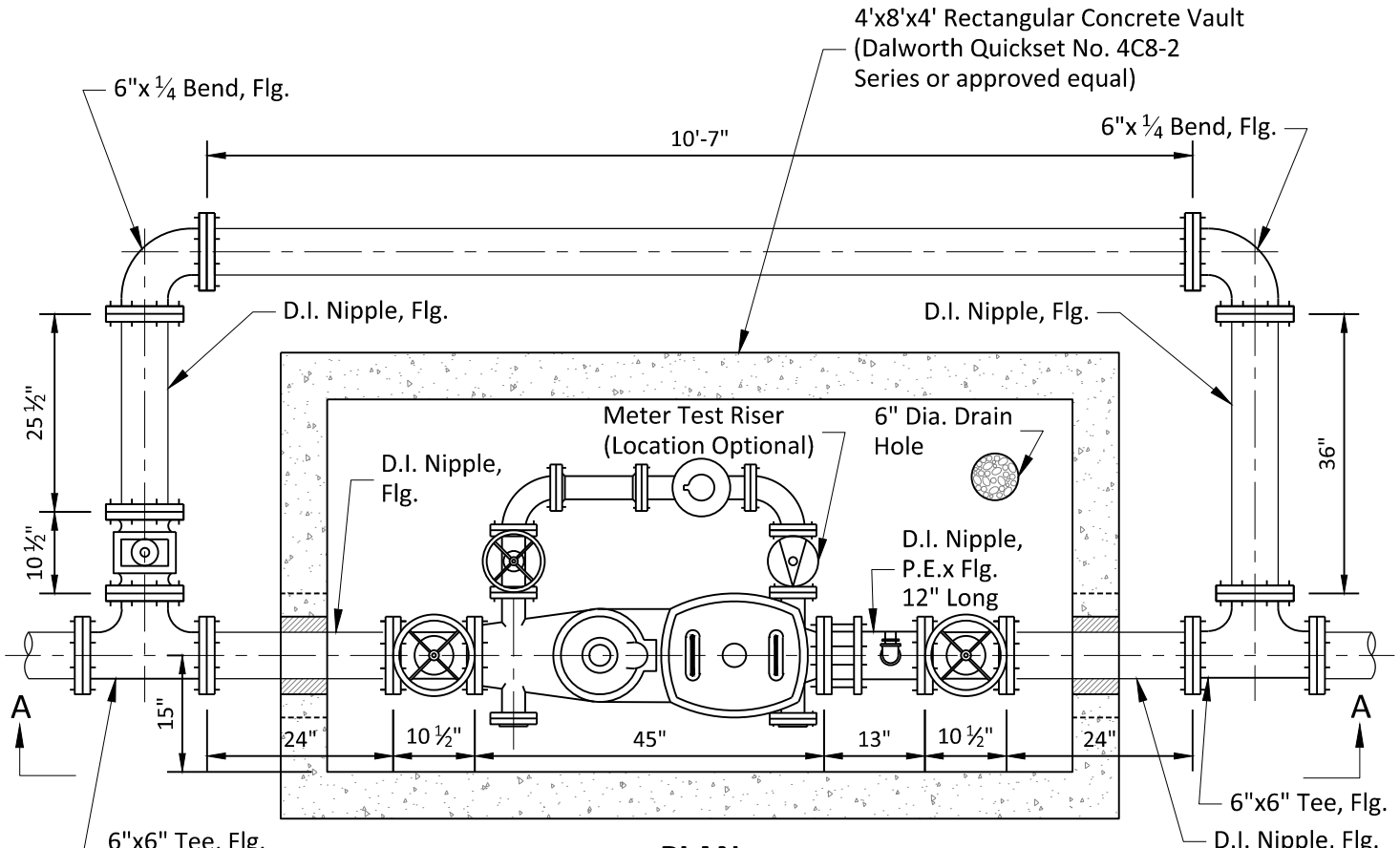


SECTION A-A

3' x 5' x 3' RECTANGULAR CONCRETE VAULT (TRAFFIC BEARING LOCATION)

* Resilient Seat

PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	6" TURBINE METER INSTALLATION	APPROVED March 2008	REVISED AUG 2019
		DD-824-09	SHEET 2 OF 2



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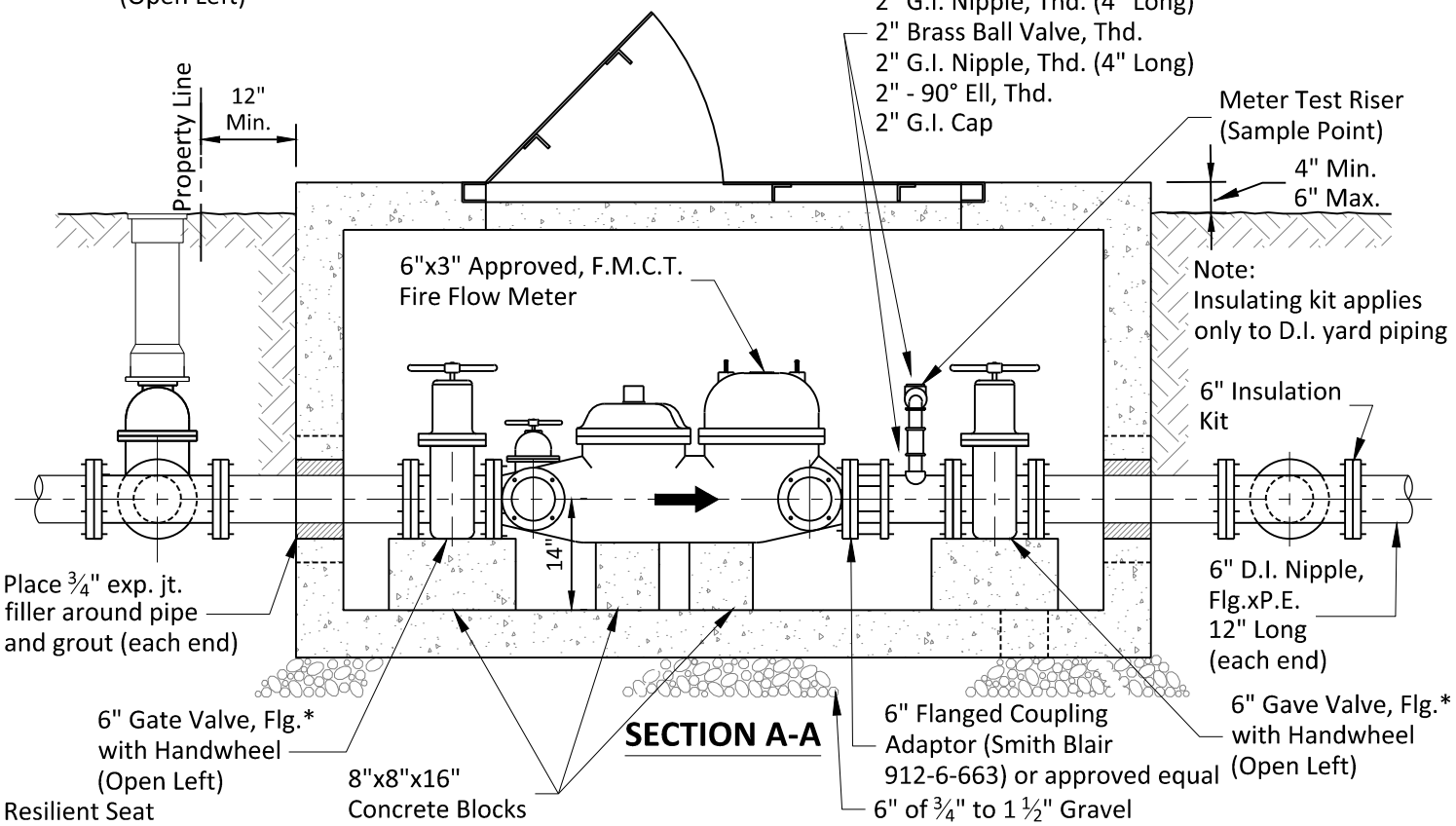
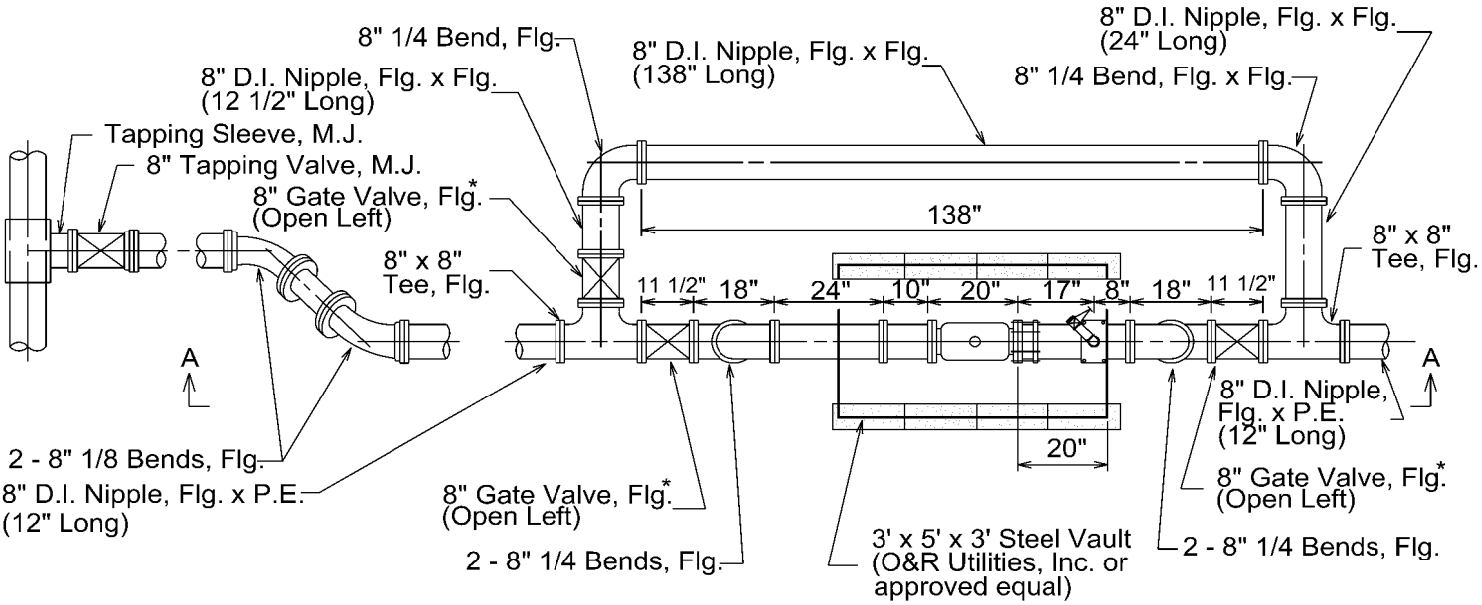


SECTION A-A

* Resilient Seat

PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	6"x3" FIRE FLOW METER INSTALLATION	APPROVED March 2008	REVISED December 2018
		DD-824-10	SHEET 1 OF 1



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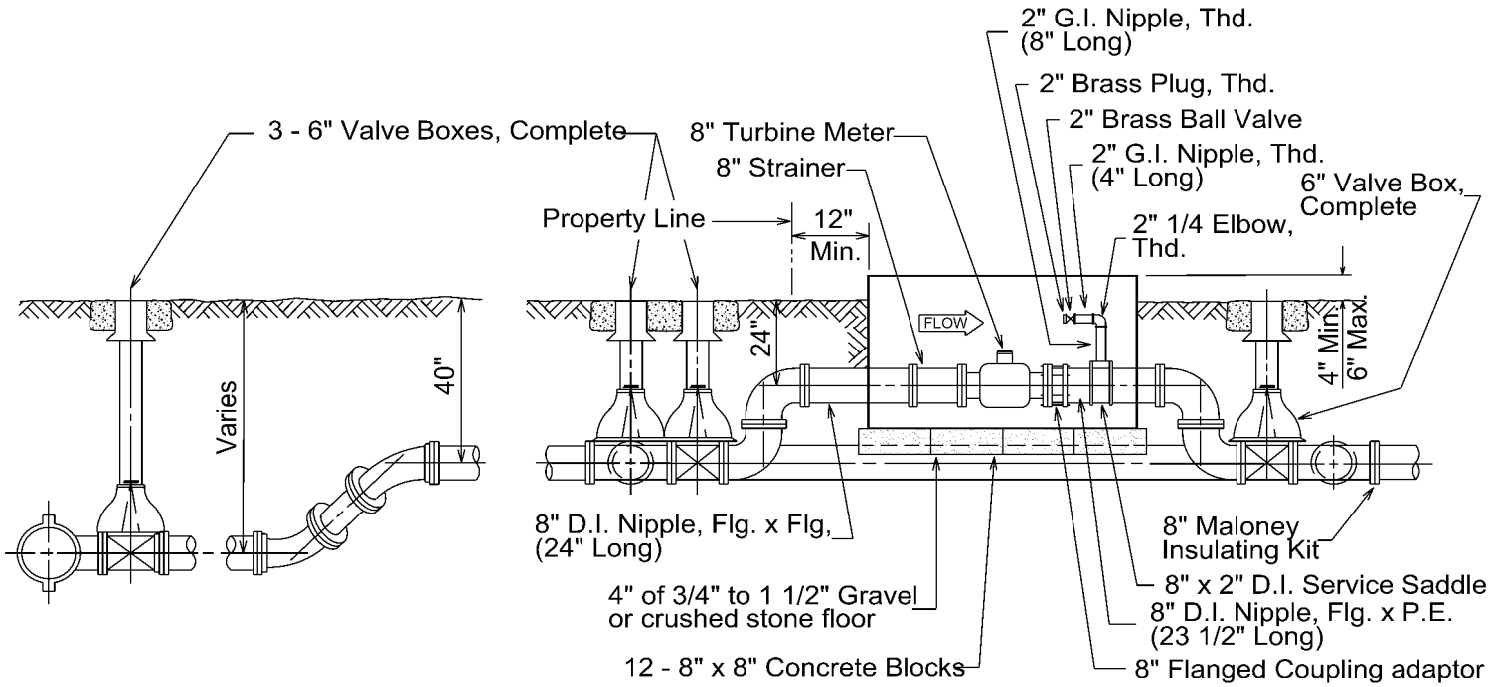
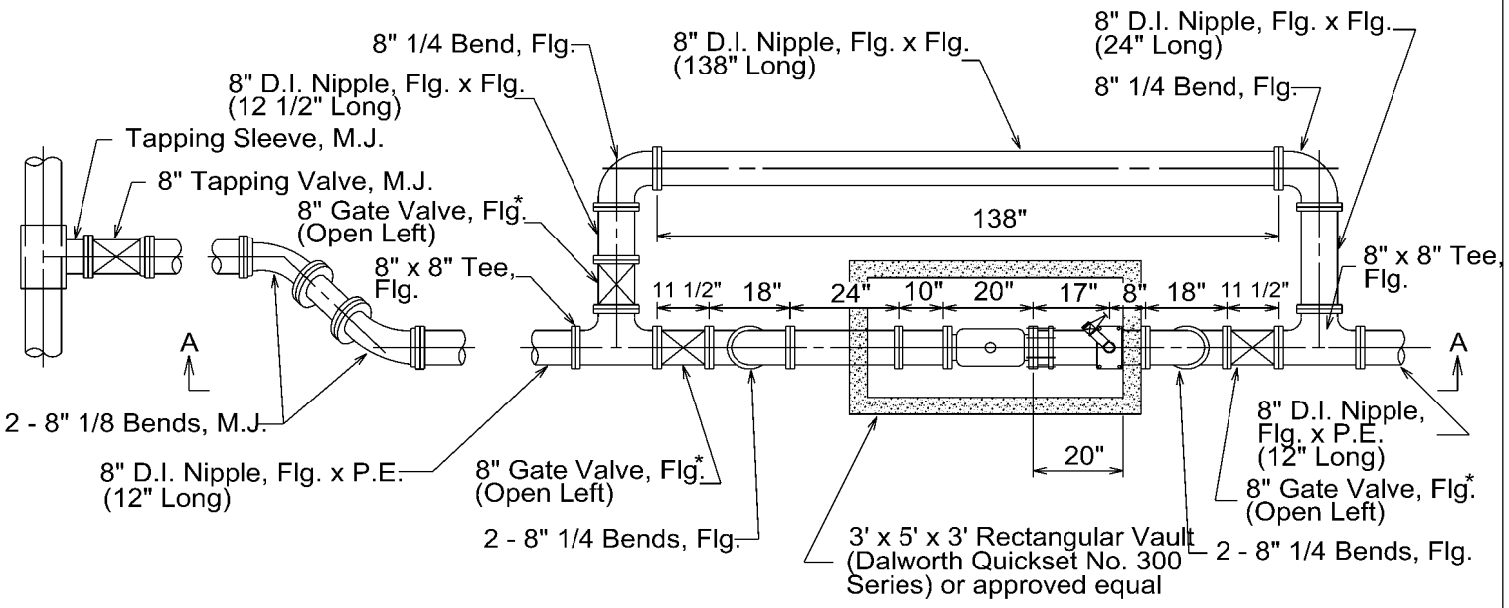


SECTION A-A

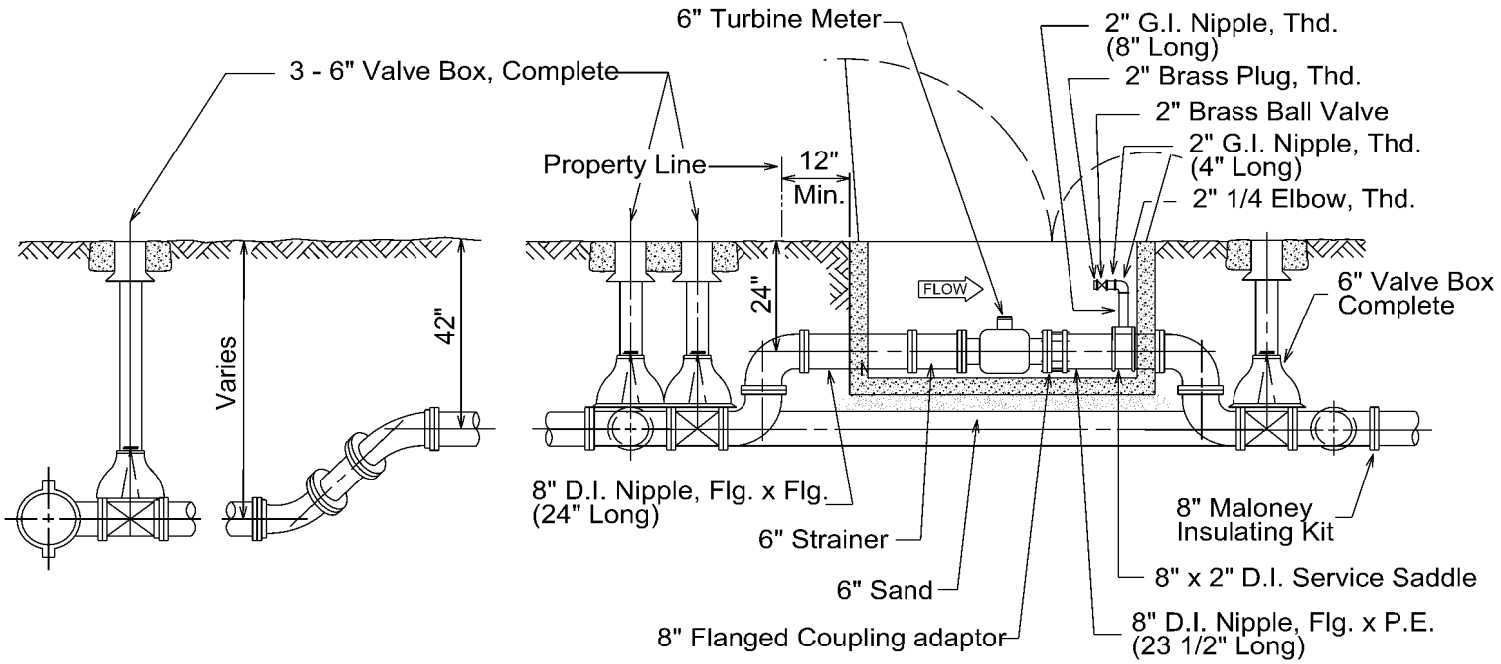
* Resilient Seat

3' x 5' x 3' STEEL VAULT
(NON-TRAFFIC BEARING LOCATION)

PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	8" SERVICE WITH AN 8" TURBINE METER	APPROVED March 2008	REVISED AUG 2019
		DD-824-12	SHEET 1 OF 2



PLAN

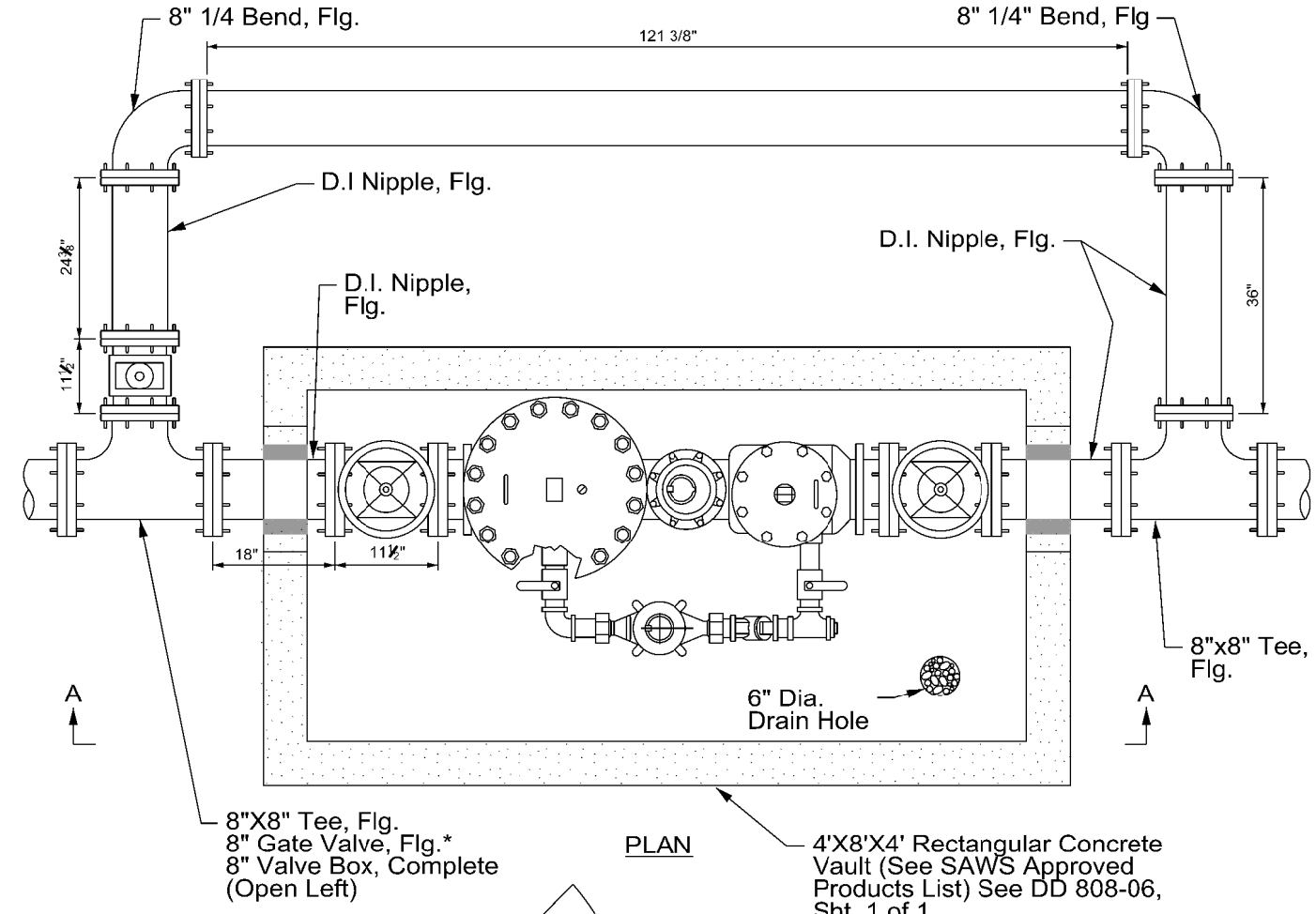


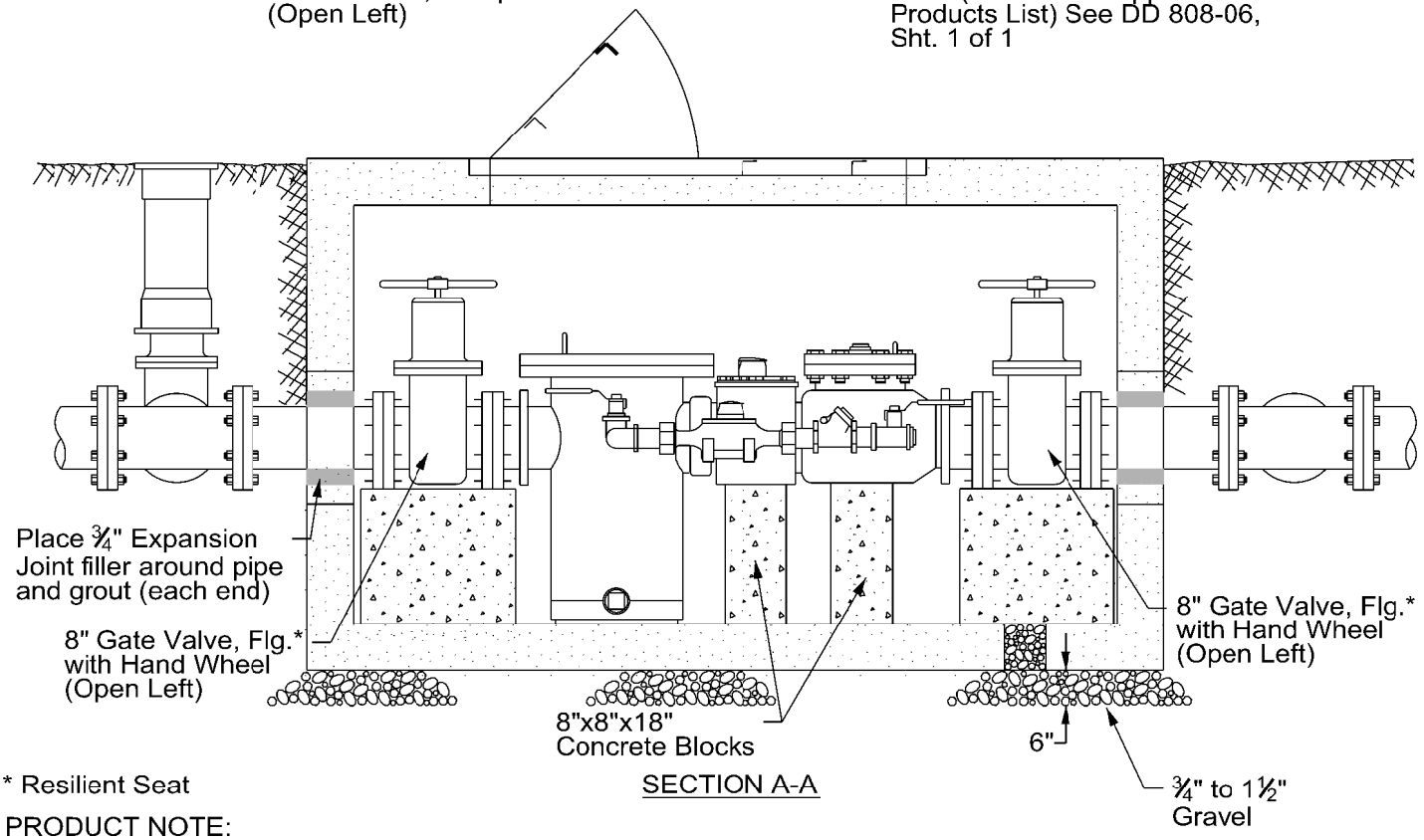
SECTION A-A

* Resilient Seat

3' x 5' x 3' RECTANGULAR CONCRETE VAULT (TRAFFIC BEARING LOCATION)

PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	8" SERVICE WITH AN 8" TURBINE METER	APPROVED March 2008	REVISED AUG 2019
		DD-824-12	SHEET 2 OF 2



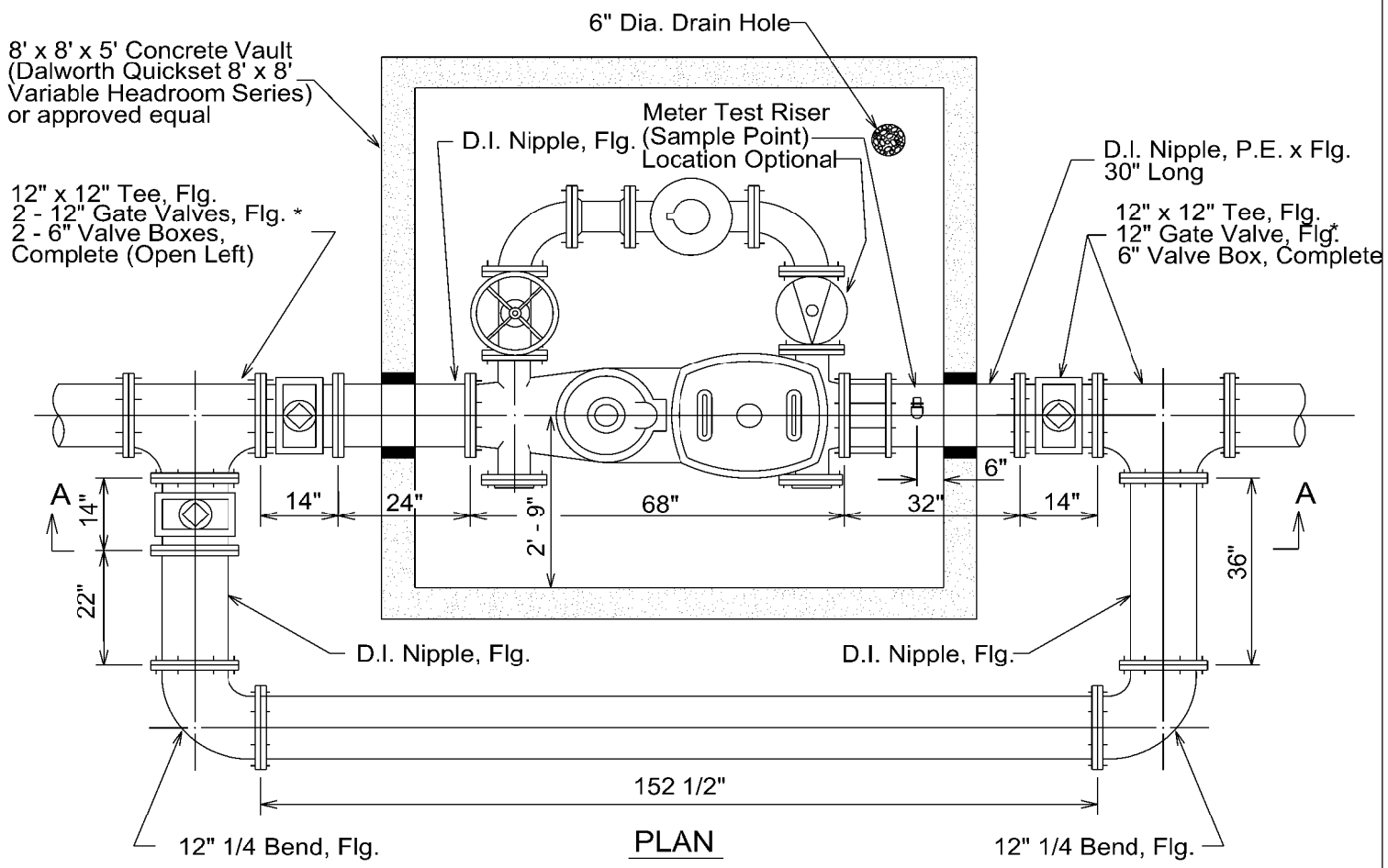


* Resilient Seat

SECTION A-A

PRODUCT NOTE:
NEPTUNE TECHNOLOGY GROUP
HIGH PERFORMANCE PROTECTUS III - FIRE SERVICE METER

PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	8" X 2" COMBINATION FIRE & DOMESTIC METER INSTALLATION	APPROVED March 2008	REVISED AUG 2019
		DD-824-13	SHEET 1 OF 1



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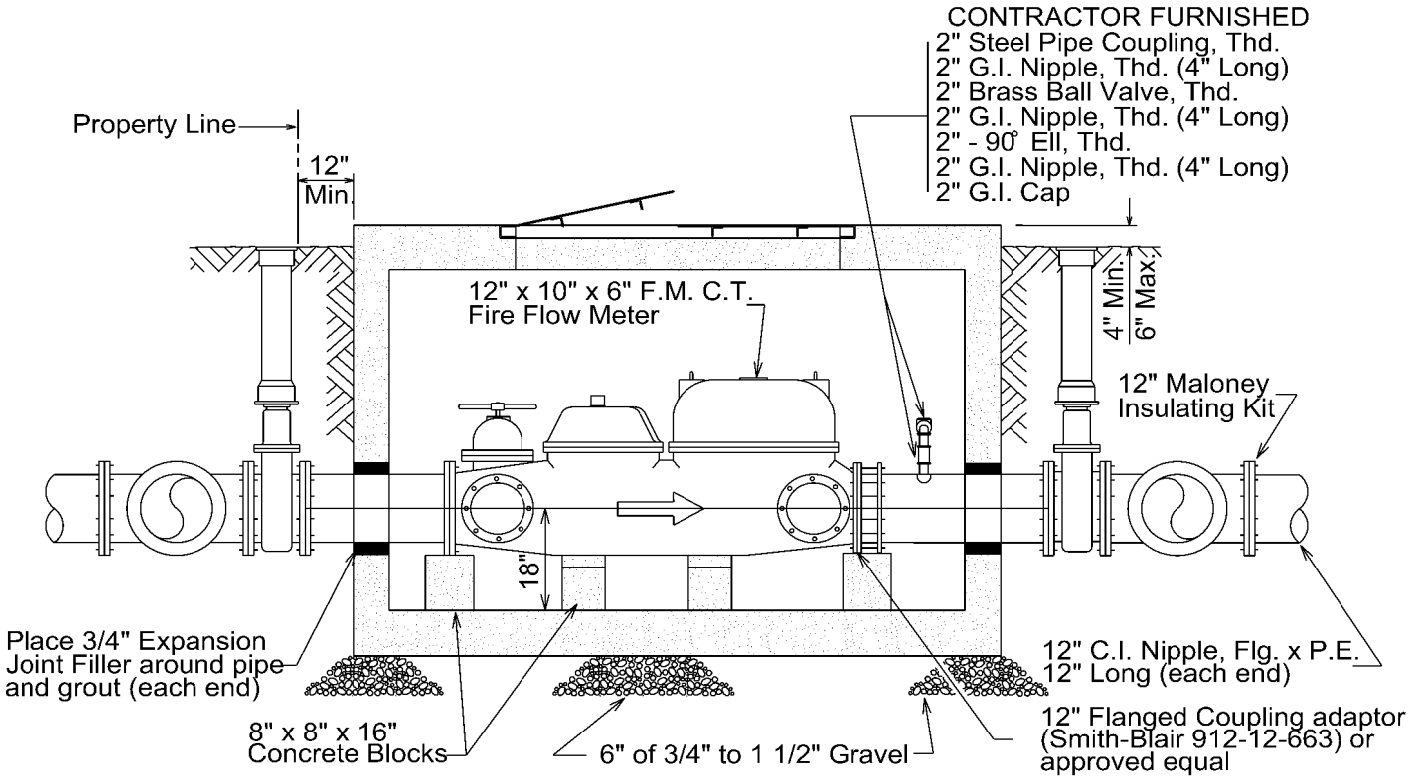
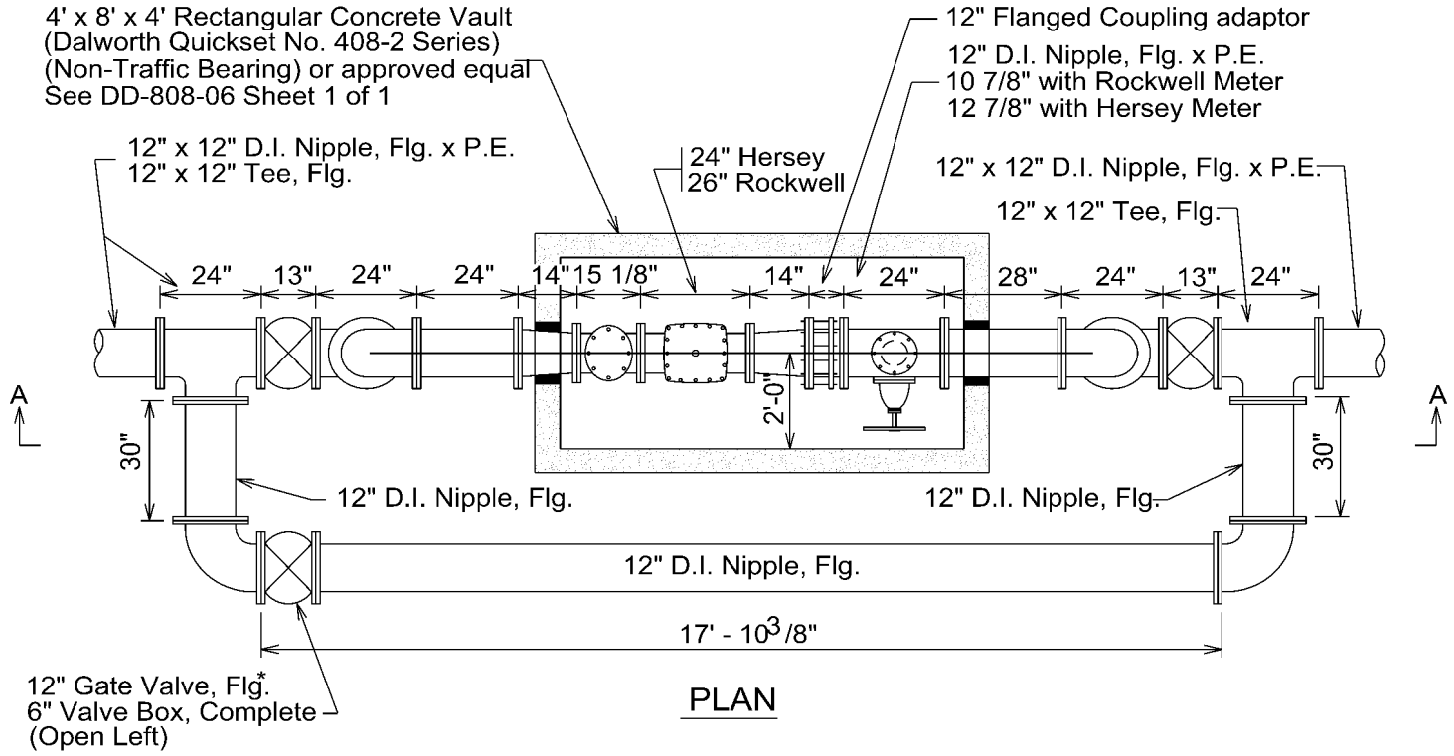


* Resilient Seat

SECTION A-A

PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	12" X 10" X 6 FIRE FLOW METER INSTALLATION	APPROVED March 2008	REVISED AUG 2019
		DD-824-14	SHEET 1 OF 1



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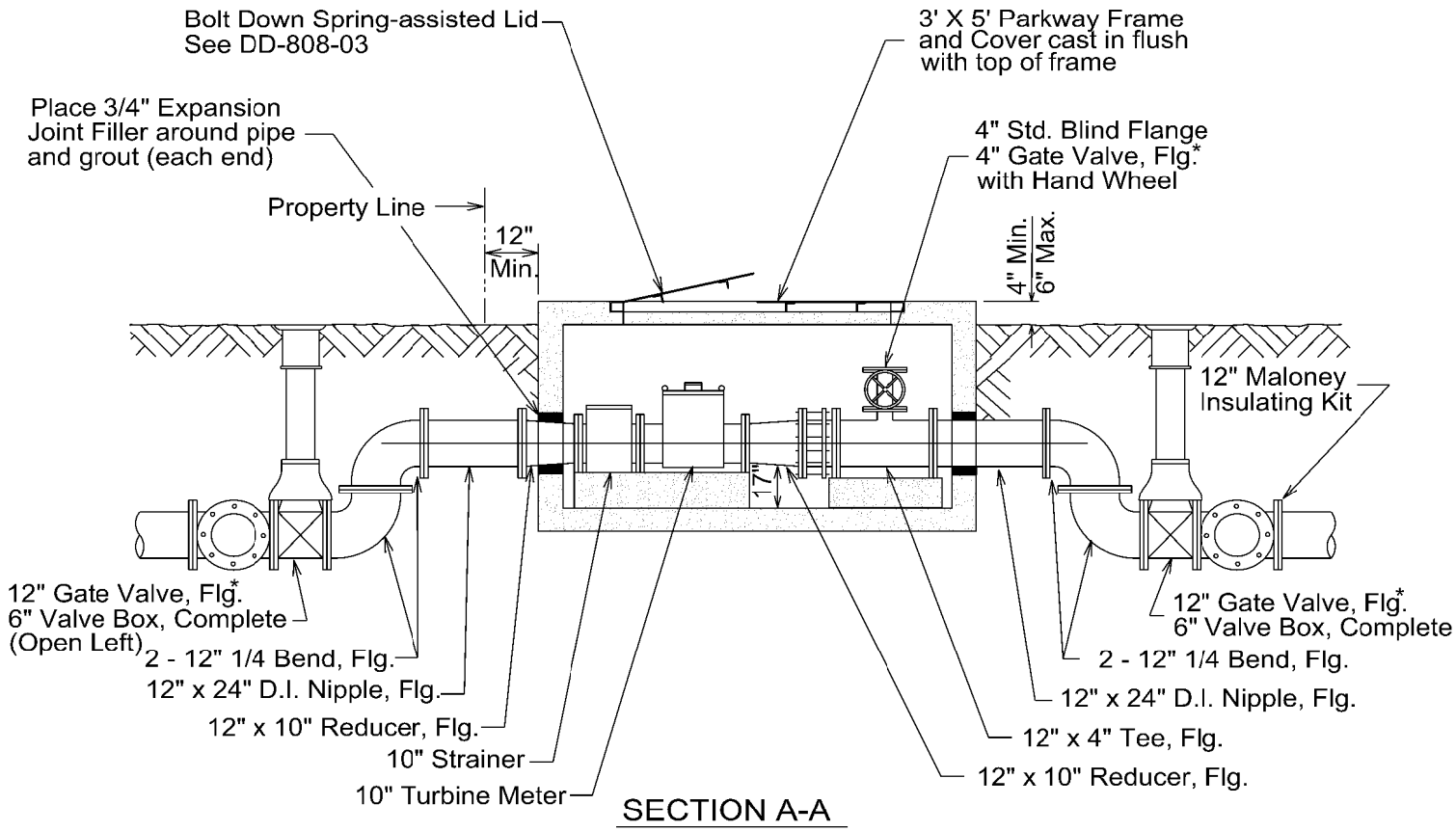
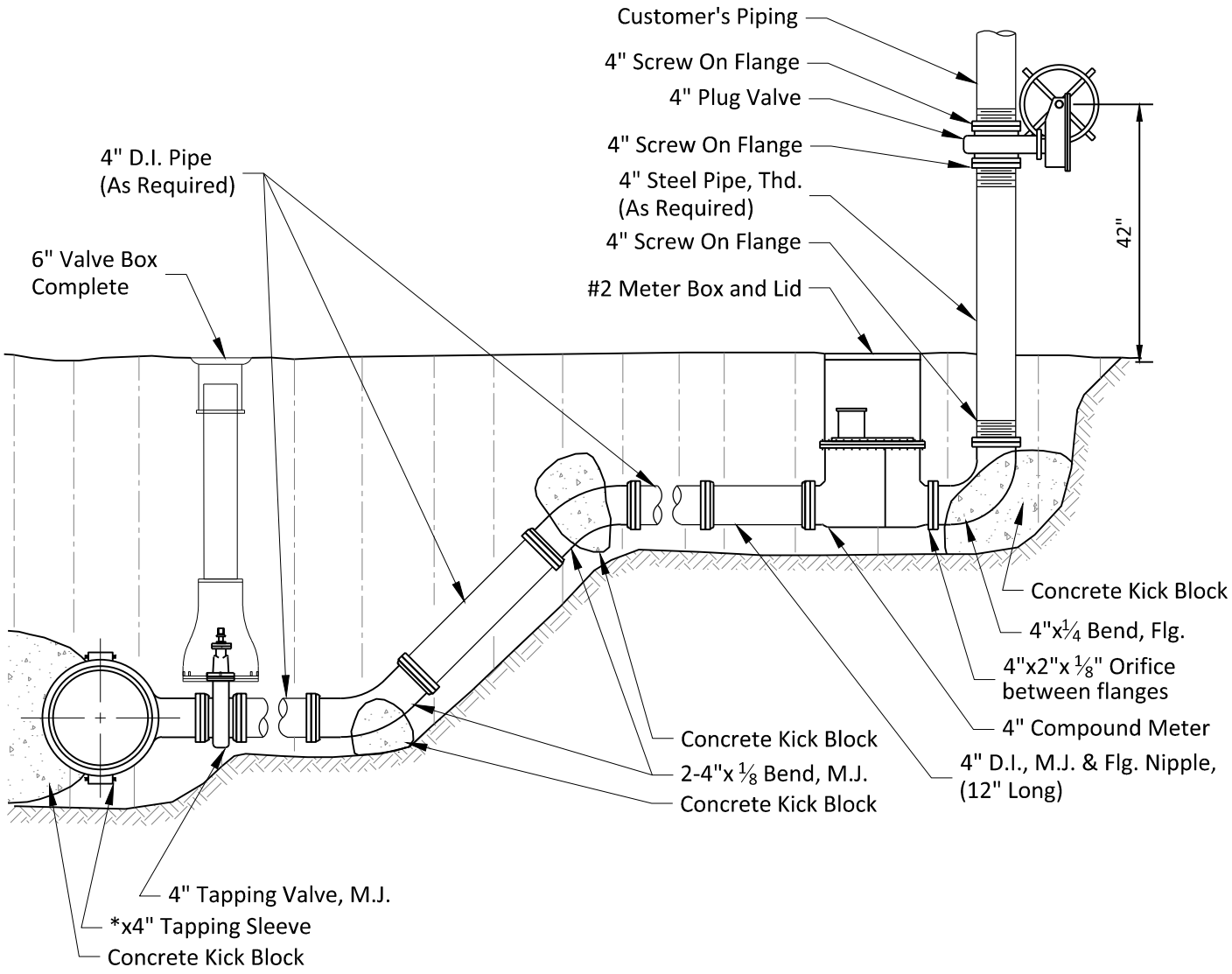


SECTION A-A

* Resilient Seat

PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	12" SERVICE WITH 10" TURBINE METER	APPROVED March 2008	REVISED AUG 2019
		DD-824-15	SHEET 1 OF 1

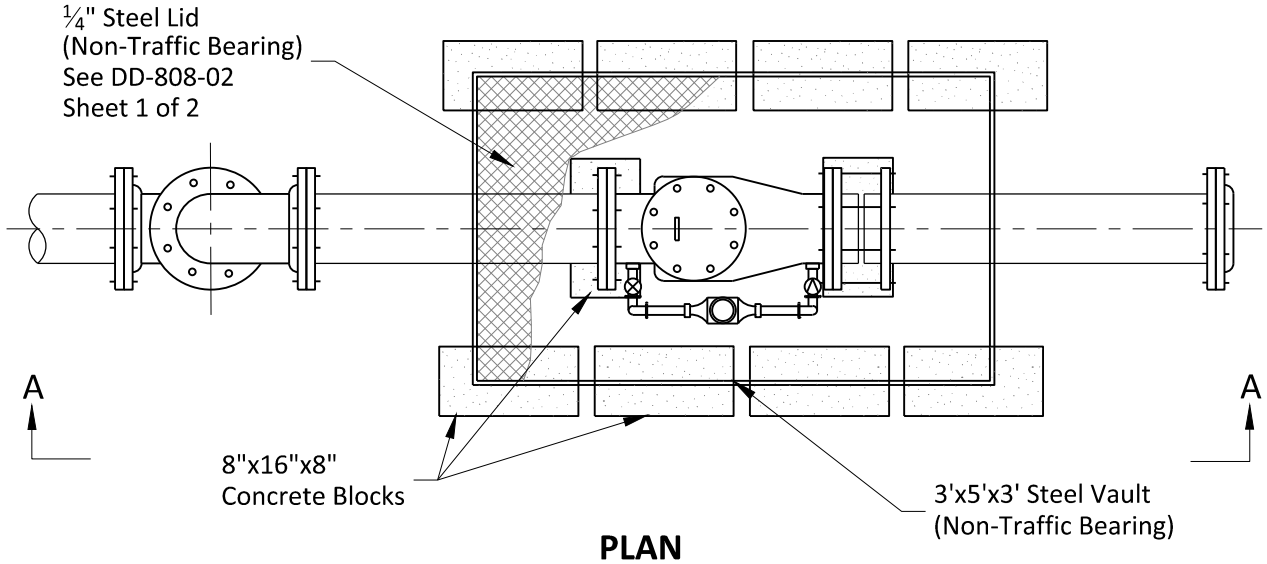


NOT TO SCALE

* Existing main size and type

PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	TYPICAL TEMPORARY 4" SERVICE WITH 4" METER (WITH PLUG VALVE)	APPROVED March 2008	REVISED December 2018
		DD-824-16	SHEET 1 OF 1

PIPE DIAMETER	DETECTOR CHECK	BY-PASS METER	SMITH-BLAIR COUPLING
6"	6"	¾"	1932-6-690
8"	8"	1"	932-8-905



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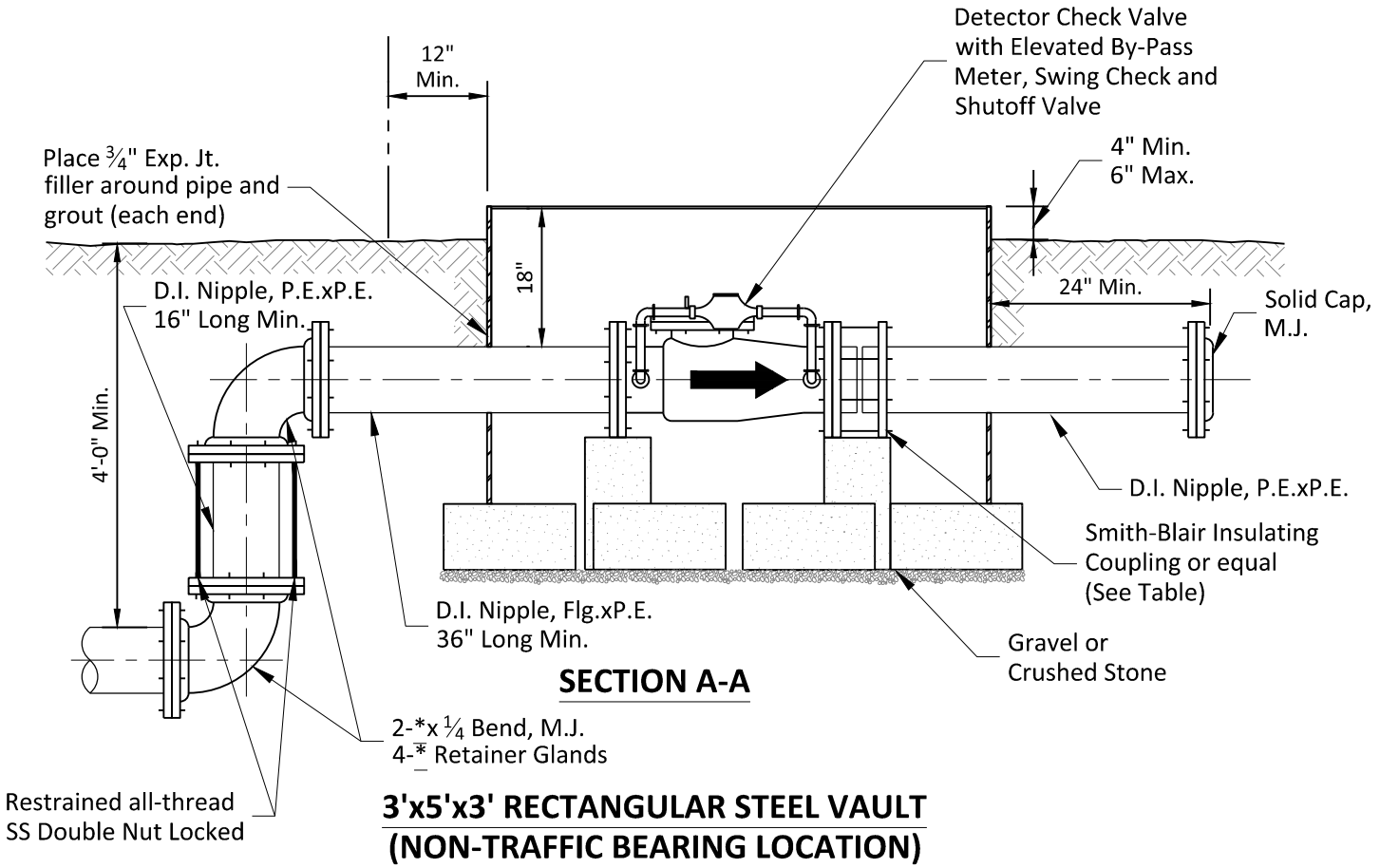
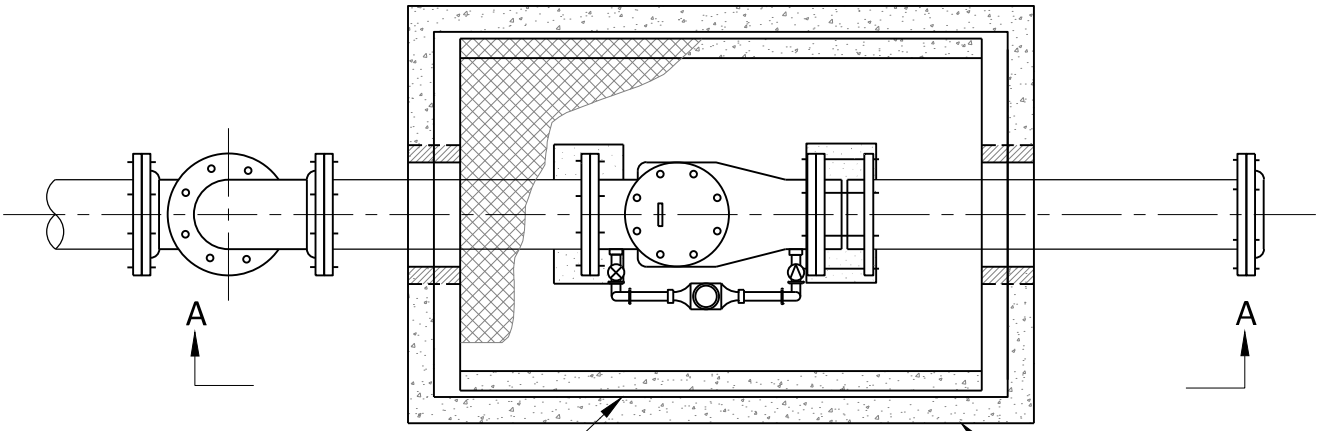


SECTION A-A

3'x5'x3' RECTANGULAR STEEL VAULT (NON-TRAFFIC BEARING LOCATION)

PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	6" & 8" DETECTOR CHECK FOR FIRE LINE	APPROVED March 2008	REVISED December 2019
		DD-824-17	SHEET 1 OF 2

PIPE DIAMETER	DETECTOR CHECK	BY-PASS METER	SMITH-BLAIR COUPLING
6"	6"	¾"	1932-6-690
8"	8"	1"	932-8-905



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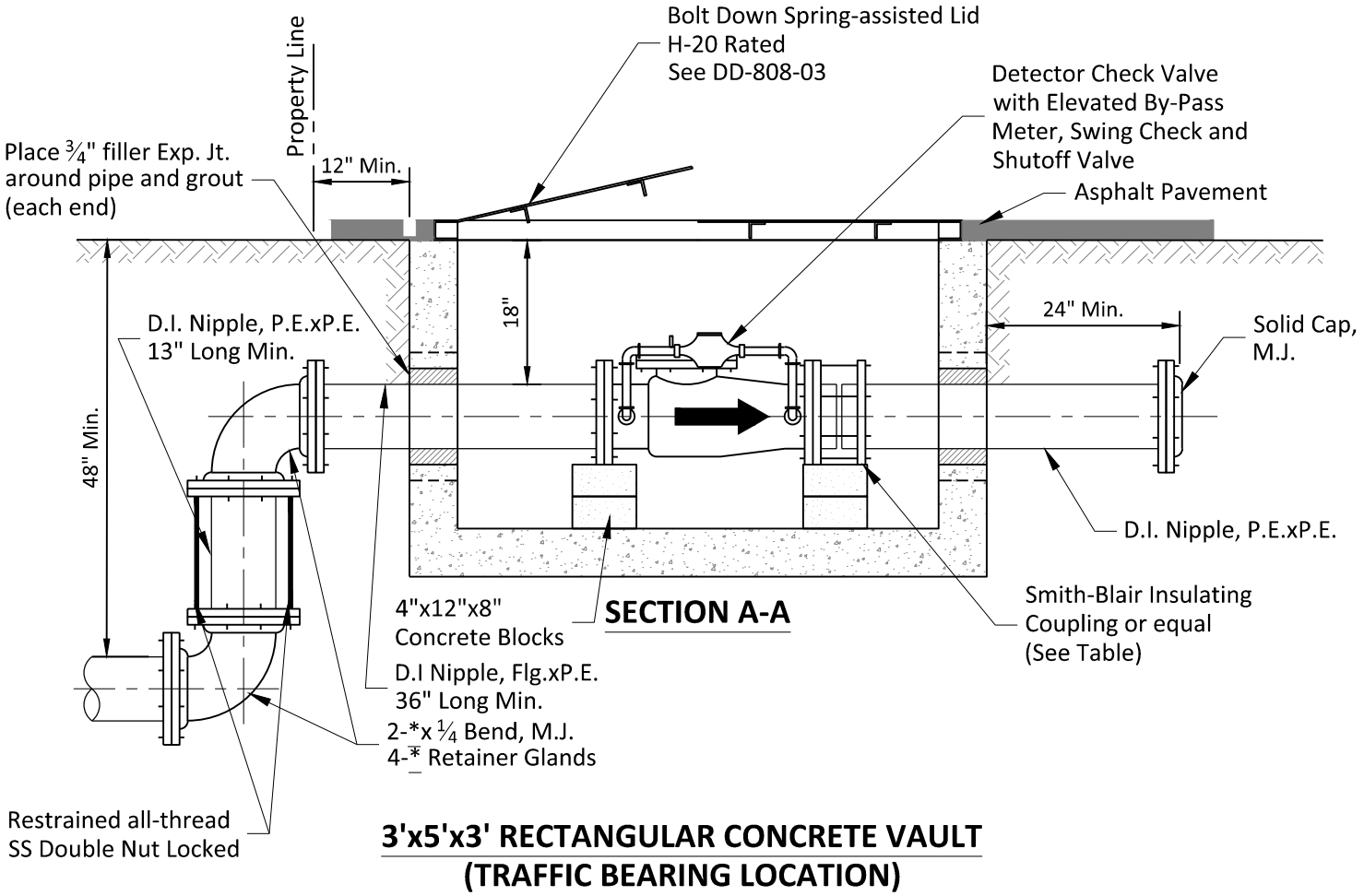
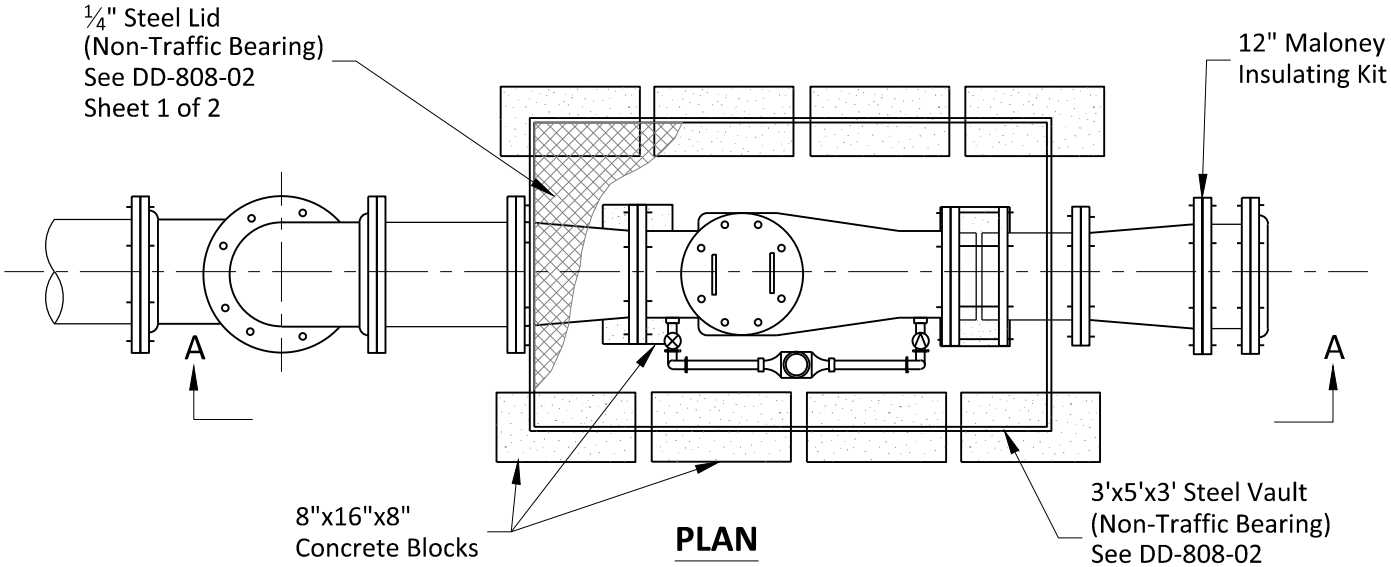


SECTION A-A

3'x5'x3' RECTANGULAR CONCRETE VAULT
(TRAFFIC BEARING LOCATION)

PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	6" & 8" DETECTOR CHECK FOR FIRE LINE	APPROVED March 2008	REVISED December 2018
		DD-824-17	SHEET 2 OF 2

PIPE DIAMETER	DETECTOR CHECK	BY-PASS METER	SMITH-BLAIR COUPLING
10"	10"	1"	912-10-663



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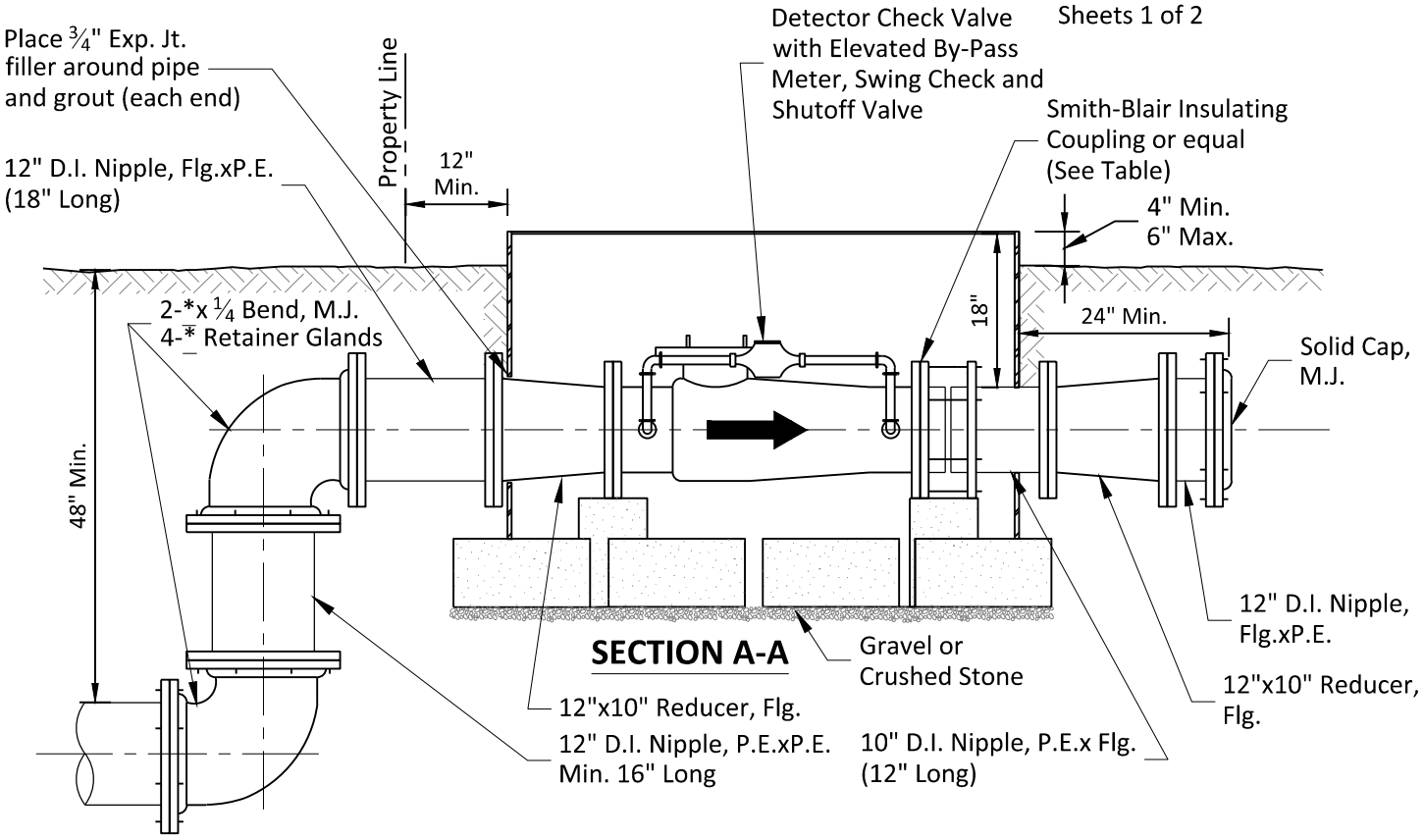
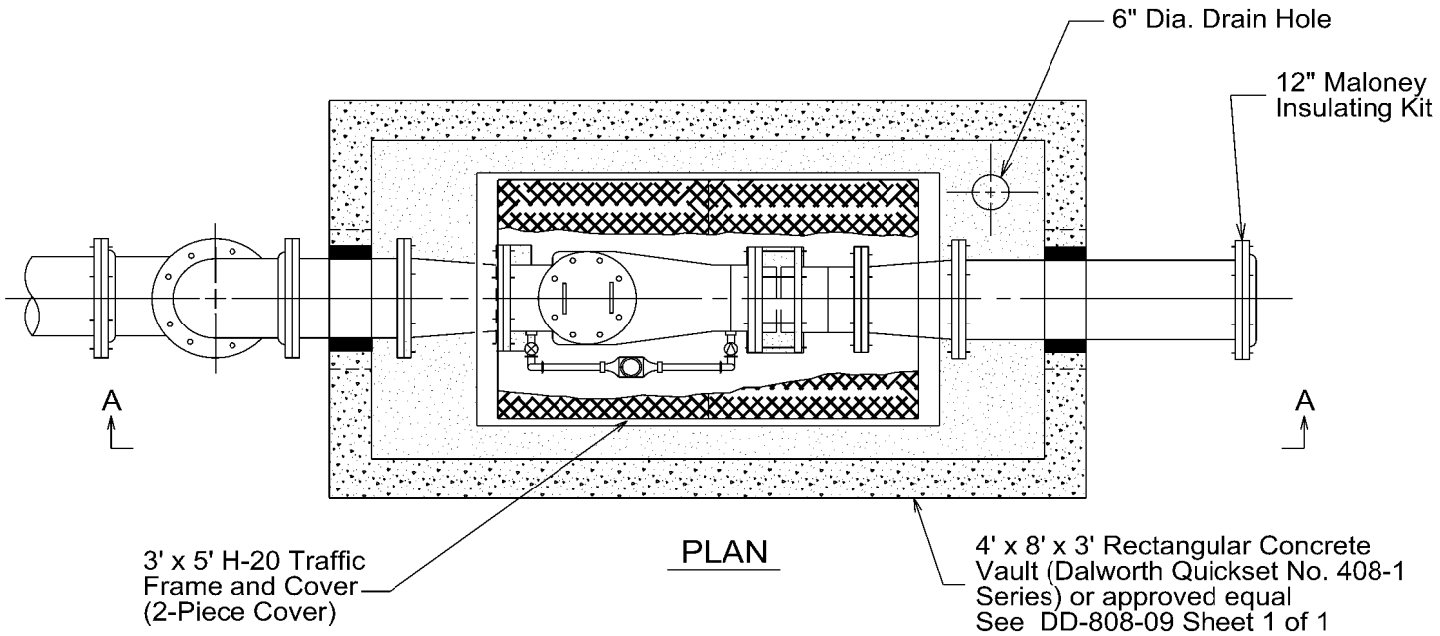


SECTION A-A

3'x5'x3' RECTANGULAR STEEL VAULT
(NON-TRAFFIC BEARING LOCATION)

PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	10"x12" DETECTOR CHECK FOR FIRE LINE	APPROVED March 2008	REVISED December 2018
		DD-824-18	SHEET 1 OF 2

PIPE DIAMETER	DETECTOR CHECK	BY-PASS METER	SMITH-BLAIR COUPLING
10"	10"	1"	912-10-663



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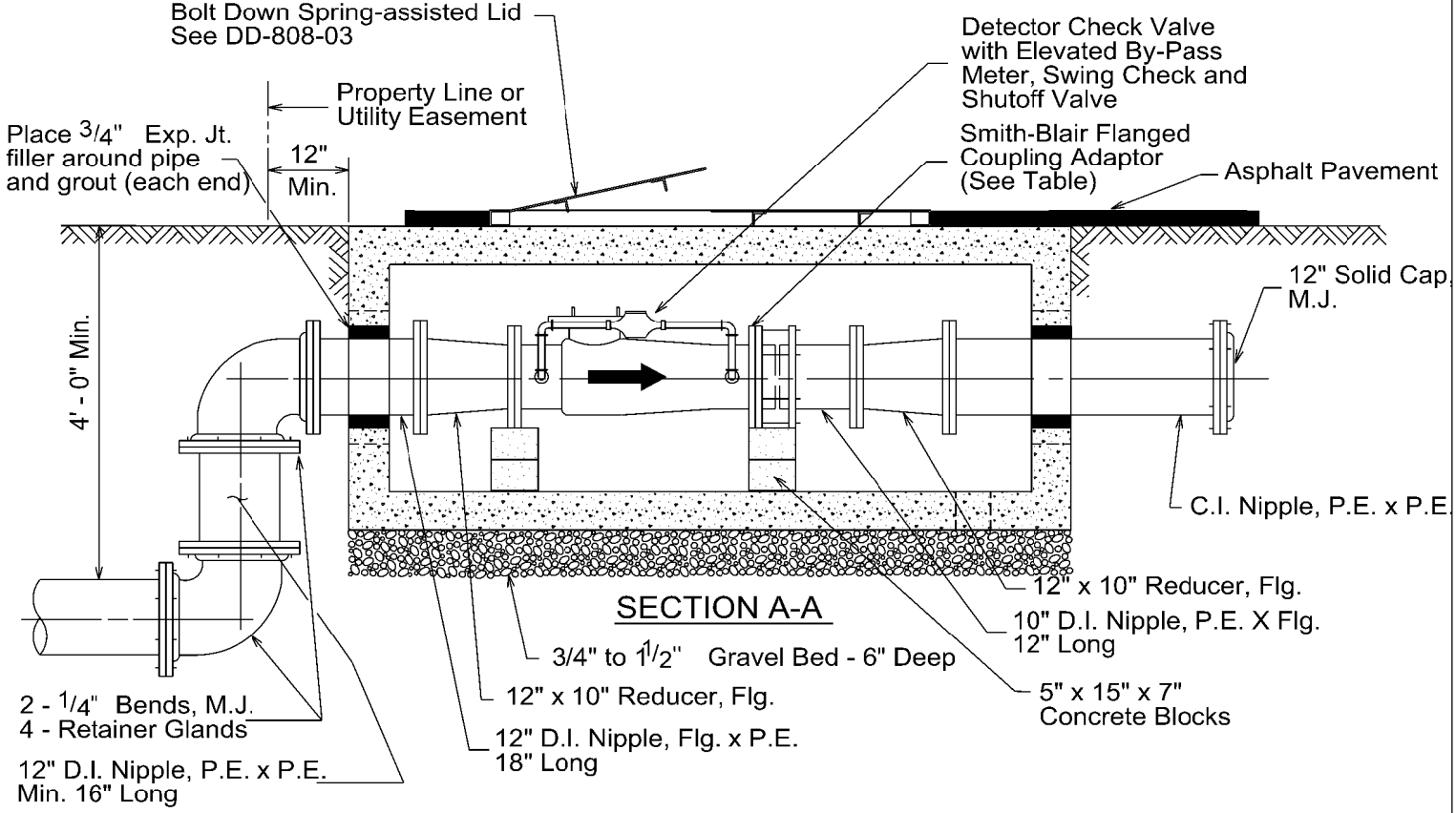
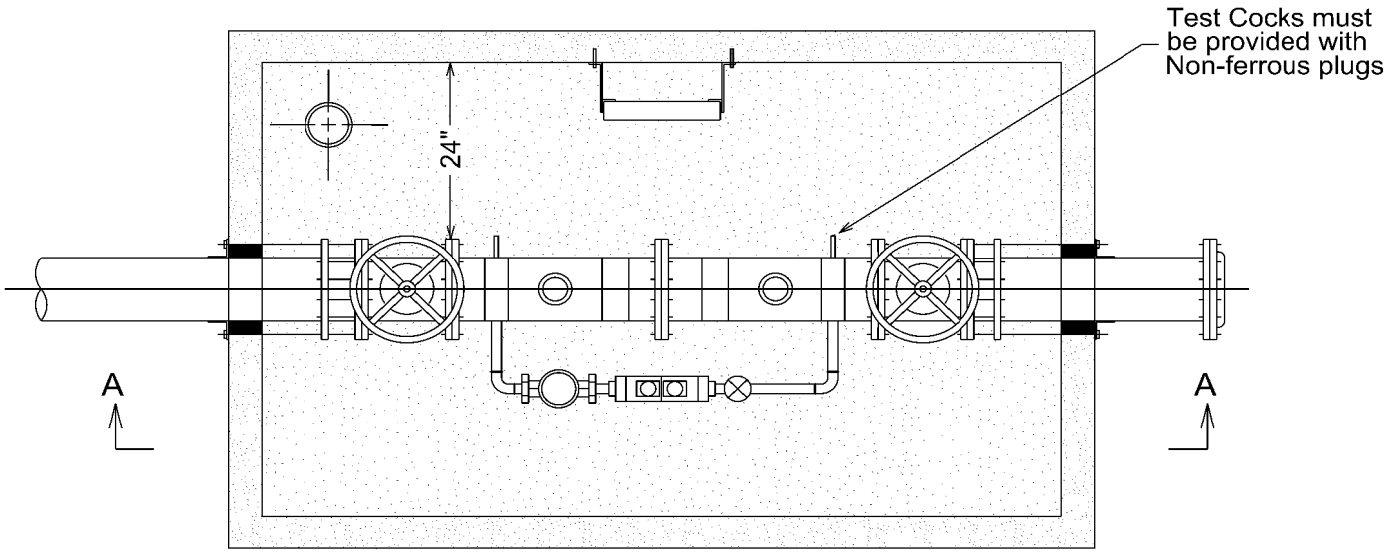


SECTION A-A

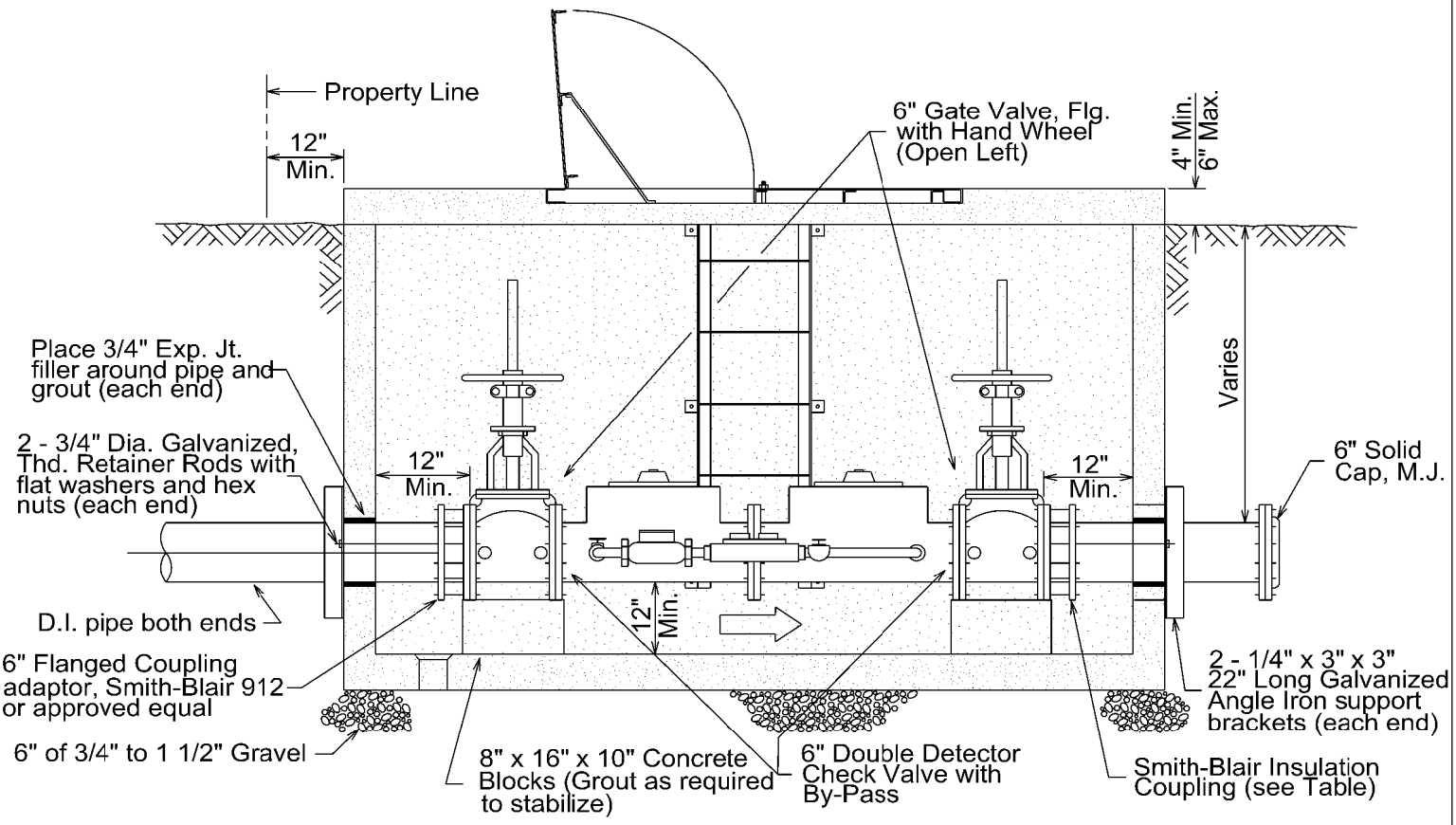
4' x 8' x 3' RECTANGULAR CONCRETE VAULT
(TRAFFIC BEARING LOCATION)

PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	10" X 12" DETECTOR CHECK FOR FIRE LINE	APPROVED March 2008	REVISED AUG 2019
		DD-824-18	SHEET 2 OF 2

Pipe Diameter	Double Detector Check	By-Pass Meter	Smith-Blair Coupling
6"	6"	5/8" - 3/4"	1932-6-690
8"	8"	5/8" - 3/4"	932-8-905



PLAN

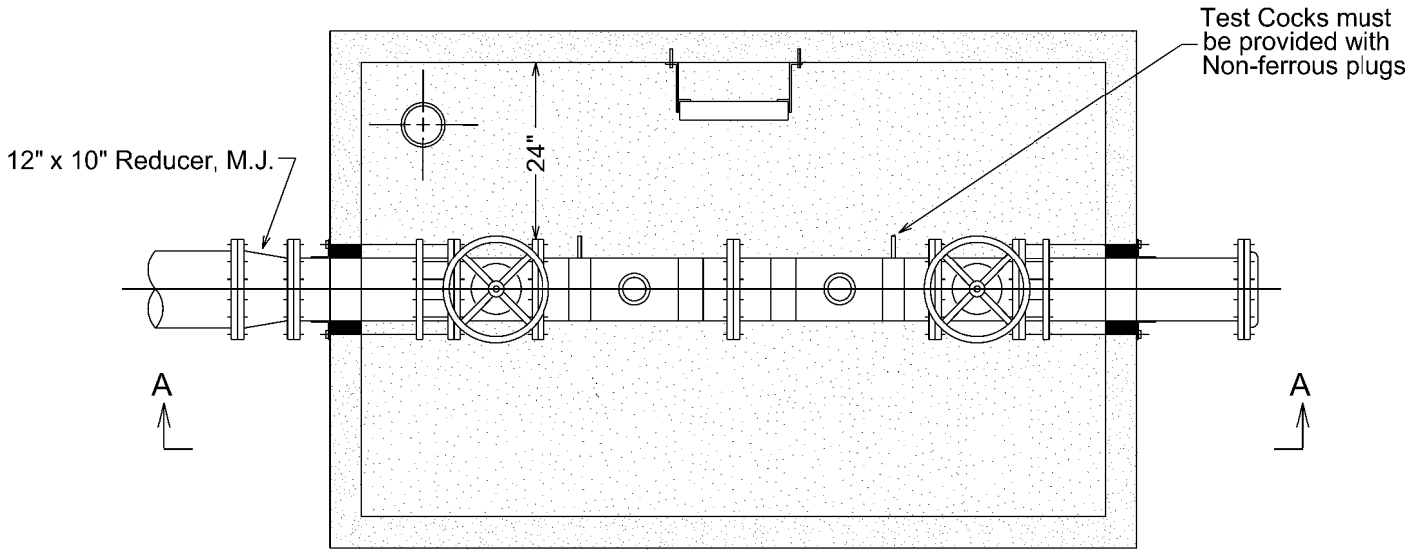


SECTION A-A

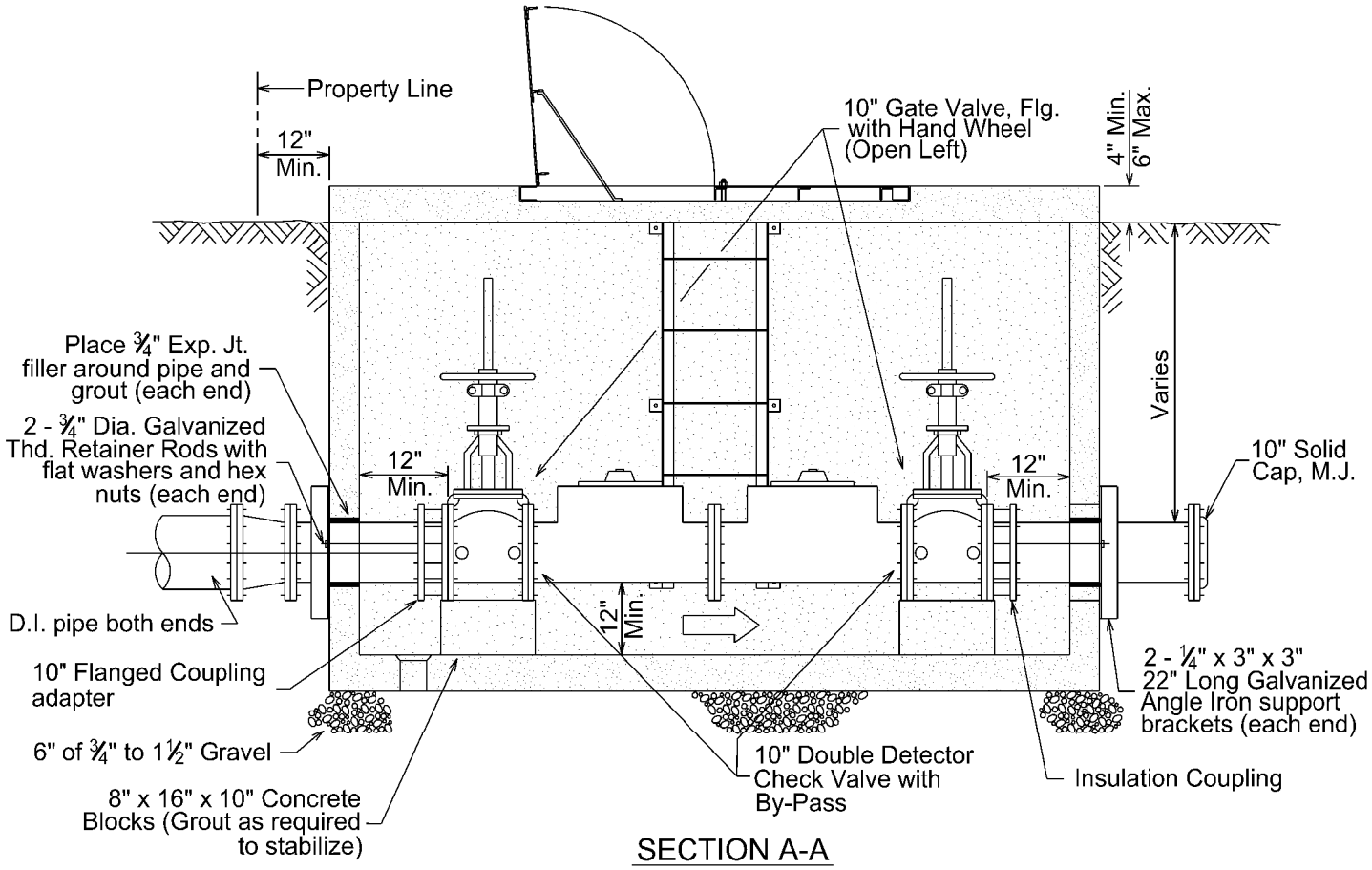
Notes:
1. Tamper switches may be required by Fire Code.
2. Assemblies must be U.L. Listed for Fire Protection purposes.

PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	6" & 8" DOUBLE CHECK (DCDA) DETECTOR ASSEMBLY INSTALLATION	APPROVED March 2008	REVISED AUG 2019
		DD-824-19	SHEET 1 OF 1

Pipe Diameter	Double Check Valve Assembly
12"	10"



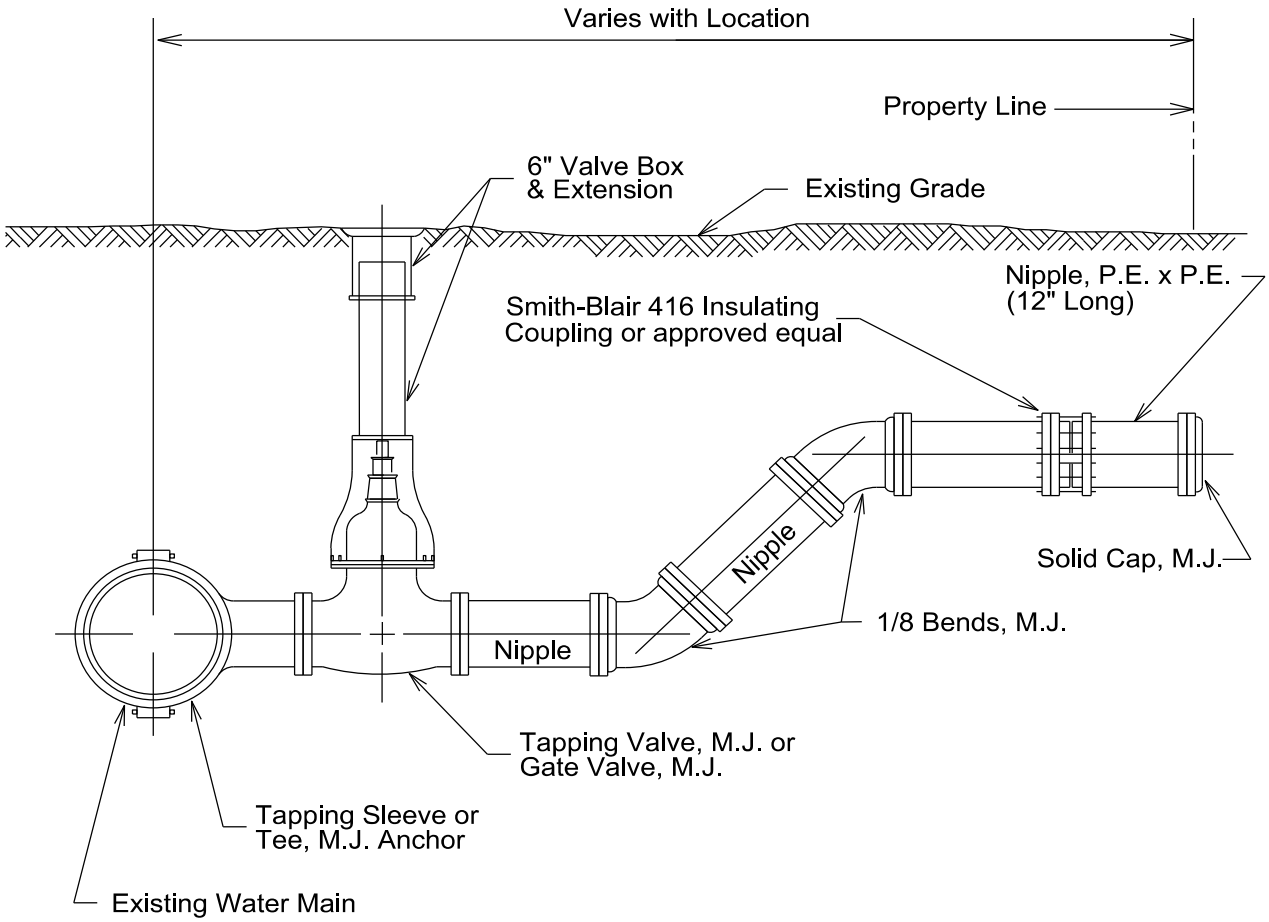
PLAN



SECTION A-A

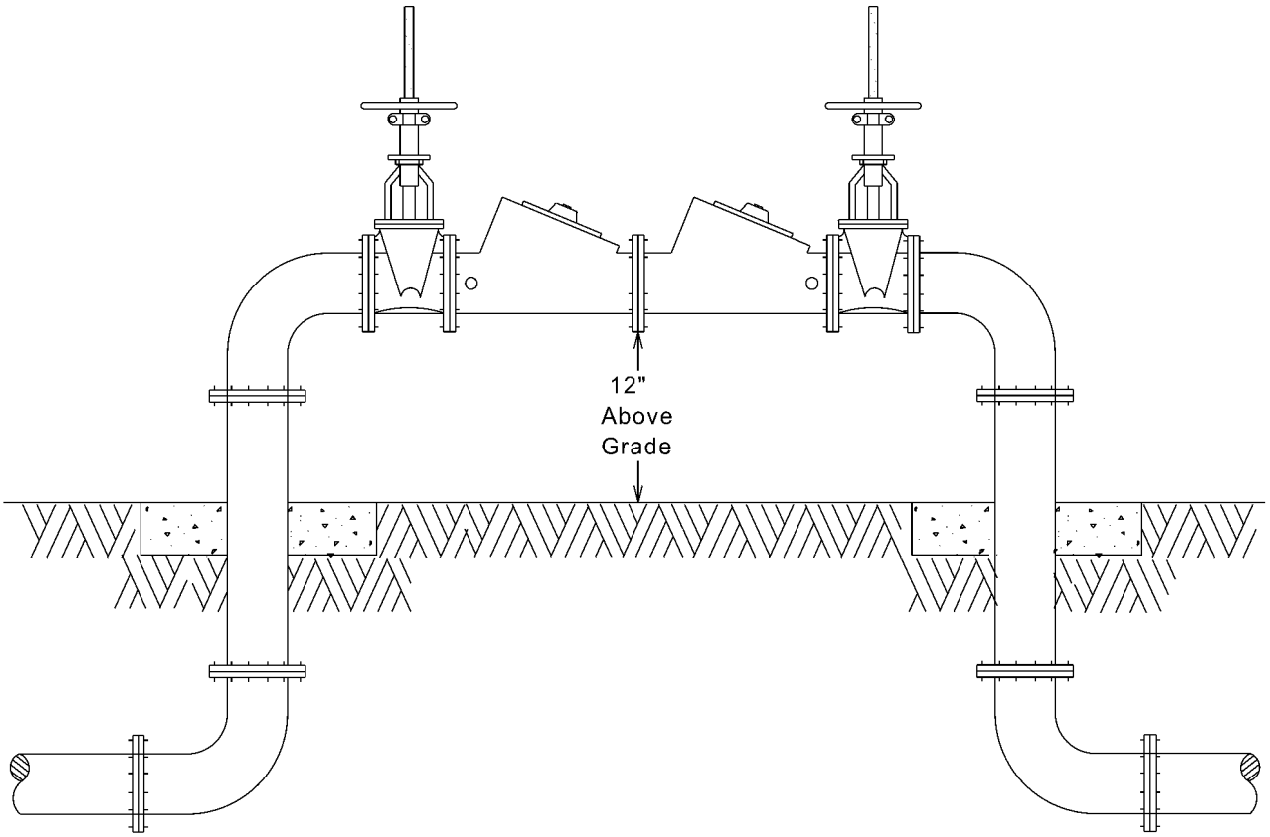
Notes:
1. Tamper switches may be required by Fire Code.
2. Assemblies must be U.L. Listed for Fire Protection purposes.

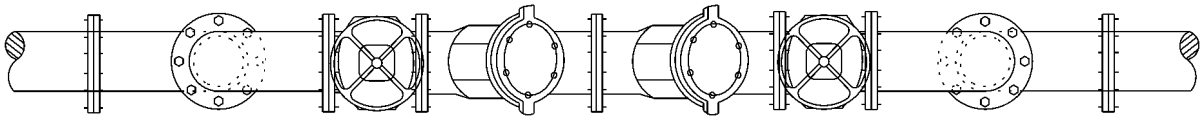
PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	10" DOUBLE CHECK ASSEMBLY INSTALLATION (DCVA)	APPROVED March 2008	REVISED AUG 2019
		DD-824-20	SHEET 1 OF 1



Notes:
Thrust Blocking as per San Antonio Water System Specifications.

PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	4", 6" & 8" NON-METERED FIRE SERVICE	APPROVED March 2008	REVISED AUG 2019
		DD-824-21	SHEET 1 OF 1





PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	DOUBLE CHECK ASSEMBLY (DCVA) ABOVE GRADE INSTALLATION	APPROVED June 2009	REVISED AUG 2019
		DD-824-22	SHEET 1 OF 1

ITEM NO. 831
Cut-In Tee

831.1 DESCRIPTION: This item shall consist of cut-in tees (various types and sizes) installed in accordance with these specifications and as directed by the Engineer.

831.2 REFERENCED STANDARDS: Reference standards cited in this Specification Item No. 831 refer to the current reference standard published at the time of the latest revision date.

1. San Antonio Water System (SAWS):
   a. Specifications for Water and Sanitary Sewer Construction
   b. SAWS Materials Specifications
2. City Of San Antonio (COSA) Standard Specifications for Construction
3. Texas Commission of Environmental Quality (TCEQ) Chapter 290 Public Water Supply
4. American Society for Testing and Materials International
   a. ASTM D 1248 - Standard Specification for Polyethylene Plastics Molding and Extrusion Materials.
   b. ASTM D 1784 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
   c. ASTM D 2122 – Standard Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings.
   d. ASTM D 2241 - Standard Specification for Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).
   e. ASTM 2412 – Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel Plate Loading
   f. ASTM D 2444 - Standard Test Method for Determination of the Impact Resistance of Thermoplastic Pipe and Fittings by Means of a Tup (Falling Weight).
   g. ASTM D 3139 - Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
   h. ASTM F 477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
5. American Water Works Association (AWWA)
   a. AWWA C 900 – Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings 4 in through 60 in (100 MM through 1,500 MM)**.**
   b. AWWA C 909 - Standard for Molecularly-Oriented Polyvinyl Chloride (PVCO) Pressure Pipe, 4 Inches through 12 Inches (100mm through 300 mm), for Water Distribution.
   c. AWWA M23 – PVC Pipe – Design and Installation
6. Plastic Pipe Institute
   a. PPI TR3 - Policies and Procedures for Developing Recommended Hydrostatic Design Stresses for Thermoplastic Pipe Materials.
7. Uni-Bell PVC Pipe Association
   a. UNI-B-13 - Recommended Standard Performance Specification for Joint Restraint Devices for Use with Polyvinyl Chloride Pipe.

831.3 SUBMITTALS: Contractor shall submit manufacturer's product data, instructions, recommendations, shop drawings, and certifications. All submittals shall be in accordance with Engineer's requirements and submittals shall be approved prior to delivery.

831.4 MATERIALS: The materials for cut-in tees shall conform to the specifications contained within the latest revision of SAWS' Material Specification for all appropriate items.

831.5 CONSTRUCTION: The work involved in cutting in a tee shall consist of the following: excavation, shutdown and isolation of existing main to which the new main is to be connected, cutting pipe for the connection, dewatering the excavation, customer notification of service interruption where required, installation of all pipe used to complete the connection, all necessary tie-ins (connections to existing or new main), fittings, approved reaction blocking required and backfilling the excavation with approved selected materials or flowable fill in accordance with Specification Item No. 804 – Trenching, Excavation and Backfill, if required.

1. Where the installation of a valve is required, payment will be made in accordance with, Specification Item No. 828, "Gate Valves."
2. The processes associated with disturbing and restoring pavements (any type), curbs, sidewalks, backfilling to final grade, flowable fill (if required) and sodding for the installation of a cut-in tee will be considered subsidiary to the work and must comply with the applicable TxDOT Specification or City of San Antonio Specifications for Public Works Construction, any other governing entity's specifications, and applicable street cut policies, ordinances, or permits.

831.6 MEASUREMENT: Cut-in tees will be measured by the unit of each such assembly of the various sizes of tee installed.

831.7 PAYMENT: Payment for cut-in tees will be made at the unit price bid for each assembly of the various types and sizes of tees to be installed to the size of the existing main.

1. Payment shall also include; all necessary tie-ins, protective coating materials for bolts, nuts, ferrous surfaces, polyethylene sleeve, cutting and replacement of surface, pavement restoration, flowable fill, thrust blocking, where required, and any necessary hauling and disposition of surplus excavated materials.
2. Materials paid on site will be in accordance with Table 1 of Specification Item No. 100 Mobilization

-End of Specification-

ITEM NO. 832

Tapping Sleeves and Valves

832.1 DESCRIPTION: This item shall consist of tapping sleeves and valves installed in accordance with these specifications and as directed by the Engineer. The use of size on size taps shall not be permitted. Only cut-in tees shall be used within the system, unless otherwise approved.

832.2 REFERNCED STANDARDS: Reference standards cited in this Specification Item No. 832 refer to the current reference standard published at the time of the latest revision date.

1. San Antonio Water System (SAWS):
   a. Specifications for Water and Sanitary Sewer Construction
   b. SAWS Materials Specifications
2. City of San Antonio (COSA) Specifications for Construction
3. Texas Commission of Environmental Quality (TCEQ)
   a. Chapter 290; Subchapter D – Rules and Regulations for Public Drinking Water
4. American Society for Testing and Materials (ASTM) International:
   a. ASTM A240 - Standard Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels
   b. ASTM A193 Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.
   c. ASTM A194 Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature Service
   d. AWWA C 110 - Standard for Ductile-Iron and Gray-Iron Fittings, 3 in. through 48 in., for Water and other Liquids.
5. American Water Works Association (AWWA)
   a. AWWA C 200 - Standard for Steel Water Pipe - 6 in. and Larger.
   b. AWWA C 207 - Standard for Steel Pipe Flanges for Waterworks Service - Sizes 4 in. Through 144 in.
   c. AWWA C 500 - Standard for Metal Seated Gate Valves, for Water Supply Service.
   d. AWWA C 223 - Fabricated Steel and Stainless Steel Tapping Sleeves.

832.3 SUBMITTALS: Contractor shall submit manufacturer's product data, instructions, recommendations, schedule, shop drawings, and certifications. All submittals shall be in accordance with Engineer's requirements and submittals shall be approved prior to delivery.

832.4 MATERIALS: The materials for tapping sleeves and valves shall conform to the specifications contained within the latest revision of SAWS' Material Specification Item Nos. 100-35, "Tapping Sleeves," and 21-02, "Resilient Seated Gate Valves and Tapping Valves."

832.5 CONSTRUCTION: The installation work involved in tapping sleeves and valves shall consist of: excavation, backfilling the excavation with approved selected material, tapping

sleeve, approved reaction blocking conforming to Standard Drawing DD-839 Series, tapping valve, valve box assembly, concrete collar and cast iron lid.

1. New taps will not be permitted closer than 2 feet of a joint or existing tap.
2. The use of a shell-type cutter shall be required when tapping sleeves and valves.
3. Whenever working on potable or recycle water systems, the shell cutter shall be disinfected with bleach prior to the start of work.
4. The cutting edge shall be sharp and round.
5. Any defective cutters shall be rejected by the Inspector.
6. All the tapping sleeves shall be air tested to 50 psi prior to tapping the main line, and shall hold pressure for 2 minutes.
7. Tapping AC pipe will require flush valve on tapping machines.
8. The valve box shall be placed in such a manner to prevent shock or stress from being transmitted to the valve.
9. Valve shall be blocked prior to tapping.
10. Valve boxes shall be centered over the valve's operating nut with the box cover flush with the finished existing grade.
11. Valve boxes located in streets or other areas subject to vehicular traffic shall be provided with concrete collars as shown in the accompanying standard drawings.
12. Collars around such valve boxes shall be formed and finished off neatly and in a sound workmanlike manner.

832.6 MEASUREMENT: Tapping Sleeves, Valves, and Boxes will be measured by the unit of each such assembly of the various sizes of tapping sleeves, valves, and boxes approved and installed.

832.7 PAYMENT: Payment for Tapping Sleeves and Valves, complete with boxes, will be made at the unit price bid for each such assembly of the various types and sizes of valves and valve boxes installed and approved.

1. Payment shall also include: excavation, cutting and replacement of surface, selected embedment material, surface restoration, anti-corrosion when specified, hauling, and disposition of surplus excavated material, backfill, installation of all-weather surface, concrete collar at the valve box, ductile iron riser pipe, cast iron boot, concrete grout, concrete reaction blocking, protective coating material for bolts, nuts, and ferrous surfaces, and polyethylene sleeve where required, and air testing of sleeve.
2. Materials paid on site will be in accordance with Table 1 of Specification Item No. 100 Mobilization

-End of Specification-

ITEM NO. 833

Meter and Meter Box Installation

833.1 DESCRIPTION: This item shall consist of meter and meter box installation and adjustment installed in accordance with these specifications and as directed by the Engineer.

833.2 REFERENCED STANDARDS: Reference standards cited in this Specification Item No. 833 refer to the current reference standard published at the time of the latest revision date.

1. San Antonio Water System (SAWS):
   a. Specifications for Water and Sanitary Sewer Construction
   b. SAWS Materials Specifications
2. City of San Antonio (COSA) Standard Specification for Construction
3. Texas Commission of Environmental Quality (TCEQ)
   a. TCEQ 290 Rules and Regulations for Public Regulations for Public Water Systems
4. American Society for Testing and Materials International
   a. ASTM A 48 - Standard Specification for Gray Iron Castings.
   b. ASTM D 256 - Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics.
   c. ASTM D 638 - Standard Test Method for Tensile Properties of Plastics.
   d. ASTM D 648 - Standard Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position.
   e. ASTM D 790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
   f. ASTM D 2240 - Standard Test Method for Rubber Property-Durometer Hardness.

833.3 SUBMITTALS: Contractor shall submit manufacturer's product data, instructions, recommendations, shop drawings, and certifications. All submittals shall be in accordance with Engineer’s requirements and submittals shall be approved prior to delivery.

833.4 MATERIALS: The materials for meter and meter box installation and adjustment shall conform to the specifications contained within the latest revision of SAWS' Material Specification Item No. 10-30, "Meter Boxes."

833.5 CONSTRUCTION:

1. Physical movement of existing meters and meter boxes to new locations may be required where service lines are transferred to new mains in conjunction with main replacement work.
2. Unless specified otherwise, the Contractor shall move existing meters, meter boxes, connect and adjust customer's yard piping as part of transferring service lines as per Specification Item 824 – Water Service Supply Lines.

3. A dielectric coupling (PVC schedule 80) shall be installed within the meter box between the meter and the customer's yard piping.
4. The Contractor shall replace non-compliant meter boxes with the new, appropriately styled oval plastic meter box with oval cover, or rectangular meter box at no additional cost to SAWS.
5. Unless otherwise specified, the old service line shall be abandoned after the existing meter has been reset in the existing or new meter box.
6. Where meter boxes are installed in sidewalks or driveways, the Contractor shall install a number one meter box (2 pieces) as shown in the Material Specifications Item No. 10-30.
7. New meters will be set by the Owner where mains are extended and new services lines are installed for new or initial customer service.
8. In lieu of the new meter, the Contractor shall furnish and install a meter template (See details this specification). Contractor shall make a 1 inch diagonal cut thru the wall of the template.
9. Meter and meter box configuration, shall have the meter set horizontal, approximately 6 inches below the top of meter box, so that the meter is above the bottom of the meter box and in-line with the meter box lid opening.
10. The top of the meter box shall be flush with the existing ground surface.
11. All excess soil above the meter coupling, meter flange and meter nuts inside the meter box shall be removed so that the meter register is clearly visible.
12. The Contractor shall exercise special precautions during excavation at the existing meter location in order to minimize the disturbance of the customer's yard piping.
13. If the existing meter elevation is low, the Contractor shall raise the existing meter to conform to the correct configuration indicated herein.
14. Adjustment of meter to proper grade is incidental to the construction and will not be paid for separately.
15. Where required, pressure reducing valves shall be installed by the customer in accordance with the Uniform Plumbing Code and shall be placed beyond the outlet side of the meter, but not within the Owner's meter box.
16. The pressure reducing valve shall be the property of the water user who will be responsible for its installation, maintenance, and replacement, as required.
17. The meter box adjustment shall not exceed 10 linear feet from the existing box.

833.6 MEASUREMENT: Installation and relocation of meters and boxes will be measured by the unit of the various types and sizes of meters and boxes.

833.7 PAYMENT: Payment for "Existing Meter and Existing Meter Box Relocation (⅝ inch through 2 inch meter)" will be made at the unit price bid for each existing meter and existing meter box installed and relocated.

1. Payment shall also include; excavation, hauling and disposition of surplus materials, sand backfill, removal and replacement of yard piping of correct type

and size up to 2 feet to complete the connection and adjustment between the relocated existing meter and existing meter box, and the existing yard piping.

2. Payment for "Existing Meter and New Meter Box Relocation (⅝ inch through 2 inch meter)" will be made at the unit price bid for each existing meter relocated to a new meter box.
   a. Such payment shall also include excavation, hauling and disposition of surplus materials, sand backfill, removal and replacement of whatever type surface structure encountered, salvaging the existing meter box, a new meter box, reconnection and adjustment of yard piping of correct type and size up to 2 feet to complete the connection between the relocated existing meter and new meter box, and the existing yard piping.
3. Payment for number one or number two meter box installation in sidewalks and driveways shall be paid in the amount of difference between the standard meter box and the number one number two box.

-End of Specification-

ITEM NO. 836
Grey Iron and Ductile-Iron Fittings

836.1 DESCRIPTION: This item shall consist of grey-iron and ductile-iron fittings installation and adjustment installed in accordance with these specifications and as directed by the Engineer.

836.2 REFERNCED STANDARDS: Reference standards cited in this Specification Item No. 836 refer to the current reference standard published at the time of the latest revision date.

1. San Antonio Water System (SAWS):
   a. Specifications for Water and Sanitary Sewer Construction
   b. SAWS Materials Specifications
2. City of San Antonio (COSA) Standard Specifications for Construction
3. Texas Commission of Environmental Quality (TCEQ) Chapter 290 Public Water Supply
4. American Society for Testing and Materials (ASTM) International:
   a. ASTM D 1248 – Standard Specification Polyethylene Plastics Molding and Extrusion Materials for Wire and Cable.
   b. ASTM F 477 – Elastomeric Seals (gaskets) for Joining Plastic Pipe.
   c. ASTM G 62 – Standard Test Methods for Holiday Detection in Pipeline Coatings.
5. American National Standard Institute (ANSI)
   a. ANSI A 21.4 (AWWA C 104) – Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings, for Water.
   b. ANSI A 21.10 (AWWA C 110) – Standard for Ductile-Iron and Gray-Iron Fittings, 3-in. through 48-in.
   c. ANSI A 21.11 (AWWA C 111) – Standard for Rubber Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   d. ANSI A 21.15 (AWWA C 115) – Standard for Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.
   e. ANSI A21.16 (AWWA C 116) – Protective Fusion Bonded Epoxy Coating for the Interior and Exterior Surfaces of Ductile Iron and Grey iron Fittings for Water Supply Service.
   f. ANSI A 21.50 (AWWA C 150) – Standard for Thickness Design of Ductile-Iron Pipe.
   g. ANSI A 21.51 (AWWA C 151) – Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water and Other Liquids.
   h. ANSI A 21.53 (AWWA C 153) – Standard for Ductile Iron Compact Fittings, 3 inches through 24 inches and 54 inches through 64 inches for Water Service.
   i. ANSI/AWS D11.2 –Guide for Welding Iron Castings
6. American Society of Mechanical Engineers (ASME)
   a. ASME B 16.1 – Cast Iron Pipe Flanges and Flanged Fittings.

7. American Water Works Association (AWWA)
   a. AWWA C 105 – Polyethylene Encasement for Ductile-Iron Pipe Systems.
   b. AWWA C 300 – Standard for Prestressed Concrete Pressure Pipe, Steel-Cylinder Type, for Water and other Liquids.
   c. AWWA C 600 – Standard for Installation of Ductile-Iron Water Mains and Their Appurtenances.
8. American Water Works Association (AWWA)
   a. SSPC-SP 6 – Steel Structures Painting Council, Commercial Blast Cleaning.

836.3 SUBMITTALS: Contractor shall submit manufacturer's product data, instructions, recommendations, shop drawings, and necessary certifications.

1. For pipes 16 inches and greater submit shop drawings signed and sealed by Professional Engineer registered in State of Texas showing the following:
   a. Manufacturer's pipe design calculations.
   b. Provide lay schedule of pictorial nature indicating alignment and grade, laying dimensions, fitting, flange, and special details, with plan view of each pipe segment sketched, detailing pipe invert elevations, horizontal bends, restrained joints, and other critical features.
   c. 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.
   d. Calculations and limits of thrust restraint shall be based on AWWA M41 or DIPRA Thrust Restraint for Ductile Iron Pipe, latest edition.
   e. Class and length of joint.
   f. Submit manufacturer's certifications that ductile iron pipe and fittings meet provisions of this Section and have been hydrostatically tested at factory and meet requirements of ANSI A 21.51.
   g. Submit certifications that pipe joints have been tested and meet requirements of ANSI A 21.11.
   h. Submit affidavit of compliance in accordance with ANSI A21.16 for fittings with fusion bonded epoxy coatings or linings.

836.4 MATERIALS: The materials for grey-iron and ductile-iron fittings installation shall conform to the latest provisions of American National Standard for Ductile- Iron (ANSI)/ American Water Works Association (AWWA) C153/A21.53, Compact Fittings 3-inch through 64-inch and ANSI/AWWA C110/A21.10, Full Body Fittings 3-inch through 48-inch for Water Service or most applicable approved equal provisions, and the specifications contained within the latest revision of SAWS' Material Specification Item No. 10-10, "Grey-Iron and Ductile-Iron Fittings."

836.5 CONSTRUCTION: All fittings shall be either restrained mechanical joint compact or flanged joint, unless otherwise specified in the contract documents. All mechanical joint compact fittings shall be installed using approved restraining glands in accordance with SAWS' Material Specification Item No. 113-02, "Ductile Iron Restrained Joint Fittings for Use on Ductile Iron."

1. No separate payment will be made for these restraining glands.
2. Approved adapters shall be used where necessary to provide a transition between pipes and/or fittings of differing outside diameters.
3. Thrust blocking shall only be utilized, in addition to restraining glands, if specified in the contract documents, when tying into existing non-restrained pipe, or when approved by the Inspector.
4. Anti-corrosion protection consisting of polyethylene sleeve and asphaltic material for ferrous surfaces shall be applied to exterior surfaces of all fittings installed. Anti-corrosion embedment shall be provided as specified in Specification Item No. 804, "Excavation, Trenching and Backfill."

836.6 MEASUREMENT: Ductile-Iron and Grey-Iron Fittings will be measured by their weight as listed in Table 836-1 of this specification of the various sizes of fittings installed.

836.7 PAYMENT: Payment for Grey-Iron and Ductile-Iron Fittings shall be for Mechanical Joint Compact fittings (AWWA) C153/A21.53 and/or flanged fittings.

1. Payment will be made at the unit price bid for each ton of fittings to the nearest one-hundredth of a ton of fittings installed.
2. Individual fitting weights used for payment calculations will be the weights of fittings listed in Table 836-1 of this specification.
3. Weights of glands, bolts, nuts, gaskets (all types) are considered subsidiary to the fittings and no separate payment will be made for their weight.
4. Payment for fitting weights listed in Table 836-1 shall be full compensation for excavation, installation, anti-corrosion protection, select anti-corrosion embedment material and installation, hauling and disposition of surplus excavated materials, all glands, bolts, nuts, rubbers, and flange gaskets of whatever type required, and concrete thrust/reaction blocking, if required.
5. If fittings other than those listed in Table 836-1 are approved and installed, the Contractor shall provide quantities and manufacturers unit weights exclusive of glands, bolts, and rubbers with pay request.
6. Materials paid on site will be in accordance with Table 1 of Specification Item No. 100 Mobilization.

TABLE 836-1							
WEIGHTS OF GREY-IRON AND DUCTILE-IRON FITTINGS (LBS.)							
BENDS							
Size (Inches)	**MJ Compact (C153)**	**MJ (C110)**	**FLG SB**	**Size (Inches)**	**MJ Compact (C153)**	**MJ (C110)**	**FLG SB**
1/4 Bend (90 Degrees)				1/8 Bend (45 degrees)			
4	25	55	44	4	21	51	36
6	43	86	67	6	35	75	57
8	61	125	115	8	50	110	105
12	119	258	236	12	96	216	196
16	264	454	478	16	200	345	315
20	447	716	878	20	337	555	485
24	602	1105	1085	24	441	777	730
30	979	1740	1755	30	775	1393	1355
36	1501	2507	2135	36	1140	2163	1755
42	2277	3410	3055	42	1652	2955	2600
48	3016	4595	4095	48	2157	4080	3580
BENDS							
Size (Inches)	**MJ Compact (C153)**	**MJ (C110)**	**FLG SB**	**Size (Inches)**	**MJ Compact (C153)**	**MJ (C110)**	**FLG SB**
1/16 Bend (22-1/2 Degrees)				1/32 Bend (11-1/4 degrees)			
4	18	50	35	4	17	50	40
6	32	75	64	6	30	73	56
8	46	110	90	8	42	109	90
12	85	220	194	12	74	220	193
16	175	354	315	16	153	354	315
20	314	550	505	20	265	553	505
24	414	809	528	24	339	815	760
30	668	1500	1385	30	603	1410	1395
36	963	2182	1790	36	830	2195	1805
42	1354	3020	2665	42	1210	3035	2680
48	1790	4170	3665	48	1523	4190	3695

TABLE 836-1 CONTINUATION				
WEIGHTS OF GREY-IRON AND DUCTILE-IRON FITTINGS (LBS.)				
TEES				
Size (Inches)		Weight		
Run	Branch	MJ Compact (C153)	MJ (C110)	FLG Short Body
3	3	26	56	53
4	3	31	76	54
	4	33	80	60
6	4	49	114	90
	6	60	124	98
8	4	65	163	155
	6	76	175	148
	8	89	188	179
12	4	99	316	322
	6	115	325	297
	8	127	339	346
	12	162	407	369
16	6	226	563	573
	8	240	565	555
	12	283	615	590
	16	326	676	635
20	6	344	750	773
	8	371	766	720
	12	427	799	816
	16	503	975	950
	20	566	1068	1005

TABLE 836-1 CONTINUATION				
WEIGHTS OF GREY-IRON AND DUCTILE-IRON FITTINGS (LBS.)				
TEES				
Size (Inches)		Weight		
Run	Branch	MJ Compact (C153)	MJ (C110)	FLG Short Body
24	6	466	1035	1089
	8	487	1047	1060
	12	539	1075	1125
	16	625	1109	1070
	20	729	1504	1510
	24	785	1617	1685
30	8	739	1808	-
	12	800	1842	1801
	16	959	1885	-
	20	1026	1941	-
	24	1228	2496	2475
	30	1373	2531	2615
36	24	1548	2710	2255
	30	1901	3545	3000
	36	2012	3686	3160
42	24	2272	3690	3245
	30	2512	4650	4125
	36	3048	5119	5360
	42	3225	6320	5580
48	24	2934	4995	4385
	30	3147	5140	4455
	36	4046	6280	5555
	42	4249	8130	7195

TABLE 836-1 CONTINUATION				
WEIGHTS OF GREY-IRON AND DUCTILE-IRON FITTINGS (LBS.)				
CROSSES				
Size (Inches)		Weight		
Run	Branch	MJ Compact (C153)	MJ (C110)	FLG Short Body
24	6	566	1025	-
	8	578	1085	1045
	12	610	1153	1110
	16	663	1256	1200
	20	975	1733	1675
	24	907	1906	1835
30	8	650	1795	-
	12	870	1925	1865
	16	900	1950	-
	20	1220	2060	-
	24	1497	2776	2675
	30	1808	3188	3075
36	24	1853	2928	2980
	30	2580	3965	-
	36	2698	4370	4370
42	24	2415	3910	-
	30	2920	5040	-
	36	3788	5835	-
	42	3908	6493	7145
48	24	3435	5210	-
	30	4145	5495	-
	36	4873	6790	-
	42	5465	8815	-
	48	5588	9380	-

TABLE 836-1 CONTINUATION				
WEIGHTS OF GREY-IRON AND DUCTILE-IRON FITTINGS (LBS.)				
CAPS			**PLUGS**	
Size (Inches)	**MJ Compact (C153)**	**MJ (C110)**	**MJ Compact (C153)**	**MJ (C110)**
4	10	17	12	16
6	16	29	19	28
8	24	45	30	46
12	45	82	54	85
16	95	160	97	146
20	141	235	146	218
24	193	346	197	350
30	362	644	381	626
36	627	912	688	884
42	893	1322	1200	1222
48	1076	1737	1550	1597

TABLE 836-1 CONTINUATION				
WEIGHTS OF GREY-IRON AND DUCTILE-IRON FITTINGS (LBS.)				
SOLID SLEEVES				
Size (Inches)	**Weight**			
	MJ Short Compact (C153)	**MJ Long Compact (C153)**	**MJ Short (C110)**	**MJ Long (C110)**
4	17	21	35	46
6	28	35	45	65
8	38	48	65	86
12	57	77	113	143
16	127	172	192	257
20	201	258	258	359
24	264	337	340	474
30	500	651	690	1005
36	725	960	947	1374
42	877	1209	1187	1628
48	1406	1516	1472	2033

TABLE 836-1 CONTINUATION			
WEIGHTS OF GREY-IRON AND DUCTILE-IRON FITTINGS (LBS.)			
CONCENTRIC REDUCERS			
Size (Inches)			Weight
Large End	Small End	MJ Compact (C153)	MJ (C110)
6	4	27	59
8	4	38	81
8	6	41	95
12	4	70	136
12	6	69	150
12	8	70	167
16	6	134	234
16	8	136	258
16	12	126	310
20	12	213	427
20	16	221	492
24	12	304	562
24	16	315	633
24	20	315	727
30	16	596	1027
30	20	599	1085
30	24	492	1204
36	20	1042	1459
36	24	785	1580
36	30	655	1868
42	24	1356	2060
42	30	1112	2370
42	36	1116	2695
48	30	1722	3005
48	36	1650	3370
48	42	1429	3750

TABLE 836-1 CONTINUATION		
WEIGHTS OF GREY-IRON AND DUCTILE-IRON FITTINGS (LBS.)		
***2"* Tapped Tees and Crosses**		
Size (Inches)	**Weight**	
	MJ Compact (C153)	**MJ (C110)**
4	24	47
6	36	71
8	54	97
10	69	130
12	87	169
20	-	259
24	-	320

TABLE 836-1 CONTINUATION		
WEIGHTS OF GREY-IRON AND DUCTILE-IRON FITTINGS (LBS.)		
OFFSETS		
Size (Inches)	**Weight**	
	MJ Compact (C153)	**MJ (C110)**
4 x 6	35	75
4 x 12	55	83
6 x 6	35	110
6 x 12	67	138
6 x 24	96	189
8 x 6	82	164
8 x 12	98	209
8 x 24	141	280
12 x 6	121	320
12 x 12	178	420
12 x 24	240	645
20 x 12	-	1025
20 x 24	-	1245

-End of Specifications-

ITEM NO. 839

Anchorage/Thrust Blocking and Joint Restraint

839.1 DESCRIPTION: This item shall consist of anchorage/thrust blocking and joint restraint installation in accordance with these specifications and as directed by the Engineer or Manufacturer's recommendations.

839.2 REFERENCED STANDARDS: Reference standards cited in this Specification Item No. 839 refer to the current reference standard published at the time of the latest revision date.

1. San Antonio Water System (SAWS):
   a. Specifications for Water and Sanitary Sewer Construction
   b. SAWS Materials Specifications
2. City of San Antonio (COSA) Standard Specifications for Construction

839.3 MATERIALS: The materials for anchorage/thrust blocking installation shall conform to the appropriate specifications contained within the latest revision of SAWS Material Specifications.

1. Pipe restraint devices shall conform to the latest revision of SAWS' Material Specification Item No. 95-10, "Specifications of Pipe Joint Restraint Systems," and Item No. 113-02, "Ductile Iron Restrained Joint Fittings for Use on Ductile Iron."

839.4 CONSTRUCTION: Suitable anchorage/thrust blocking or joint restraint shall be provided at all of the following main locations: dead ends, plugs, caps, tees, crosses, valves, and bends, in accordance with the Standard Drawings DD-839 Drawing Series.

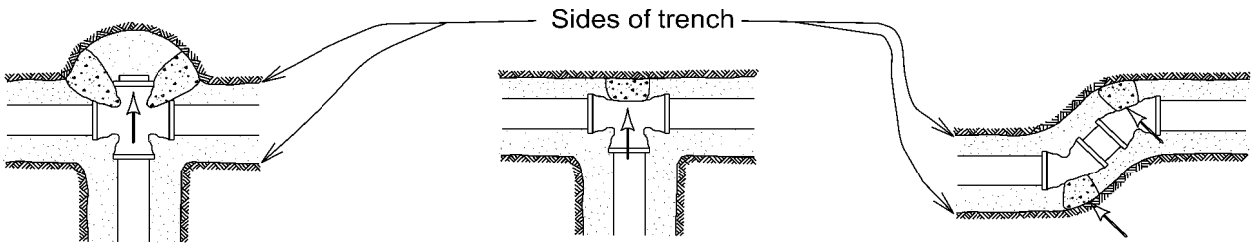
1. All mechanical (joint) restraints shall be bidirectional.
2. Anchor blocks shall be constructed solidly behind the fitting and symmetrical with the axis of resultant thrust, except where this is not possible as in the case of gravity anchorage for vertical bends.
3. If the restraint limits do not fall on a joint, restraint shall be moved to next further joint.
4. Cutting of pipe to install joint restraints is not permitted.
5. Special ties and anchor fittings may be utilized in conjunction with blocking when shown in the contract documents or as directed by Engineer or Inspector.
6. All thrust blocking shall be a minimum of 3,000 psi concrete placed between solid ground and the fitting except as otherwise shown in the contract documents.
7. The area of bearing in contact with solid ground shall be that as shown in the contract documents or as directed by the Engineer.
8. All thrust blocking placed in conjunction with mains and appurtenances shall be in accordance with Standard Drawings DD-839 Series.
9. In all cases, the design of thrust blocking shall be of sufficient size to withstand an assumed soil lateral load bearing capacity of 3,000 psf, unless specified otherwise in the contract documents.

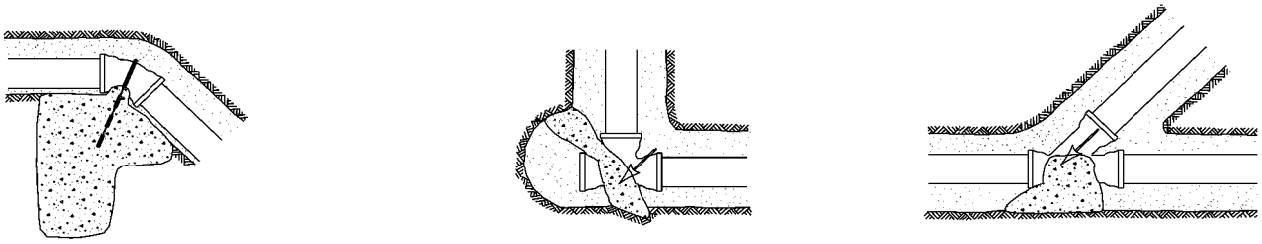
10. When specifically requested by the Contractor and approved by the Engineer, the maximum soil lateral load bearing capacity that will be allowed for the design of thrust blocking shall be 5,000 psf.
11. When soil lateral load bearing capacities of 4,000 psf or 5,000 psf are recorded for design of thrust blocks, copies of soil tests made for determining the lateral load bearing capacity of the subject soil shall be submitted to the Engineer for approval.
12. The blocking shall be placed so that pipe and fitting joints will be accessible.
13. Pipe restraint devices shall be installed according to the lengths prescribed herein, recommended by pipe manufacturer, or as noted in the contract documents, whichever is more restrictive.
14. Pipe polywrap shall be placed between the pipe or fitting and the concrete.
15. The reaction block on the unused branch of a fitting shall be poured separately from the block across the back of the fitting. If they are poured simultaneously, a rigid partition shall be placed between the blocks.
16. Valves 12 inches or larger in size shall be supported on a concrete pad extending vertically from 12 inches below the bottom of the valve to the lower quarter point of the hub and laterally from face to face of hubs and transversely from wall to wall of the trench.
17. All joints for carrier pipe installed within casing shall be restrained.

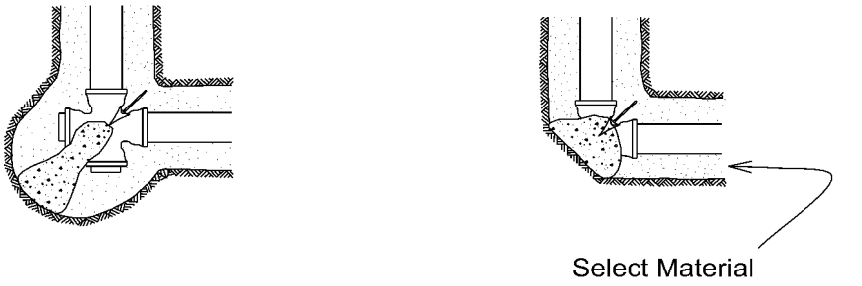
839.5 MEASUREMENT: Anchorage/Thrust Blocking or Joint Restraints are considered subsidiary to the work and no separate payment will be made to the Contractor for this work.

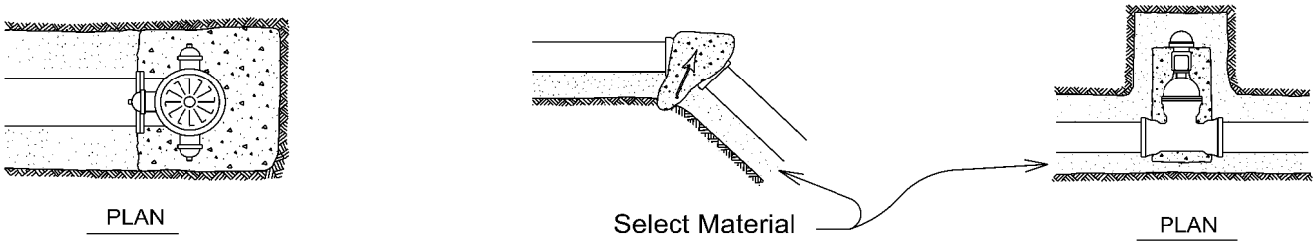
839.6 PAYMENT: Anchorage/Thrust Blocking or Joint Restraints are considered subsidiary to the work and no separate payment will be made to the Contractor for this work.

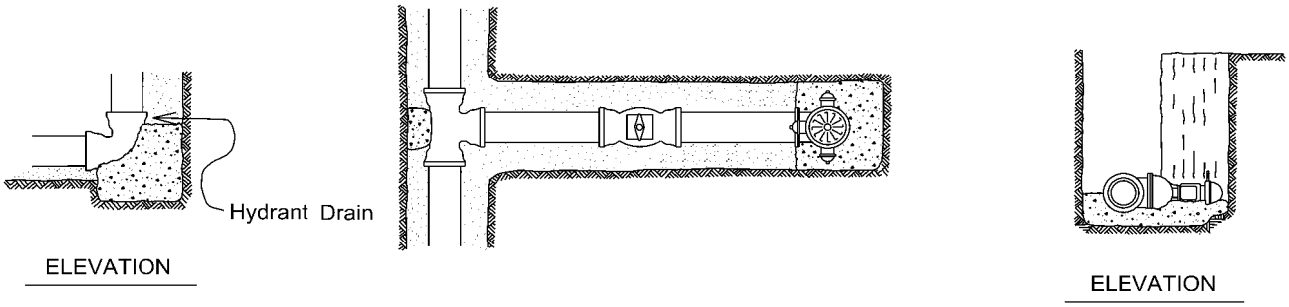
-End of Specification-



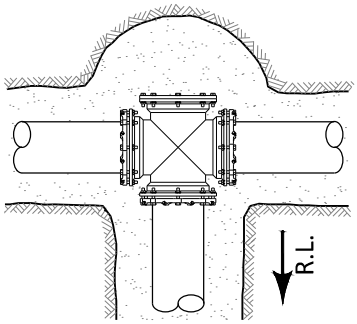


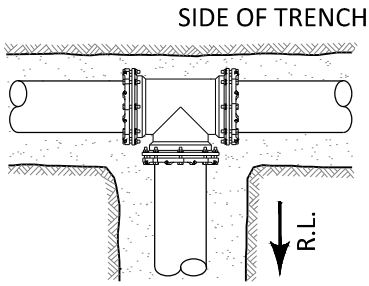


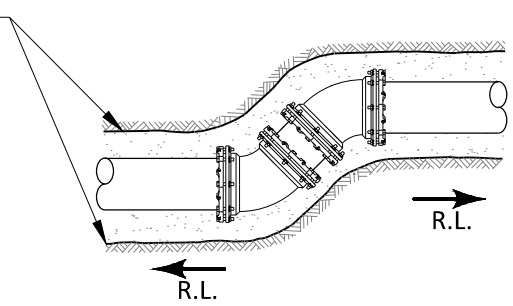


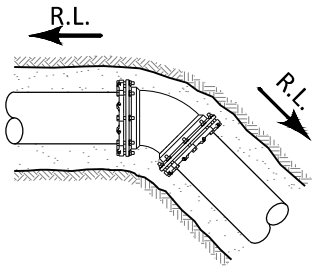


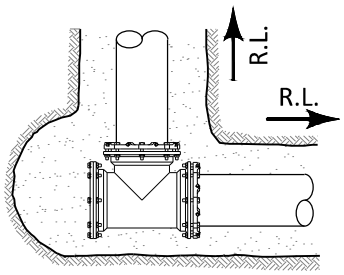
PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	THRUST BLOCKS FOR FITTINGS (WATER ONLY)	APPROVED March 2008	REVISED AUG 2019
		DD-839-01	SHEET 1 OF 2

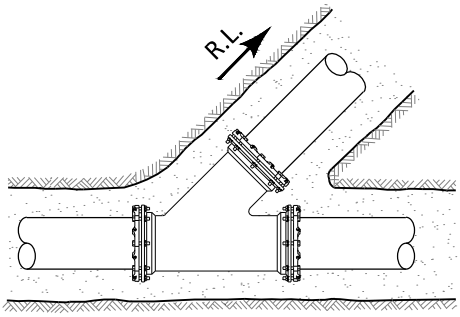




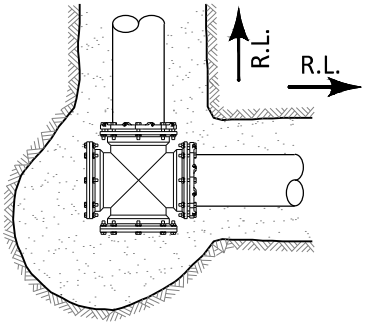


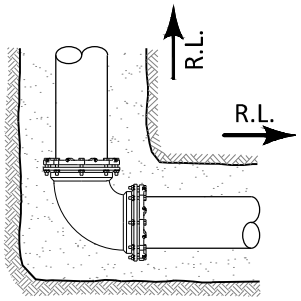


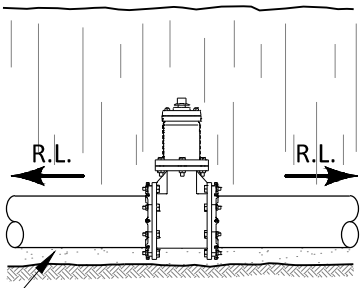


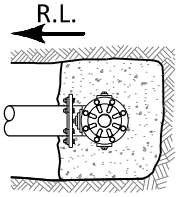


R.L. = RESTRAINED LENGTHS TO BE DETERMINED BY DESIGN ENGINEER



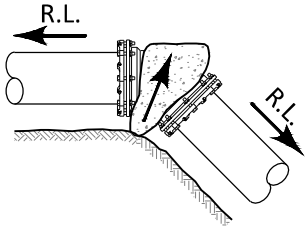


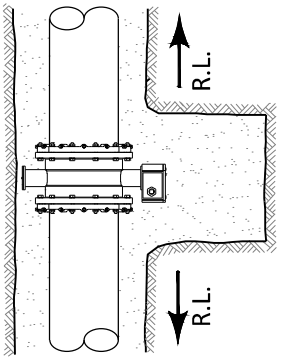




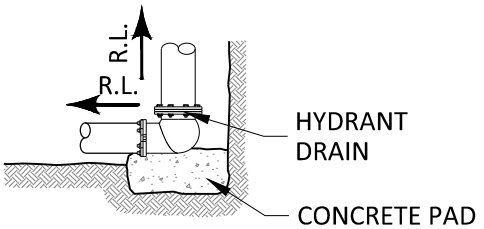
PLAN

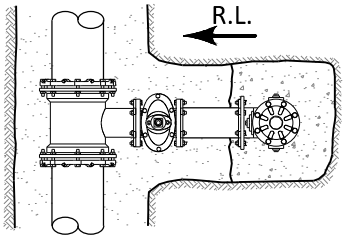
POUR CONCRETE AFTER HYDRANT HAS BEEN PLACED



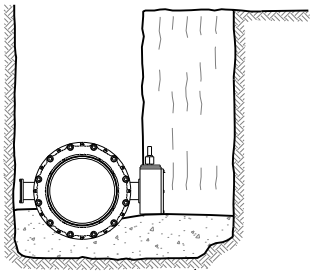


PLAN





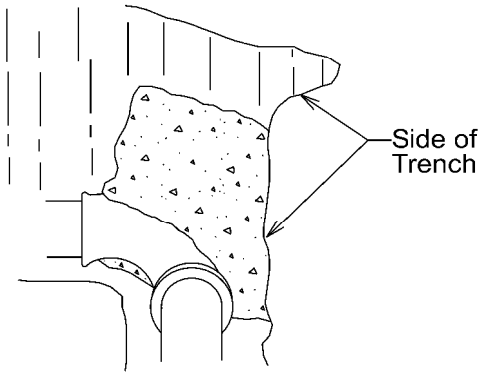
ELEVATION



ELEVATION

PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	JOINT RESTRAINTS FOR FITTINGS (WATER ONLY)	APPROVED March 2008	REVISED December 2019
		DD-839-01	SHEET 2 OF 2

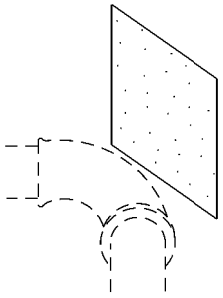
Typical blocking for 90° Bend



Area in Sq. Ft. for each of the following pipe sizes

Area Sq. Ft.

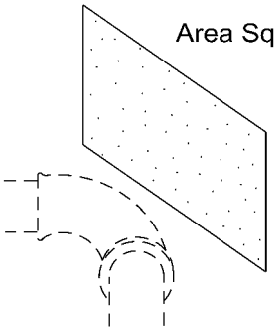
2 Sq. Ft. in rock
&
4 Sq. Ft. in other soils



6" Class 200

Area Sq. Ft.

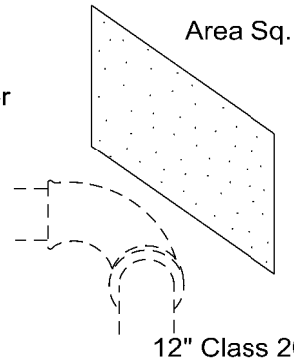
4 Sq. Ft. in rock
&
6 Sq. Ft. in other soils



8" Class 200

Area Sq. Ft.

9 Sq. Ft. in rock
&
14 Sq. Ft. in other soils



12" Class 200

Blocking area for 200 psi tests & 175 psi working pressures.

THRUST BLOCKING DESIGN

On basis of 200 psi water pressure used for tests, the blocking required for two types of soils are noted below. In one case, a soil pressure of 5000 psf is used for rock excavation and for soils other than rock a 3000 psf bearing soil pressure is used. The distribution on system is pressure of 175 psf all calculations apply to A.C. Pipe Class 200 and Ductile Iron Pipe Class 2. PVC Pipe Class 200 (SDR 13.5)

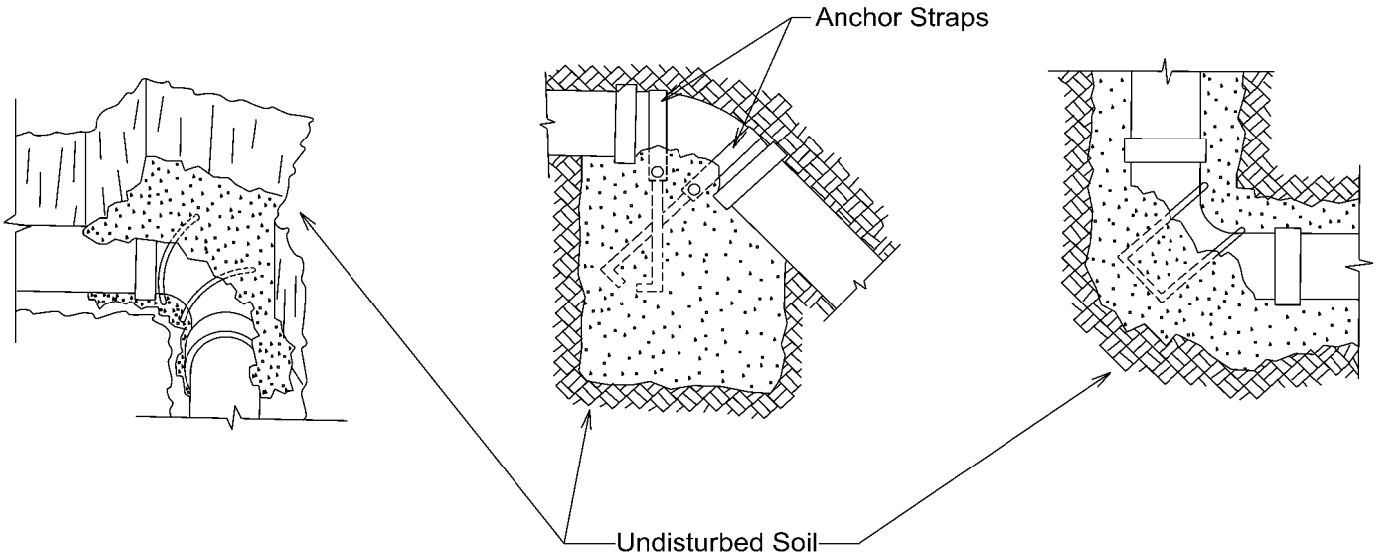
Square feet of blocking required for rock excavation

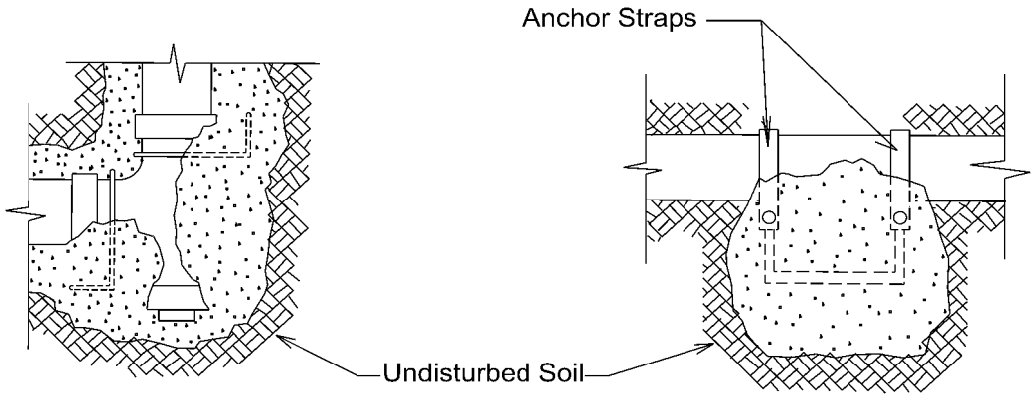
SIZE PIPE	TEES & DEAD ENDS	90° BENDS	45° BENDS	22 1/2° BENDS
6"	2	2	1	1
8"	3	4	2	1
12"	6	9	5	2
16"	11	15	8	4

Square feet of blocking required for other than rock excavation

SIZE PIPE	TEES & DEAD ENDS	90° BENDS	45° BENDS	22 1/2° BENDS
6"	3	4	2	1
8"	4	6	4	2
12"	10	14	8	4
16"	18	25	14	7

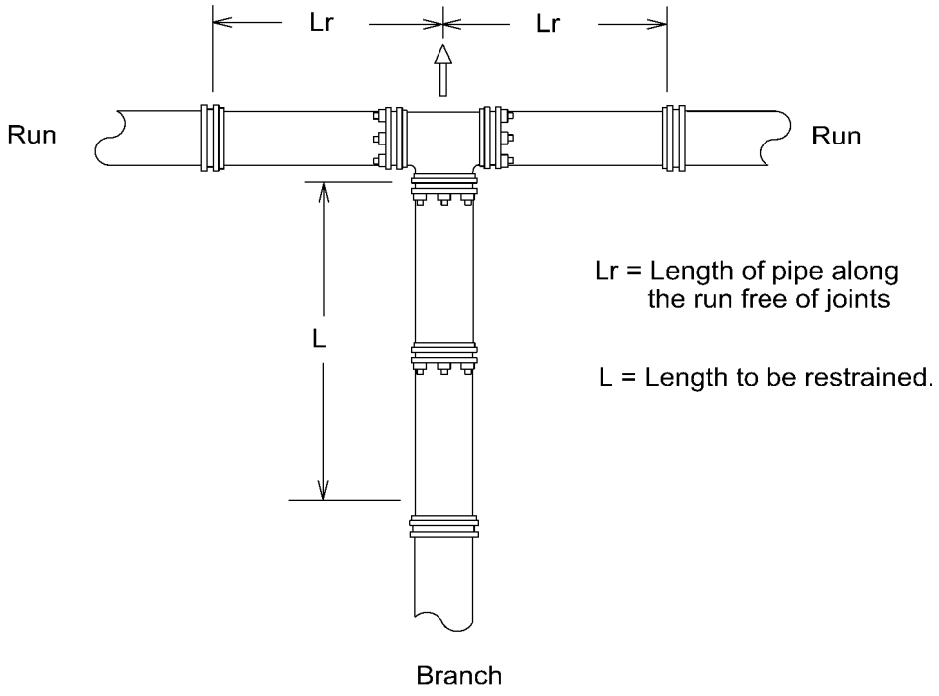
PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	THRUST BLOCKING FOR HIGH PRESSURE SYSTEM	APPROVED March 2008	REVISED AUG 2019
		DD-839-02	SHEET 1 OF 1





Note:
All concrete used for thrust blocking shall have a minimum concrete strength of 3,000 psi

PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	TYPICAL THRUST BLOCKS (SEWER ONLY)	APPROVED March 2008	REVISED AUG 2019
		DD-839-03	SHEET 1 OF 1



RESTRAINED LENGTH FOR TEES

PIPE SIZE (inch)	BRANCH SIZE (inch)	LENGTH OF RUN (ft.)	RESTRAINED LENGTH IN FEET, WHEN TEST PRESSURE = 200 psi	RESTRAINED LENGTH IN FEET, WHEN TEST PRESSURE = 150 psi
6	4	0	42	31
6	4	5	7	1
6	4	10	1	1
6	6	0	59	44
6	6	5	35	20
6	6	10	11	1
8	4	0	42	31
8	4	5	1	1
8	6	0	59	44
8	6	5	28	13
8	6	10	1	1
8	8	0	77	58
8	8	5	53	34
8	8	10	30	11
8	8	15	6	1

RESTRAINED LENGTH DESIGN

Restrained length calculations are for P.V.C pipe bedded in compacted granular material extending to the top of the pipe.The native soil material is assumed to be inorganic clay of high plasticity. Depth of bury is assumed to be 4 feet.

Note:
These calculations are provided for reference. The restrained length shall be designed based upon the conditions encountered during the installation.

PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	RESTRAINED LENGTHS FOR TEES	APPROVED	REVISED
		March 2008	AUG 2019
		DD-839-04	SHEET 1 OF 2

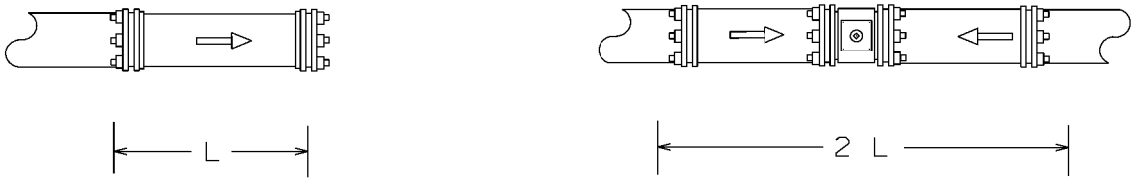
RESTRAINED LENGTH FOR TEES (Cont'd)

PIPE SIZE (inch)	BRANCH SIZE (inch)	LENGTH OF RUN (ft.)	RESTRAINED LENGTH IN FEET, WHEN TEST PRESSURE = 200 psi	RESTRAINED LENGTH IN FEET, WHEN TEST PRESSURE = 150 psi
12	4	0	42	31
12	4	5	1	1
12	6	0	59	44
12	6	5	13	1
12	6	10	1	1
12	8	0	77	58
12	8	5	42	23
12	8	10	7	1
12	8	15	1	1
12	12	0	109	82
12	12	5	86	59
12	12	10	63	35
12	12	15	39	12

RESTRAINED LENGTH DESIGN

Restrained length calculations are for P.V.C pipe bedded in compacted granular material extending to the top of the pipe.The native soil material is assumed to be inorganic clay of high plasticity. Depth of bury is assumed to be 4 feet.

Note:
These calculations are provided for reference. The restrained length shall be designed based upon the conditions encountered during the installation.



L=LENGTH TO BE RESTRAINED

PIPE SIZE (inch)	RESTRAINED LENGTH IN FEET, WHEN TEST PRESSURE = 200 psi	RESTRAINED LENGTH IN FEET, WHEN TEST PRESSURE = 150 psi
6	59	44
8	77	58
10	93	69
12	109	82

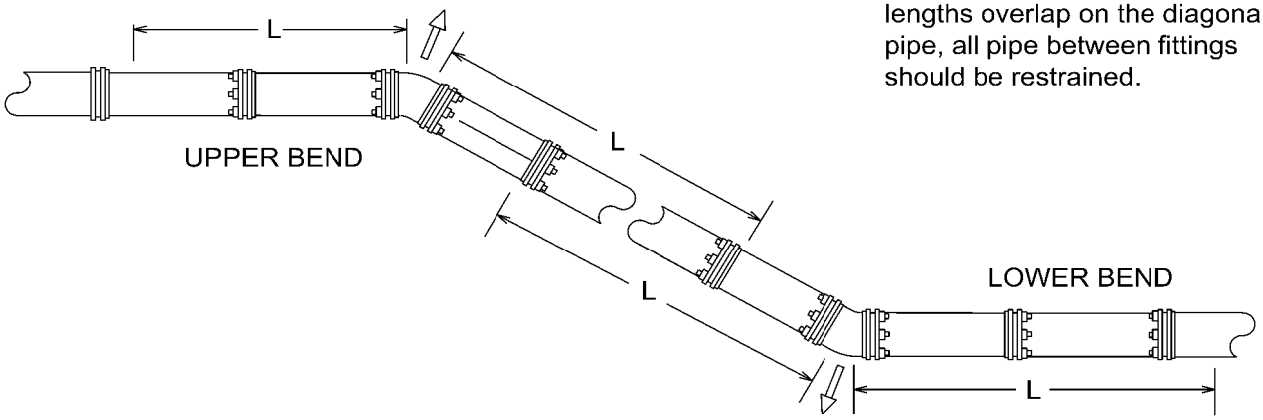
RESTRAINED LENGTH DESIGN

Restrained length calculations are for P.V.C. pipe bedded in compacted granular material extending to the top of the pipe. The native soil material is assumed to be inorganic clay of high plasticity. Depth of bury is assumed to be 4 feet.

Note:
These calculations are provide for reference. The restrained length shall be designed based upon the conditions encountered during the installation.

PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	RESTRAINED LENGTHS FOR DEAD ENDS / INLINE VALVES	APPROVED	REVISED
		MARCH 2008	AUG 2019
		DD-839-05	SHEET 1 OF 1

L = Length to be restrained on both sides of fitting. When restrained lengths overlap on the diagonal pipe, all pipe between fittings should be restrained.



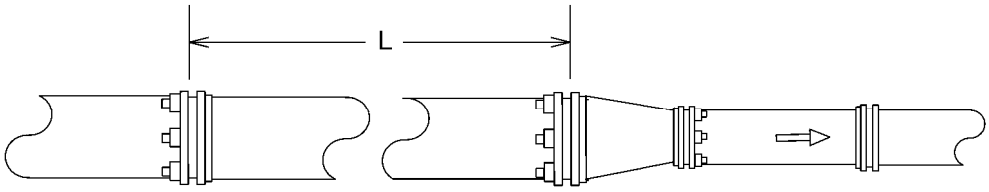
PIPE SIZE (inch)	BEND ANGLE (deg.)	LOW SIDE DEPTH	UPPER BEND RESTRAINED LENGTH IIN FEET TEST PRESSURE = 200 psi	LOWER BEND RESTRAINED LENGTH IN FEET TEST PRESSURE = 200psi	UPPER BEND RESTRAINED LENGTH IN FEET TEST PRESSURE = 150 psi	LOWER BEND RESTRAINED LENGTH IN FEET TEST PRESSURE = 150 psi
6	45	5	24	8	18	6
6	22.5	5	12	4	9	3
6	11.25	5	6	2	4	1
6	45	10	24	5	18	4
6	22.5	10	12	2	9	2
6	11.25	10	6	1	4	1
8	45	5	32	11	24	8
8	22.5	5	15	5	11	4
8	11.25	5	8	3	6	2
8	45	10	32	7	24	5
8	22.5	10	15	3	11	2
8	11.25	10	8	2	6	1
12	45	5	45	16	34	12
12	22.5	5	22	7	16	6
12	11.25	5	11	4	8	3
12	45	10	45	10	34	7
12	22.5	10	22	5	16	3
12	11.25	10	11	2	8	2

RESTRAINED LENGTH DESIGN

Restrained length calculations are for P.V.C. pipe bedded in compacted granular material extending to the top of the pipe. The native soil material is assumed to be inorganic clay of high plasticity. Depth of bury is assumed to be 4 feet.

Note:
These calculations are provided for reference. The restrained length shall be designed based upon the conditions encountered during the installation.

PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	RESTRAINED LENGTHS VERTICAL OFFSETS	APPROVED	REVISED
		MARCH 2008	AUG 2019
		DD-839-06	SHEET 1 OF 1



L=Length to be restrained

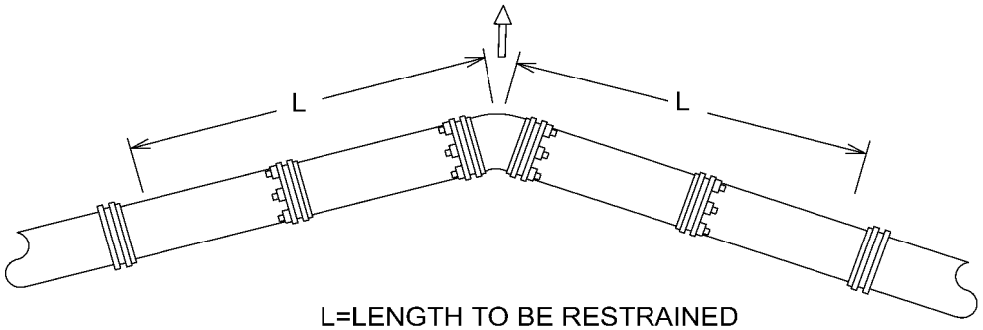
PIPE SIZE (inch)	SMALL SIZE (inch)	RESTRAINED LENGTH IN FEET, WHEN TEST PRESSURE = 200 psi	RESTRAINED LENGTH IN FEET, WHEN TEST PRESSURE = 150 psi
6	4	30	23
8	4	55	42
8	6	32	24
12	4	95	71
12	6	80	60
12	8	58	43

RESTRAINED LENGTH DESIGN

Restrained length calculations are for P.V.C. pipe bedded in compacted granular material extending to the top of the pipe. The native soil material is assumed to be inorganic clay of high plasticity. Depth of bury is assumed to be 4 feet.

Note:
These calculations are provided for reference. Th restrained length shall be designed based upon the conditions encountered during the installation.

PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	RESTRAINED LENGTHS FOR REDUCERS	APPROVED MARCH 2008	REVISED AUG 2019
		DD-839-07	SHEET 1 OF 1



L=LENGTH TO BE RESTRAINED
ON BOTH SIDES OF FITTING

PIPE SIZE (inch)	BEND ANGLE (deg)	RESTRAINED LENGTH IN FEET, WHEN TEST PRESSURE = 200 psi	RESTRAINED LENGTH IN FEET, WHEN TEST PRESSURE = 150 psi
6	90	23	17
6	45	9	7
6	22.5	5	3
6	11.25	2	2
8	90	30	22
8	45	12	9
8	22.5	6	4
8	11.25	3	2
12	90	43	32
12	45	18	13
12	22.5	8	6
12	11.25	4	3

RESTRAINED LENGTH DESIGN

Restrained length calculations are for P.V.C pipe bedded in compacted granular material extending to the top of the pipe. The native soil material is assumed to be inorganic clay of high plasticity. Depth of bury is assumed to be 4 feet.

Note:
These calculations are provided for reference. The restrained length shall be designed based upon the conditions encountered during the installation.

PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	RESTRAINED LENGTHS FOR HORIZONTAL BENDS	APPROVED	REVISED
		MARCH 2008	AUG 2019
		DD-839-08	SHEET 1 OF 1

ITEM NO. 840

Water Tie-Ins

840.1 DESCRIPTION: This item shall consist of water main tie-ins installed in accordance with these specifications and as directed by the Engineer. A Water Tie-In is defined as a connection between a new main and an existing main that is no longer than one joint of pipe.

840.2 REFERENCED STANDARDS: Reference standards cited in this Specification Item No. 840 refer to the current reference standard published at the time of the latest revision date.

1. San Antonio Water System (SAWS):
   a. Specifications for Water and Sanitary Sewer Construction
   b. SAWS Materials Specifications
2. City of San Antonio (COSA) Specifications for Construction
3. Texas Commission on Environmental Quality (TCEQ)
   a. Chapter 290; Subchapter D – Rules and Regulations for Public Drinking Water
4. American National Standards Institute (ANSI)
   a. ANSI A 21.11/AWWA C111 - Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   b. ANSI/NSF Standard 61 - Drinking Water System - Health Components.
5. American Society for Testing and Materials (ASTM) International:
   Pressure Pipe and Fittings.
   a. ASTM A 36 - Standard Specification for Carbon Structural Steel.
   b. ASTM A 536 - Standard Specification for Ductile Iron Castings.
   c. ASTM A 126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
   d. ASTM B 21 - Standard Specification for Naval Brass Rod, Bar, and Shapes.
   e. ASTM B 98 - Standard Specification for Copper-Silicon Alloy Rod, Bar, and Shapes.
   f. ASTM B 301 - Standard Specification for Free-Cutting Copper Rod and Bar.
   g. ASTM B 584 - Standard Specification for Copper Alloy Sand Casting for General Application.
   h. ASTM E 165 - Standard Test Method for Liquid Penetrant Examination.
   i. ASTM E 709 - Standard Guide for Magnetic Particle Examination.
   j. ASTM F 1674 - Standard Test Method for Joint Restraint Products for Use with PVC Pipe.

6. American Water Works Association (AWWA)
    a. AWWA C 206 - Standard for Field Welding of Steel Water Pipe.
    b. AWWA C 207 - Standard for Steel Pipe Flanges for Waterworks Service - Sizes 4 Inches through 144 Inches.
    c. AWWA C 800 - Standard for Underground Service Line Valves and Fittings.
7. Occupational Safety and Health Administration (OSHA)
    a. OSHA 29 CFR 1926.1101 – Asbestos.

840.3 SUBMITTALS: Contractor shall submit manufacturer's product data, instructions, recommendations, shop drawings, and certifications. All submittals shall be in accordance with Engineer's requirements and submittals shall be approved prior to delivery.

840.4 MATERIALS: The materials for water main tie-ins shall conform to the specifications contained within the latest revision of SAWS' Material Specifications for all appropriate items.

840.5 CONSTRUCTION: The Contractor shall make tie-ins from new water mains to existing water mains as shown in the contract documents or as directed by the Engineer.

1. The Contractor shall be responsible for all shutdowns and isolation of the existing mains; cutting pipe for the connection; dewatering the excavation; advanced customer notification of the shutdown; and all other requirements as directed and coordinated through the SAWS Inspector to provide completion of this effort in a safe and secure manner.
2. The opening or closing of SAWS valves smaller than 12-inches can only be performed in the presence of the SAWS Inspector.
3. The opening or closing of SAWS valves 12-inches and larger, and any valves identified as critical (e.g., division valves) can only be operated by SAWS Distribution and Collection Department.
4. The planned shutdown, tie-in work and hours shall be coordinated through and approved by the SAWS Inspector. The Contractor is required to provide written notification to the SAWS Inspector at least twenty-five (25) Calendar Days in advance of the anticipated tie-in date for customer coordination and test shutdowns. The shutdowns shall be accomplished at a time that results in the least inconvenience to SAWS customers, including overnight shutdowns at no additional cost to SAWS. The twenty-five (25) Calendar Day notification is required for all shutdowns to account for cases where the shutdown affects a significant number of SAWS customers, critical services, or when an extended shutdown duration will negatively impact customers. The twenty-five (25) Calendar Day period begins at written notification to the SAWS Inspector and ends at initiation of the tie-in work. This will allow SAWS time to review shut-down options, coordinate with affected customers and engage with the public. Contractor should plan for the twenty-five (25) Calendar Days in their project schedule and bid for every shutdown.

5. A temporary water main, defined as a 4-inch main or greater, may be required to maintain customer services during the shutdown. SAWS approval will be required for the addition of a temporary water main. If approved by SAWS and there is no existing line item a separate temporary water main bid item will be established and negotiated for payment.
6. A cut-in valve may be required to facilitate the shutdown. If approved by SAWS and there is no existing line item a separate cut-in valve bid item will be established and negotiated for payment.
7. Tapping of CSC pipe is only allowed by the CSC Manufacturer of pipe brand being tapped or CSC Manufacturer approved by SAWS. See specification Item No. 820 Concrete Steel Cylinder Pipe Installation.
8. No additional compensation will be provided for tie-ins, and any related costs, accomplished outside of normal working hours.
9. Prior to installation of tie-ins, all materials and equipment to complete tie in work shall be on-site and verified by the inspector prior to beginning any associated work.
10. If System allows, multiple tie-ins must be coordinated and approved in advance with SAWS' Inspector, but multiple tie ins may not be guaranteed.
11. Contractor to be prepared for water main shutdown as coordinated with SAWS Inspector. Fines may be assessed if Contractor cancels or delays owner.
12. Contractor to consider dewatering of the main as part of the duration of tie-in work.
13. SAWS cannot guarantee a complete water shutdown, Contractor is responsible for providing adequate dewatering efforts to complete tie-in work
14. Contractor is responsible for providing temporary water connections to critical services that are required to stay in service during the tie-in or where a tie-in duration will affect a critical services normal operation. Advanced coordination with inspections will be required to identify critical services that could be impacted by the shutdown.
15. All tie-ins must be restrained in accordance with Specification Item No. 839,

    "Anchorage/Thrust Blocking And Joint Restraint."

840.6 MEASUREMENT: Tie-ins will be measured by the unit of each such assembly of the various sizes of tie-ins installed at the proposed mains to be accepted.

840.7 PAYMENT: Payment for "Tie-ins" will be made at the unit price bid for each tie-in of the various types and sizes completed from an existing main to the proposed main to be accepted.

1. Such payment shall include; shut-down and isolation of the existing main to which the new main is to be connected, cutting pipe for the connection, dewatering the excavation, assembly, excavation, selected embedment material, initial backfill, secondary backfill, anti-corrosion embedment when specified, compaction, compaction testing, blocking, transition coupling, all required restraints, accessories and appurtenances, hauling and disposition of surplus excavated material, including all existing pipe, fittings, appurtenances to be abandoned or removed, surface and pavement restoration, installation of all-

weather surface, dewatering of the main, other required testing, temporary service connections, customer coordination and customer notification of service interruption where required.

2. Connections between new and existing mains which are made with cut-in tees and tapping sleeves and valves will be processed as separate pay items in accordance with SAWS specification Item No. 831 and Item No. 832, respectively.
3. Temporary water mains (4" or greater) will be processed as a separate pay item.
4. Cut-in valves will be processed as a separate pay item.
5. Removal and handling of asbestos cement pipe required for tie-ins will be processed as a separate pay item in accordance with SAWS specification Item No. 3000.
6. Materials paid on site will be in accordance with Table 1 of Specification Item No. 100 Mobilization.

-End of Specification-

ITEM NO. 841

Water and Reclaimed Water Mains Hydrostatic Testing Operations

841.1 DESCRIPTION: This item shall consist of hydrostatic testing operations of water mains and reclaimed water mains in accordance with these specifications.

841.2 REFERENCED STANDARDS: Reference standards cited in this Specification Item No. 841 refer to the current reference standard published at the time of the latest revision**.**

1. San Antonio Water System (SAWS):
    a. Specifications for Water and Sanitary Sewer Construction
    b. SAWS Materials Specifications
2. City of San Antonio (COSA) Standard Specification for Construction
3. Texas Commission of Environmental Quality (TCEQ)
    a. Chapter 210 Use of Reclaim Water and
    b. Chapter 290 Public Water Systems
    c. Chapter 217 Design Criteria for Domestic Wastewater Systems
    d. Chapter 213 Edwards Aquifer

841.3 SUBMITTALS: Contractor shall submit manufacturer's product data, instructions, recommendations, shop drawing, and certifications. All submittals shall be in accordance with Engineer's requirements and submittals shall be approved prior to delivery.

841.4 MATERIALS: The materials for hydrostatic testing operations installation and adjustment shall conform to the appropriate specifications contained within the latest revision of SAWS' Material Specifications.

841.5 CONSTRUCTION:

1. General:
    a. Flushing: Immediately upon completion of water main work, the Contractor shall flush all mains affected by the scope of the work. This flushing shall consist of completely filling sections of main between valves and then displacing such initial volumes of water by introducing clear water from existing facilities into and through the main to the point of discharge from the main being flushed. The flow-through shall continue until it is determined all dust, debris, or foreign matter that may have entered during pipe laying operations has been flushed out. All new mains shall then be isolated prior to and during testing.

b. For flushing and testing of reclaimed water main with reclaimed water, water must be disposed of in accordance with TCEQ Chapter 210 Use of Reclaimed Water.

c. To avoid damage to pavement and inconvenience to the public, fire hoses shall be used to direct flushing water from the main into suitable drainage channels or sewers. The Contractor is to coordinate with the Inspector prior to flushing.

d. Cross Contamination is to be avoided.

e. Operation of Valves: No valve in the Owner's water distribution system shall be operated by the Contractor without prior permission of the Inspector. The Contractor shall notify the Inspector when a valve is to be operated and shall only operate the valve in the presence of the Inspector.

2. Hydrostatic Test: All new mains shall be hydrostatically field tested at a maximum test pressure of 160 psi before acceptance by the Engineer or Inspector or where designated as a SAWS High Pressure Area all mains shall be hydrostatically tested at a maximum test pressure of 200 psi.

   a. It is the intent of these Specifications that all joints be watertight and that all joints which are found to leak by observation during any test shall be made watertight by the Contractor.

   b. When repairs are required, the hydrostatic field test shall be repeated until the pipe installation conforms to the specified requirements and is acceptable to the Engineer/Inspector.

   c. The Contractor shall insure that the Engineer/Inspector be present for the duration of the pressure test.

3. Test Procedures: After the new main has been laid and backfilled as required in Specification Item No. 804 "Excavation, Trenching, and Backfill," (but prior to chlorination and replacement of pavement), it shall be filled with water for a minimum of 24 hours and then subjected to a hydrostatic pressure test.

   a. The specified test pressure shall be supplied by means of a pump connected to the main in a satisfactory manner.

   b. The pump, pipe connection, and all necessary appurtenances including gauges and meters measuring (gallons) shall be furnished by the Contractor.

   c. Unless otherwise specified, the Owner will furnish water for filling lines and conducting tests from existing mains.

   d. Before applying the specified test pressure, all air shall be expelled from the main.

   e. To accomplish this, taps shall be made, if necessary, at the points of highest elevation and afterwards tightly plugged at no cost to the Owner.

f. At intervals during the test, the entire route of the new main shall be inspected to locate any leaks or breaks.
   1. If any are found, the test shall be stopped and the main repaired, and the main test shall be repeated until satisfactory results are obtained.

g. The hydrostatic test shall be made so that the maximum pressure at the lowest point does not exceed the specified test pressure.

h. The duration of each pressure test shall be a minimum of 4 hours for new mains in excess of 1000 linear feet and a minimum of 1 hour for new mains less than 1000 linear feet after the main has been brought up to test pressure.

i. The test pressure shall be measured by means of a tested and properly calibrated pressure gauge acceptable to the Engineer/Inspector.

j. All pressure tests shall be continued until the Inspector is satisfied that the new main meets the requirements of these Specifications.

k. Should any test of pipe in place disclose leakage greater than that listed in Table 841-1 or 841-2, "Hydrostatic Test Leakage Allowances," as applicable, the Contractor shall, at his own expense, locate and repair the main until the leakage is within the specified allowance.

l. All pipelines with welded joints shall have zero leakage.

m. Leakage is defined as the quantity of water supplied into the newly laid main, or any valved section of it, necessary to maintain the specified leakage test pressure after the main has been filled with water and the air expelled.

n. DD-841 Drawing Series includes a schematic showing the arrangement of the test apparatus as well as the detailed procedure for conducting the hydrostatic field test.

841.6 MEASUREMENT: Water and Reclaimed Water Main Hydrostatic Pressure Test shall be measured by the unit of each required successful test conducted.

841.7 PAYMENT: Payment for "Water and Reclaimed Water Main Hydrostatic Pressure Test" will be made at the unit price bid for each required successful test. Such payment shall also include all pipe, valves, fittings, pumping equipment, pressure gauge, and other required apparatus incidental to conduct the test.

TABLE 841-1

HYDROSTATIC TEST LEAKAGE ALLOWANCES (MAXIMUM) @ 150 PSI

Nominal Diameter & Type Pipe	ALLOWABLE LEAKAGE IN GALLONS PER HOUR (GPH)*													
	100 L.F.	200 L.F.	300 L.F.	400 L.F.	500 L.F.	600 L.F.	700 L.F.	800 L.F.	900 L.F.	1000 L.F.	2000 L.F.	3000 L.F.	4000 L.F.	5000 L.F.
6" DI**	0.11	0.22	0.33	0.44	0.55	0.66	0.77	0.88	0.99	1.10	2.20	3.30	4.40	5.50
8" DI**	0.15	0.29	0.44	0.59	0.71	0.88	1.03	1.18	1.32	1.47	2.94	4.41	5.88	7.35
12" DI**	0.22	0.44	0.66	.088	1.10	1.32	1.54	1.76	1.98	2.20	4.40	6.60	8.80	11.00
16" DI**	0.29	0.59	0.88	1.18	1.47	1.76	2.06	2.35	2.65	2.94	5.88	8.82	11.76	14.70
20" DI**	0.39	0.74	1.10	1.47	1.84	2.21	2.55	2.94	3.31	3.68	7.63	11.04	14.72	18.40
20" CSC	0.08	0.16	0.24	0.32	0.40	0.47	0.55	0.63	0.71	0.79	1.58	2.37	3.16	3.95
24" DI**	0.44	0.88	1.32	1.76	2.21	2.65	3.09	3.53	9.97	4.41	8.82	13.23	17.64	22.05
24" CSC	0.1	0.19	0.29	0.38	0.48	0.57	0.67	0.76	0.86	0.95	1.90	2.85	3.80	4.75
30" DI**	0.55	1.1	1.66	2.21	2.76	3.31	3.86	4.42	4.97	5.52	11.04	16.56	22.08	27.60
30" CSC	0.12	0.24	0.35	0.47	0.59	0.71	0.83	0.94	1.06	1.18	2.36	3.54	4.72	5.90
36" DI**	0.66	1.32	1.99	2.65	3.31	3.97	4.63	5.3	5.96	6.62	13.24	19.86	26.48	33.10
36" CSC	0.14		0.28	0.57	0.71	0.85	0..99	1.14	1.28	1.42	2.84	4.26	5.68	7.10
42" DI**	0.77	1.54	2.32	3.09	3.86	4.63	5.4	6.18	6.95	7.72	15.44	22.16	30.88	38.60
42" CSC	0.17	0.33	0.5	0.66	0.83	1	1.16	1.33	1.49	1.66	3.32	4.98	6.64	8.30
48" DI**	0.88	1.77	2.65	3.53	4.42	5.3	6.18	7.06	7.95	8.83	17.66	26.16	35.32	44.15
48" CSC	0.19	0.38	0.57	0.76	0.95	1.13	1.32	1.51	1.7	1.89	3.78	4.98	6.64	8.30
54" CSC	0.21	0.42	0.63	0.84	1.05	1.26	1.47	1.68	1.89					
60" CSC	0.24	0.48	0.72	0.96	1.2	1.44	1.68	1.92	2.16					

* PVC pipe shall be tested to DI pressures. GPH for CSC Pipe are manufacturer's maximum.

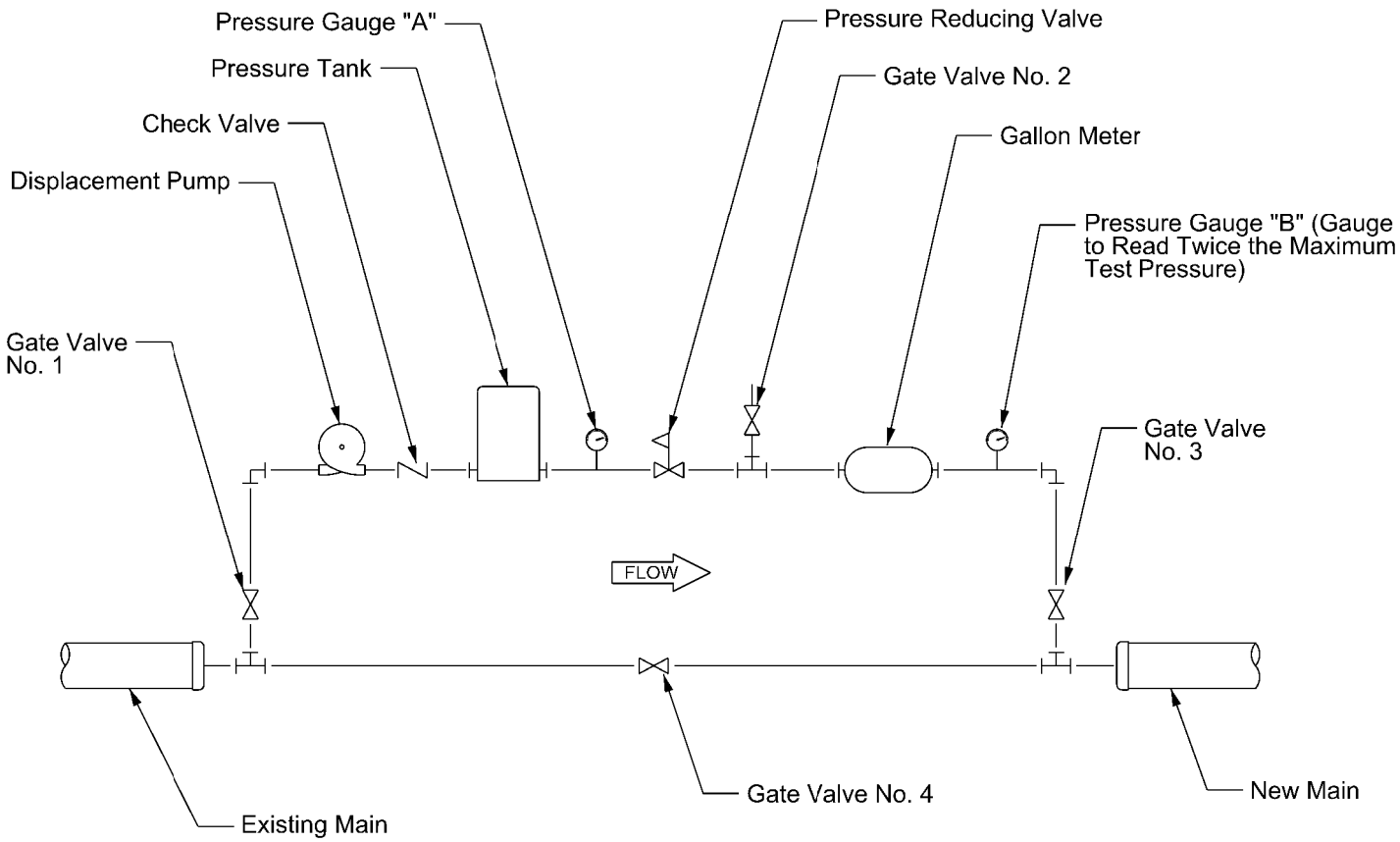
** DI pipe includes mechanical and push-on joints.

TABLE 841-2										
Hydrostatic Test Leakage Allowances (Maximum) @ 200 PSI										
Nominal Pipe Diameter	**Allowable Leakage in Gallons Per Hour (GPH)***									
	100 L.F.	**200 L.F.**	**300 L.F.**	**400 L.F.**	**500 L.F.**	**600 L.F.**	**700 L.F.**	**800 L.F.**	**900 L.F.**	**1000 L.F.**
6" DI**	0.13	0.25	0.38	0.51	0.64	0.6	0.89	1.02	1.14	1.27
8" DI**	0.17	0.34	0.51	0.68	0.85	1.02	1.19	1.36	1.53	1.7
12" DI**	0.26	0.51	0.77	1.02	1.28	1.53	1.79	2.04	2.3	2.55
16" DI**	0.34	0.68	1.02	1.36	1.7	2.04	2.38	2.72	3.06	3.4
20" DI**	0.43	0.85	1.28	1.7	2.13	2.55	2.98	3.4	3.83	4.25
20" CSC	0.08	0.16	0.24	0.32	0.4	0.47	0.55	0.63	0.71	0.79
24" DI**	0.51	1.02	1.53	2.04	2.55	3.06	3.57	4.08	3.59	5.1
24" CSC	0.1	0.19	0.29	0.38	0.48	0.57	0.67	0.76	0.86	0.95
30" DI**	0.64	1.27	1.91	2.55	3.19	3.82	4.46	5.1	5.73	6.37
30" CSC	0.12	0.24	0.35	0.47	0.59	0.71	0.83	0.94	1.06	1.18
36" DI**	0.76	1.53	2.29	3.06	3.82	4.58	5.35	6.11	6.88	7.64
36" CSC	0.14	0.28	0.43	0.57	0.71	0.85	0.99	1.14	1.28	1.42
42" DI**	0.89	1.78	2.68	3.57	4.46	5.35	6.24	7.14	8.03	8.92
42" CSC	0.17	0.33	0.5	0.66	0.83	1	1.16	1.33	1.49	1.66
48" DI**	1.02	2.04	3.06	4.08	5.1	6.11	7.13	8.15	9.17	10.19
48" CSC	0.19	0.38	0.7	0.76	0.95	1.13	1.32	1.51	1.7	1.89
54" CSC	0.21	0.42	0.63	0.84	1.05	1.26	1.47	1.68	1.89	2.1
60" CSC	0.23	0.46	0.69	0.92	1.15	1.38	1.61	1.84	2.07	2.3

* PVC pipe shall be tested to DI pressures. GPH for CSC pipe are manufacturer's maximum.

** DI pipe includes mechanical and push-on joints.

-End of Specification-



Step One: Close Gate Valve No. 3 and Gate Valve No. 4 and open Gate Valve No. 1 and Gate Valve No. 2 and fill test piping to system pressure. All test equipment and joints on test equipment must be watertight. If leakage occurs, the test should not be continued until approriate repairs are made.

Step Two: Close Gate Valve No. 1, Gate Valve No. 2 and Gate Valve No. 3. Open Gate Valve No. 4 and fill new main to system pressure. All air should be expelled from the new main at this time.

Step Three: Close Gate Valve No. 4 and open Gate Valve No. 1 and Gate Valve No. 2, leaving Gate Valve No. 3 closed. Start pump and with flow through Gate Valve No. 2, set the maximum test pressure on the down stream side of the pressure reducing valve. Pressure Gauge "B" should read maximum test pressure in pounds per square inch.

Step Four: Close Gate Valve No. 2 and open Gate Valve No. 3, leaving Gate Valve No. 1 open and Gate Valve No. 4 closed. Pump pressure tank to a pressure 20% greater than the maximum test pressure and maintain a positive head on the pressure reducing valve during the test period. Pressure Gauge "A" should always read higher than Pressure Gauge "B" during the test period. When Pressure Gauge "B" reaches maximum test pressure, record reading on gallon meter and start timing the hydrostatic pressure test. After the specified time has passed, record reading on gallon meter and compare water loss with Table 841-1 or Table 841-2 "Hydrostatic Test Leakage Allowances," as appropriate, in the San Antonio Water System - Standard Specifications For Water Works Construction.

HYDROSTATIC FIELD TEST EQUIPMENT SCHEMATIC AND FIELD TESTING SEQUENCE

PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	HYDROSTATIC FIELD TEST EQUIPMENT SCHEMATIC AND FIELD TESTING SEQUENCE	APPROVED	REVISED AUG 2019
		DD 841 - 01	SHEET 1 OF 1

ITEM NO. 845
Gate, Fencing, and Property Marker Details

845.1 DESCRIPTION: This item shall consist of gates, fences, and property markers installed, replaced, or modified in accordance with these specifications and as directed by the Engineer.

845.2 REFERENCED STANDARDS: Reference standards cited in this Specification Item No. 845 refer to the current reference standard published at the time of the latest revision date.

1. San Antonio Water System (SAWS):
   a. Specifications for Water and Sanitary Sewer Construction
   b. SAWS Materials Specifications
2. City of San Antonio (COSA) Standard Specification for Construction

845.3 SUBMITTALS: Contractor shall submit manufacturer's product data, installation instructions, recommendations, shop drawings, and any required installer certification(s). All submittals shall be in accordance with Engineer's requirements and submittals shall be approved prior to delivery.

845.4 MATERIALS: The materials for gate and fence installation and/or adjustment, as well as property marker installation shall conform to those as identified on drawings DD-903 Drawing Series.

1. Chain Link Fabric: 96" FABRIC, 1" PATTERN
   a. Hot dipped Galvanized chain link conforming to ASTM A392-89, Class 2; galvanized after weaving (GAW).
   b. Height: 96 inches, unless otherwise shown.
   c. Wire Gauge: No. 9.
   d. Pattern: 1"-inch diamond-mesh.
   e. Diamond Count: Manufacturer's standard and consistent for fabric furnished of same height.
   f. Loops of Knuckled Selvages: Closed or nearly closed with space not exceeding diameter of wire.
   g. Wires of Twisted Selvages.
   h. Twisted in a closed helix three full turns.
   i. Cut at an angle to provide sharp barbs that extend minimum 1/4-inch beyond twist top and bottom.
2. Do not install chain link until concrete has cured minimum of 7 days.
3. PIPE POSTS and LINE POSTS
   a. Steel pipe shall be galvanized and conform to ASTM F 1083-90 with strength and stiffness required by ASTM F 669-90a, Heavy Industrial Fence, except as modified herein.
   b. End, Corner, Angle, and Gate posts shall have a 4 inch outside diameter and a weight of 9.11 pounds per foot, in conformance with ASTM F 900-84.
   c. Line Post posts shall have a 2-3/8 inch outside diameter and a weight of 3.65 pounds per foot.
4. Installation of ground bonding shall be evaluated by the design engineer on a case-

by-case basis.

5. Design engineer shall be responsible for determine when ground bonding will be required.
6. TOP RAILS, MIDDLE RAILS, BOTTOM RAILS AND BRACE RAILS
   a. Galvanized steel pipe.
   b. Protective Coatings: As specified for posts.
   c. Strength and Stiffness Requirements: ASTM F1043-08, Top Rail, Heavy Industrial Fence.
   d. Steel Pipe:
      i. ASTM F1083-08.
      ii. Outside Diameter: 1-5/8-inch.
      iii. Weight: 2.27 pounds per foot.
7. FENCE FITTINGS: In conformance with ASTM F626-14, except as modified by this article.
8. Post and Line Caps:
   a. Designed to accommodate passage of top rail through cap, where top rail required.
   b. Rail and Brace Ends: Attach rails securely to each gate, corner, pull, and end post.
9. Rail Fittings: Provide the following:
   a. Bottom and Top-Rail Sleeves: Pressed steel or round steel tubing not less than 7 inches long.
   b. Rail Clamps: Line and corner boulevard clamps for connecting intermediate and bottom rails in the fence line to line posts.
10. Tension and Brace Bands: Pressed steel, 0.105 inch thick, minimum 0.75 inch wide, with 2.0-oz/sq. ft. metallic (zinc) coating.
11. Tension Bars: Steel, length not less than 2 inches shorter than full height of chain-link fabric with 2.0-oz/sq. ft. metallic (zinc) coating. Minimum cross section of 1/4-inch by 3/8-inch. Provide one bar for each gate and end post, and two for each corner and pull post unless fabric is integrally woven into post.
12. Truss Rod Assemblies: Steel, hot-dip galvanized after threading rod and turnbuckle or other means of adjustment. Minimum 5/16-inch diameter truss rod.
13. Barb Arms: 45-degree arms facing outward for supporting three strands of barbed wire.
14. Tie Wires, Clips, and Fasteners: According to ASTM F 626 and ASTM F 1916.
15. High-Security Round Wire Ties: For attaching chain-link fabric to posts, rails, and frames, complying with the following:
   a. Metallic-Coated Steel: 9 gauge wire with galvanized coating thickness matching coating thickness of chain-link fence fabric.
   b. Pre-formed steel post ties.
   c. Install with Easy Twist tool.
16. Finish:
   a. Metallic Coating for Pressed Steel or Cast Iron: Not less than 2.0-oz/sq. ft. metallic (zinc) coating.
   b. Aluminum: Mill finish.
17. TENSION WIRE

a. Metallic-Coated Steel Wire: 0.177-inch diameter, marcelled tension wire complying with ASTM A824 and the following:
b. Metallic Coating: Type II, zinc coated (galvanized) hot-dip process, with the following minimum coating weight:
c. Class 5: Not less than 2.0 oz./sq. ft. of uncoated wire surface.

18. BARBED WIRE
    a. Zinc-Coated Barbed Wire: ASTM A121-13, Chain Link Fence Grade:
        i. Line Wire: Three (3) strands of No. 12-1/2 gauge.
    b. Barbs:
        i. Number of Points: Four.
        ii. Length: 3/8-inch minimum.
        iii. Shape: Round.
        iv. Diameter: No. 14-gauge.
        v. Spacing: 5 inches.
19. GATES (UNLESS OTHERWISE SPECIFIED ELSEWHERE)
    a. Gate Operation: Opened and closed easily by one person.
    b. Welded Steel Joints: Paint with zinc-based paint.
    c. Chain Link Fabric: Attached securely to gate frame at intervals not exceeding 24 inches.
    d. Swing Gates: ASTM F900-84.
    e. Hinges:
    f. Furnished with large bearing surfaces for clamping in position.
    g. Designed to swing either 180 degrees outward, 180 degrees inward, or 90 degrees in or out, as shown, and not twist or turn under action of gate.
    h. Latches: Plunger bar arranged to engage stop, except single gates of openings less than 10 feet wide may each have forked latch.
    i. Gate Stops: Mushroom type or flush plate with anchors, suitable for setting in concrete.
    j. Locking Device and Padlock Eyes: Integral part of latch, requiring production lock carousel for locking both gate leaves of double gates.
    k. Hold-Open Keepers: Designed to automatically engage gate leaf and hold it in open position until manually released.
20. CHAIN LINK CANTILEVER SLIDE GATE
    a. ASTM F-1184.
    b. Classification: Fabricate chain link cantilever slide gates in accordance with ASTM F 1184-05.Type II Cantilever Slide, Class 2 with internal roller assemblies.
    c. The cantilever slide gate system shall be manufactured by Tymetal Corp., 2549 State Route 40 Greenwich, NY 12834. Ph. (800) 328-4283.
    d. Gate manufacturer shall provide independent certification as to the use of a documented Welding Procedure Specification and Procedure Qualification
    e. Record to insure conformance to the AWS D1.2 welding code. Upon request, Individual Certifications of Welder Qualifications documenting successful completion of the requirements of the AWS D1.2 code shall be provided.
    f. Dimensions: Per the Project Contract Plans.

21. DOUBLE GATES: Gates shall be lengths as required in scope constructed of 1½ inch diameter, galvanized 16 gauge steel tubing with all joints welded. Gates shall comply with ASTM F 900-84.
    a. Hinges shall be galvanized having large bearing surfaces for clamping in position and shall be designed to swing either 180 degrees outward, 180 degrees inward, or 90 degrees in and out, and not twist or turn during action of the gate. Bolt hooks shall be galvanized steel or stainless steel.
    b. Installation of gatekeepers and padlock keepers are not required except for hardware at cantilevered gates. Upon beneficial completion of the gate installations, SAWS will install chains and combination locks. Refer to details and drawings for hardware on cantilever gate.
    c. Gate Operation: Opened and closed easily by one person.
    d. Welded Steel Joints: Paint with zinc-based paint.
    e. Chain Link Fabric: Attached securely to gate frame at intervals not exceeding 15 inches.
    f. Only Tubular steel swing gates as indicated on the plans will be allowed.
    g. No temporary gap-type gates or panel gates will be allowed.
22. GATE OPERATORS
    a. HySecurity
    b. SlideDriver 50VF2/3
    c. Operator Specifications
    d. Duty Cycle Continuous
    e. Travel Speed Field adjustable, 2.2 ft. /s (70 cm/s) or 3 ft. /s (91 cm/s). Emergency Fast Operate 3 ft/s (91 cm/s)
    f. Gate Length Limited only by weight
    g. Gate Capacity up to 5,000 lb (2,268 kg)
    h. Operator HP 2 hp
    i. Drive Type Hydraulic
    j. Pull Force 300 lb (136 kg)
    k. UPS Optional 230V AC Power Supply w/HyInverter AC™ provides up to 3,000 ft (914 m) of gate travel after AC power loss.*
    l. Standard voltage system shall be
    m. Three Phase Voltages 230-Vac, 60-Hz. Other voltage systems will be accepted on a case-by-case basis.
    n. Minimum branch circuit for gate operators shall be stranded copper 10-AWG, XHHW run within a 1-inch dedicated conduit. All discrete signal circuits shall be installed in a dedicated 1-inch conduit. Any analog signal, if used, shall be installed in a dedicated 1-inch conduit.
    o. Gate Operator Disconnecting Means
    p. Disconnecting means shall be provided at the gate operator, and one spare 1-inch conduit shall be provided from panelboard source to the disconnecting means.
    q. Temperature Rating -40° to 158° F (-40° to 70° C) No heater necessary.

r. Communication RS-232, RS-485; Ethernet/fiber using optional HyNet™ Gateway accessory. Communication wiring from SAWS Security panel to gate operator board shall be installed in a dedicated 1-inch conduit. One spare 1-inch conduit from SAWS security panel to gate operator shall be provided.

s. User Controls Smart Touch Controller with 70+ configurable settings. Smart Touch keypad and 32 character, OLED display or a PC using S.T.A.R.T. software.

t. Relays three configurable user relays: one 30VDC, 3A solid state and two 250VAC, 10A electromechanical; Optional Hy8Relay™ for 8 additional relay outputs.

u. App Class Usage Class III, IV

v. Enclosure N/A

w. Finish Type Zinc plated with powder coating

x. * *The operator's normal duty cycle and the actual number of gate cycles available from battery depends upon gate length/weight, battery size, state of charge and health, ambient temperature, accessory power draw and frequency of gate cycles during power outage. The design consultant shall be responsible for evaluating how critical is accessibility to the facility, what is the expected peak gate cycles per day and to provide a recommendation.

23. CONCRETE & CONCRETE FOOTING DETAILS

a. Concrete shall achieve a 21 day compressive strength of at least 3,000 psi.

b. Installation of a continuous concrete footing throughout the entire length of the new fence with proper formwork continuous.

c. All fence posts (corner, line etc.) are to be centered and incorporated into the concrete footing.

d. Bottom of fencing shall be flush with proposed footing, fencing shall be secured to the footing by a galvanized rod at two foot intervals or as submitted by Contractor and approved by the Owner.

e. Footing shall be a continuous "mow strip" 12"W x 6"D and flush with existing ground elevation. Any significant grade change will require a step in fencing and "Mow strip" footing shall step as required with fence. Contractor to verify any drops in existing grades and step in footing with owner prior to setting formwork.

   i. When the potential for storm runoff entering the site exist, the "mow strip" shall be raised 8" above finish grade to provide a protection concrete barrier. Design engineer shall be responsible for adjusting dimensions to compensate for raised "mow strips" and to incorporate site draining means to prevent puddling within the site.

f. Concrete shall conform with the A - Classification for 3,000 PSI concrete as specified in Specification Item No. 300 "Concrete (Natural Aggregate).

g. Footing shall have two number four (#4) rebar throughout the entire

length, with #3 rebar at 10" o.c. as shown on attached drawings expansion joints shall be installed at forty foot intervals while dummy joints shall be placed every 10'.

i. When "mow strip" needs to be raised for storm runoff protection, the design engineer shall be responsible for determine any additional rebar to assure the raised mow strip has proper resistance to cracking.

h. Check size and spacing of rebar and footing width and depth. Ensure that there is a minimum of 3" between earth and rebar. Rebar should be centered in footing as shown on drawings.

i. Rebar must be properly supported/tied to maintain its position during concrete placement operations through the use of wire ties (18 gauge or greater), chairs, spacers or other approved supporting devices. Do not allow the use of rocks, wood blocks, or other unapproved material as support for reinforcement. Reinforcement support chairs shall be spaced typically every 5 to 6 feet. Wire tie ends shall be twisted away from concrete surfaces (toward the interior of the footer.)

j. Formwork must be properly braced and supported to prevent "blowouts" or unacceptable deformation of the formed surfaces. All formed surfaces shall be coated with approved form oil before placement of reinforcement so as to avoid coating the reinforcement.

k. During hot weather (temperatures above 80 degrees F) or during high winds, care must be taken to prevent excessive moisture loss in the concrete which can lead to surface shrinkage cracking.

l. Top of concrete at continuous footing shall have a continuous crown to readily shed water before concrete sets.

m. Top of concrete at continuous footing shall be sloped to readily shed water away from base of posts before concrete sets.

n. Where mow-strip is installed through asphalt, the asphalt shale be saw cut to provide smooth edges. Any broken asphalt will require patching.

o. Mow Strip to be continuous across gate openings.

845.5 CONSTRUCTION: Install chain link fences and gates in accordance with ASTM F567-14a except as modified in this section, and in accordance with fence manufacturer's recommendations, as approved by the Engineer. Erect fencing in straight lines between angle points.

1. Provide all necessary hardware for a complete fence and gate installation.
2. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, pavement work, and other conditions affecting.
3. Do not begin installation before final grading is completed, unless otherwise permitted by the Engineer.
4. Proceed with installation only after unsatisfactory conditions have been corrected.
5. Preparation
    a. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 100 feet or line of sight between stakes. Indicate locations

of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

6. Post Setting
    a. Driven posts are not acceptable.
    b. Post Hole Depth and Diameter :
        i. Minimum 38 inches below finished grade.
    c. 2 inches deeper than post embedment depth below finish grade.
    d. Diameter SAWS standard 18".
    e. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
    f. Concrete Fill: Place concrete around posts to dimensions indicated and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter. Blend with concrete mow strip.
7. Terminal Posts: Locate terminal end, corner, and gate posts per ASTM F 567 and terminal pull posts at changes in horizontal or vertical alignment of 15 degrees or more.
8. Line Posts: Space line posts uniformly at 10 feet o.c.
9. Post Bracing and Intermediate Rails: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Install braces at end and gate posts and at both sides of corner and pull posts.
    a. Locate horizontal braces at mid-height of fabric 6 feet or higher, on fences with top rail, and at 2/3 fabric height on fences without top rail. Install so posts are plumb when diagonal rod is under proper tension.
10. Top Rail: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Run rail continuously through line post caps, bending to radius for curved runs and terminating into rail end attached to posts or post caps fabricated to receive rail at terminal posts. Provide expansion couplings as recommended by fencing manufacturer.
11. Tie Wires: Power-fastened or manually fastened ties configured to wrap a full 360 degrees around rail or post and a minimum of 1 complete diamond of fabric. Twist ends one and one-half machine twists or three full manual twists, and cut-off protruding ends to preclude untwisting by hand.
    a. Maximum Spacing: Tie fabric to line posts at 12 inches o.c. and to braces at 24 inches o.c.
12. Chain-Link Fabric: Apply fabric to outside of enclosing framework. Pull fabric taut and tie to posts, rails, and tension wires. Anchor to framework so fabric remains under tension after pulling force is released.
    a. Do not install fabric until concrete has cured minimum *7 calendar* days.
    b. Install fabric with twisted and barbed selvage at top.
13. Barbed Wire
    a. Install three strands of barbed wire on brackets, tighten, and secure at each bracket.
    b. Brackets to be vertical facing outward.
14. Gate Frame:
    a. The gate frame shall be fabricated from 6063-T6 aluminum alloy

extrusions. The top member shall be a 3 inch x 5 inch (76 mm x 127 mm) aluminum structural channel/tube extrusion weighing not less than 3.0 lb/lf (4.4 kg/m).

b. To maintain structural integrity this frame member shall be "keyed" to interlock with the "keyed" track member.
c. If fabricated as a single horizontal piece, the bottom member shall be a 2 inch x 5 inch (51 mm x 127 mm) aluminum structural tube weighing not less than 2.0 lb/lf (2.9kg/m).
d. When the gate frame is manufactured in two horizontal pieces or sections, they shall be spliced in the field (the gate frame shall be fabricated in one or multiple sections depending on size requirements or project constraints.

15. Vertical Members:
    a. The vertical members at the ends of the gate frame shall be "P" shaped in cross section with a nominal base dimension of no less than 2 inch x 2 inch (51 mm x 51 mm) and weighing not less than 1.1 lb/lf (2.3kg/m).
    b. Major 2 inch x 2 inch (51 mm x 51 mm) vertical members weighing not less than 1.1 lb/lf shall separate each bay and shall be spaced at less than gate height intervals.
    c. Intermediate 1 inch x 2 inch (25mm x 51mm) vertical members weighing not less than 0.82 lb/lf shall alternate between 2 inch x 2 inch major members.
16. Gate Track
    a. The gate frame shall have a separate semi-enclosed "keyed" track, extruded from 6005A-T61 or 6105-T5 aluminum alloy, weighing not less than 2.9 lb./lf (4.2 kg/m).
    b. The track member is to be located on only one side of the top primary.
    c. Welds to be placed alternately along the top and side of the track at 9 inch (229) centers with welds being a minimum of 2 inch (51 mm).
17. Welds
    a. All welds on the gate frame shall conform to Welding
    b. Procedure Specification and Procedure Qualification Record to insure conformance to the AWS D1.2 Structural Welding Code.
    c. All individual welders shall be certified to AWS D1.2 welding code.
18. Gate Mounting
    a. The gate frame is to be supported from the track by two (2) swivel type, self-aligning, 8-wheeled, sealed lubricant, ball-bearing truck assemblies.
    b. The bottom of each support post shall have a bracket equipped with a pair of 3 inch (76 mm) UHMV guide wheels.
    c. Wheel cover protectors shall be included with bottom guides to comply with UL325.
    d. Gap protectors shall be provided and installed, compliant with ASTM F 2200-05.
19. Diagonal Bracing
    a. Diagonal "X" bracing of 3/16 inch (5 mm) minimum diameter stainless steel aircraft cable shall be installed throughout the entire gate frame.
    b. The gate shall be completed by installation of approved filler as specified.

20. Chain Link: 1 inch x 1 inch, 9 gauge galvanized steel chain link fabric shall extend the entire length of the gate (if operated gate, counterbalance must also have fabric to prevent reach through and comply with ASTM F2200.
    a. Fabric shall be attached at each end of the gate frame by standard fence industry tension bars and tied at each 2 inch x 2 inch and 1 inch x 2 inch vertical members with standard fence industry ties at three different places each member.
    b. ASTM F2200 requires attachment method that leaves no leading or bottom edge protrusions (cannot exceed 0.5 inch).
    c. Chain link fabric must have a triple twisted selvage top and bottom with a cut at slant ¼ inch above twist.
21. Finish: Gate to be mill finish aluminum.

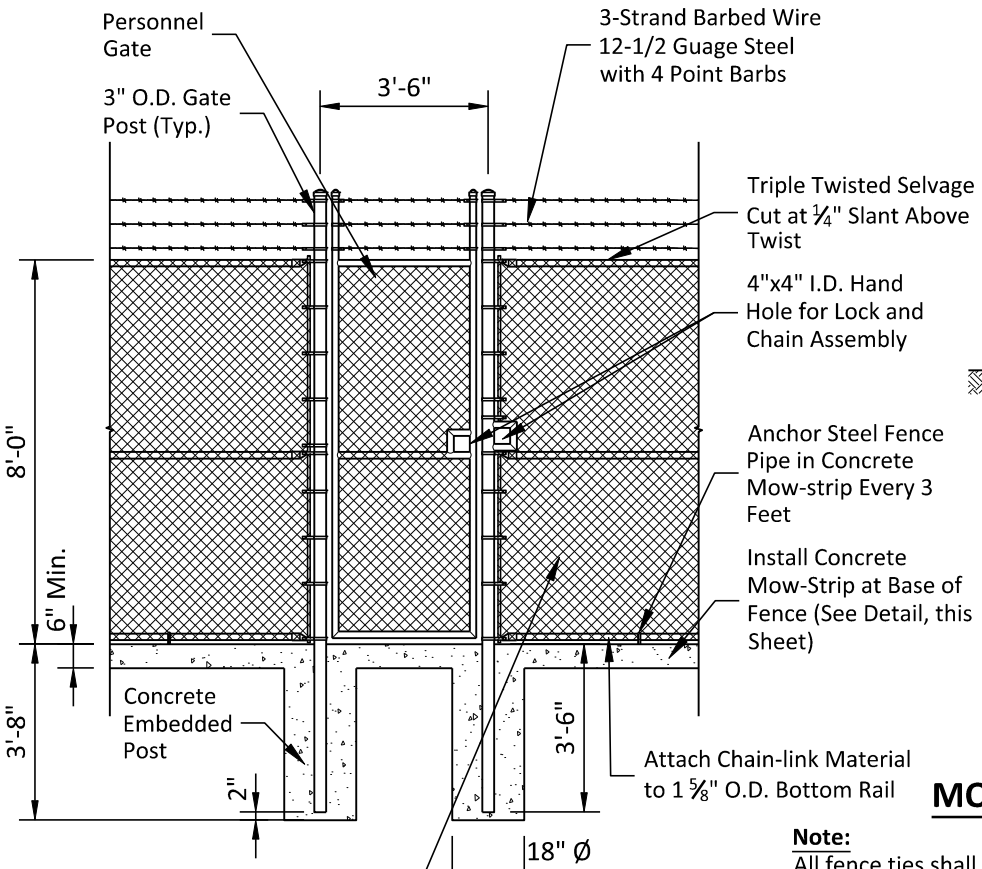
845.6 MEASUREMENT:

1. Measurement for fencing installed will be measured by the linear foot for each size and type shown installed, replaced, or modified herein or as superseded by the contract documents.
2. Measurement for gates installed will be measured by the unit of each hinged or cantilevered assembly shown installed herein or as superseded by the contract documents.
3. Measurement for property markers will be measured by the unit of each assembly shown installed herein or as superseded by the contract documents.

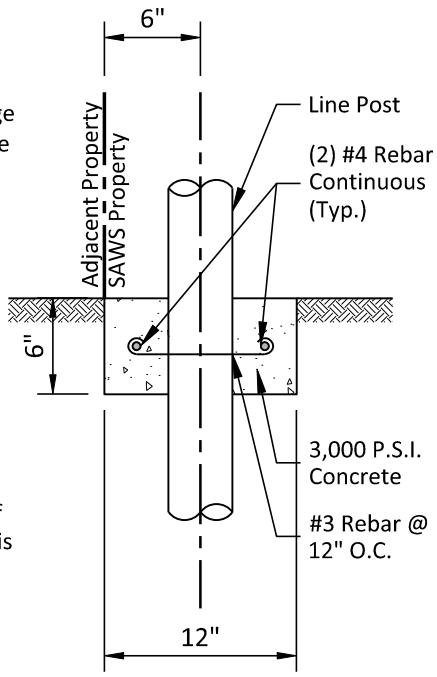
845.7 PAYMENT:

1. Payment for fencing will be made at the unit price bid for each linear foot installed.
2. Payment for gates will be made at the unit price bid for each such assembly of the type and size installed in accordance with the details shown in the Standard Drawing DD-903 Drawing Series, or as superseded by the contract documents.
3. Payment for property markers will be made at the unit price bid for each such assembly of the type and size installed in accordance with the details shown in the Standard Drawing DD-903 Drawing Series, or as superseded by the contract documents.

-End of Specification-

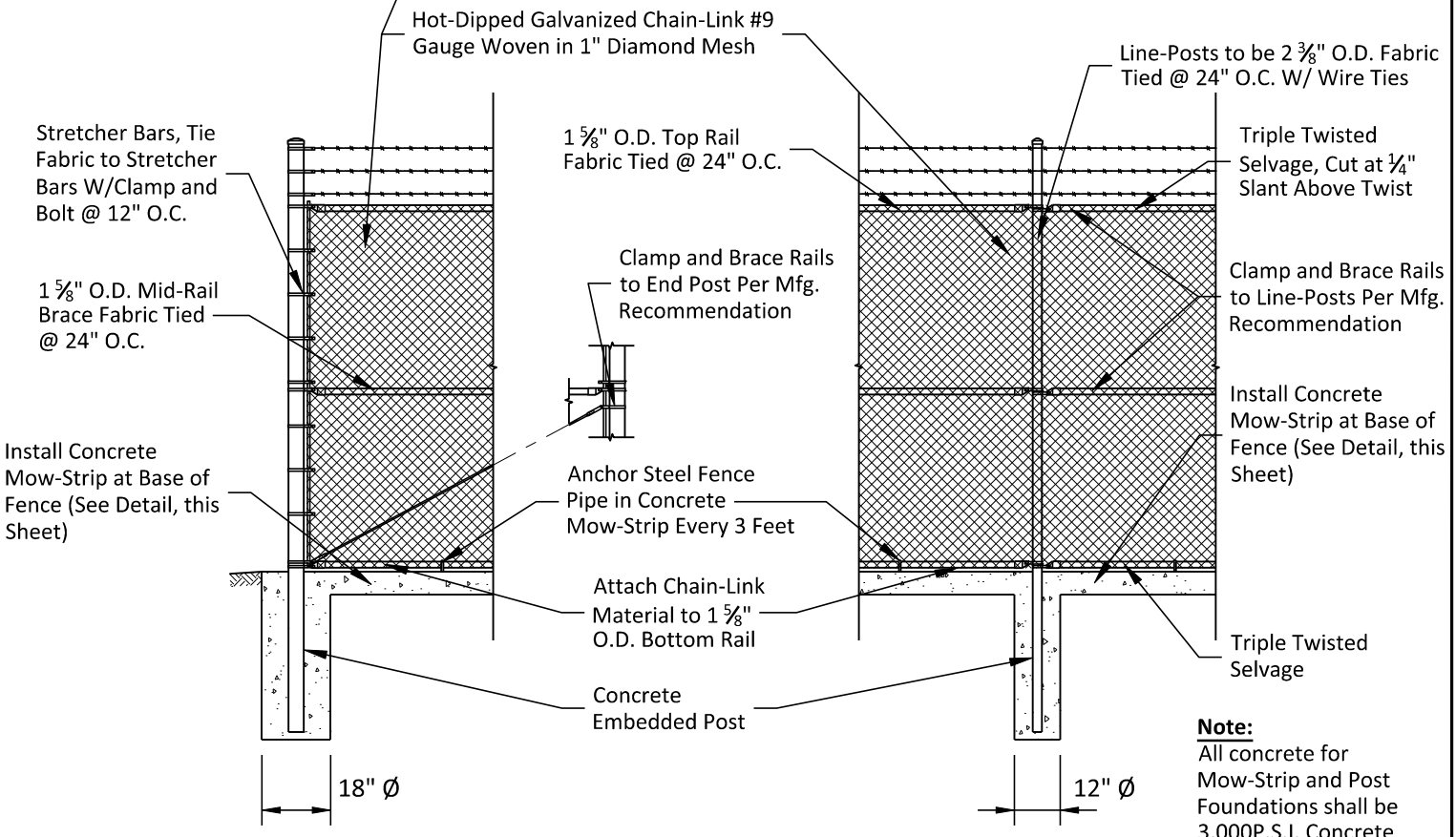


PERSONNEL GATE



MOW-STRIP SECTION DETAIL

Note:
All fence ties shall be 9 Gauge Galvanized Steel to be twisted on the inside of fence.

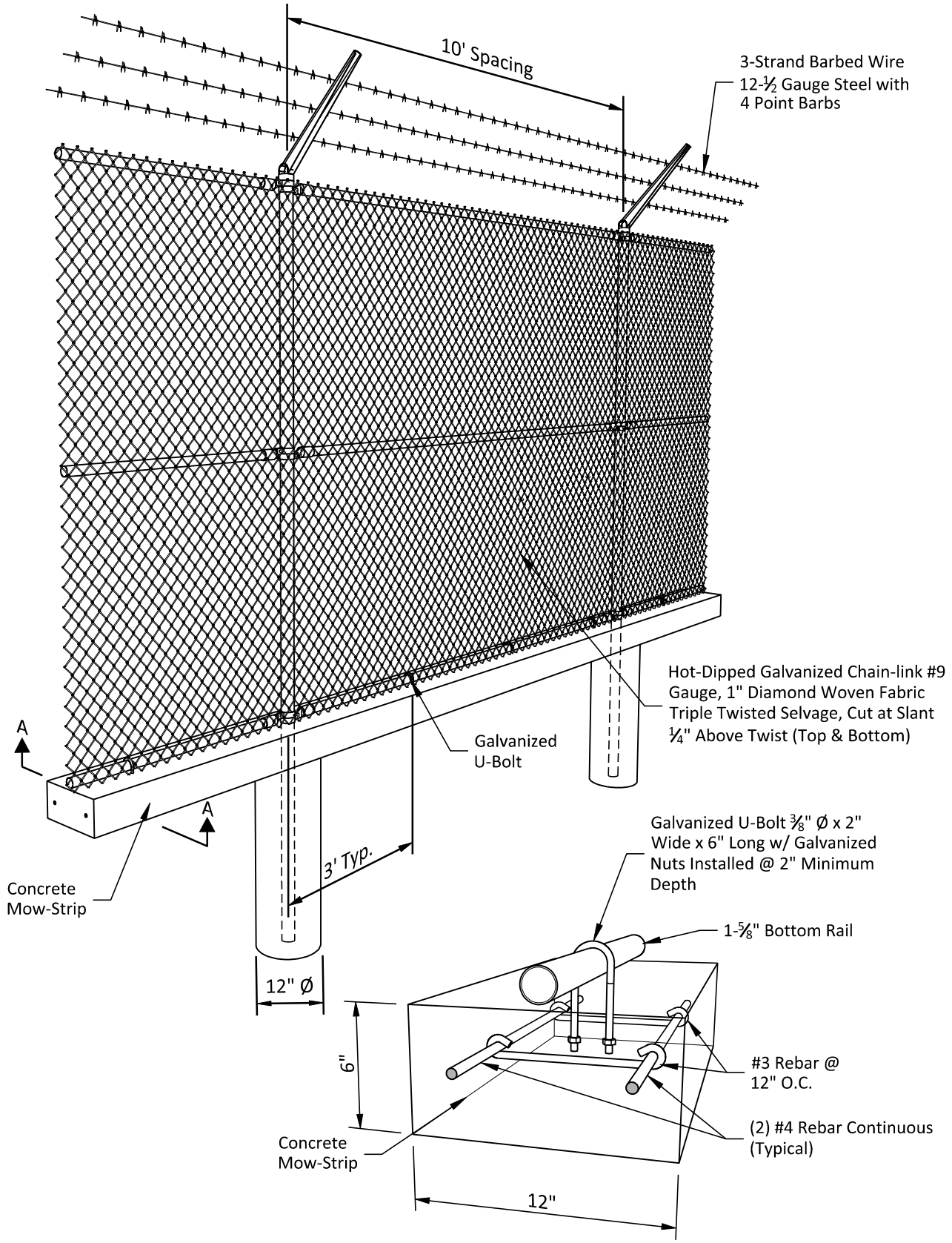


FENCE CORNER-POST

INLINE-POST

Note:
All concrete for Mow-Strip and Post Foundations shall be 3,000P.S.I. Concrete

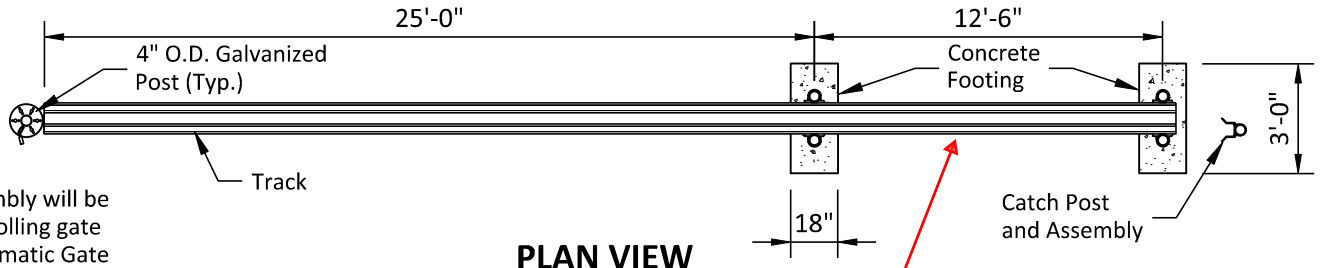
PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	FENCE DETAILS	APPROVED MARCH 2011	REVISED AUG 2019
		DD-903-17	SHEET 1 OF 2



NOTE:
All fence ties shall be 9 Gauge Galvanized steel to be twisted on the inside of the fence

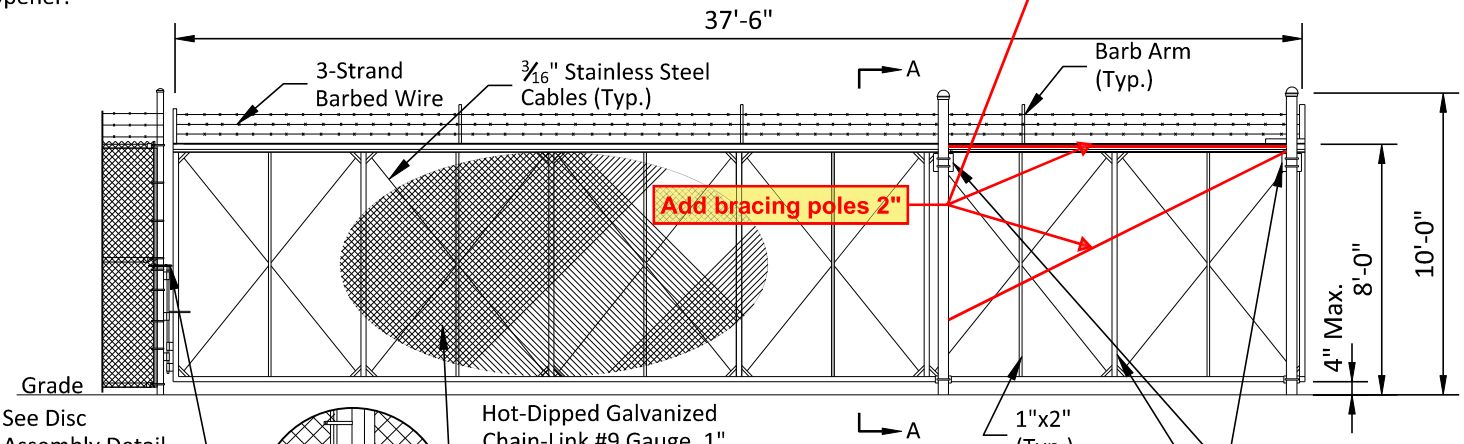
SECTION A-A

PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	FENCE DETAILS	APPROVED MARCH 2011	REVISED AUG 2019
		DD-903-17	SHEET 2 OF 2

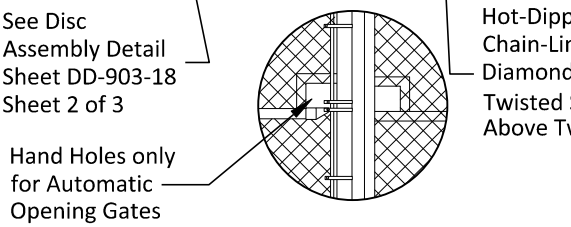


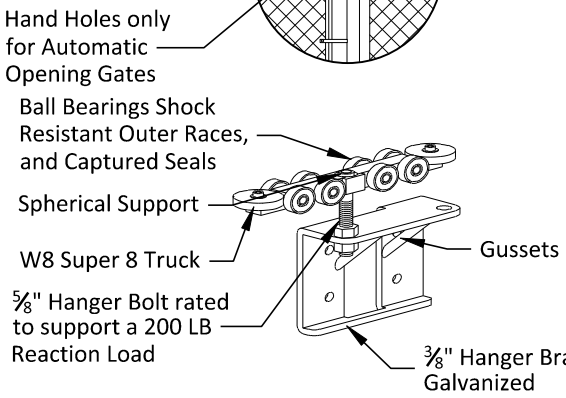
Note:
No Disc Assembly will be used on any rolling gate with an Auto-matic Gate Opener.

PLAN VIEW

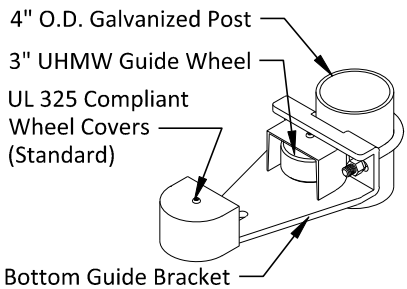


ELEVATION

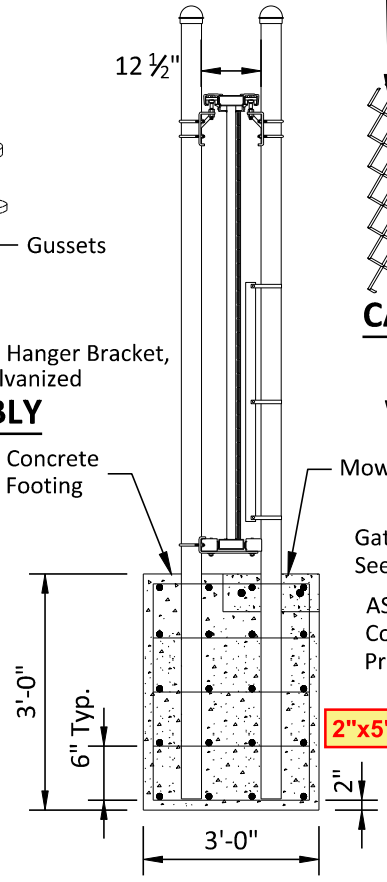




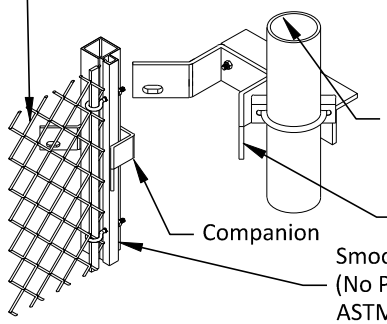
GATE HANGER ASSEMBLY



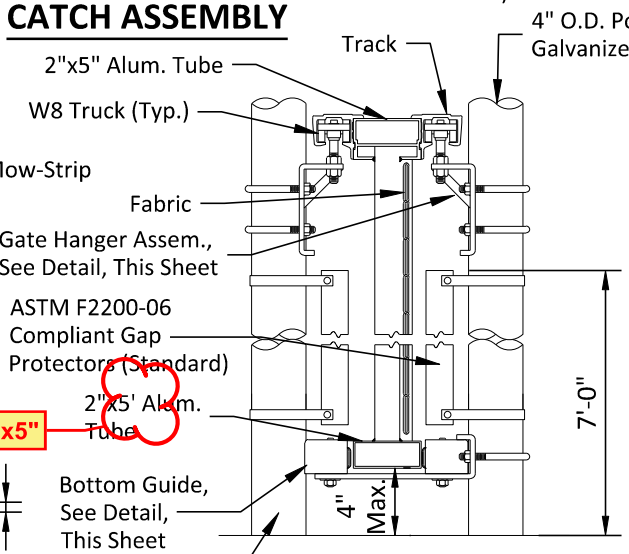
BOTTOM GUIDE



SECTION A-A



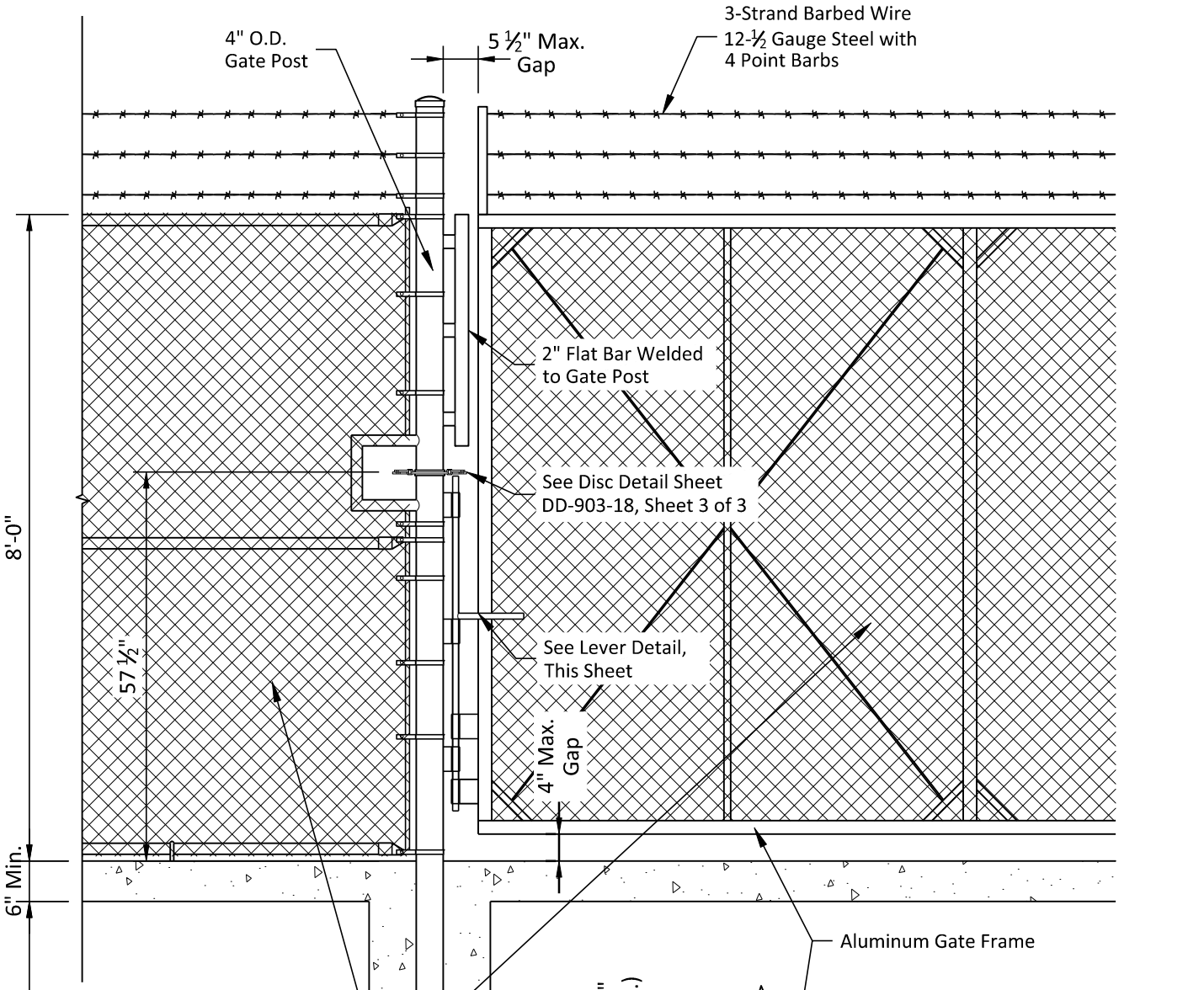
CATCH ASSEMBLY

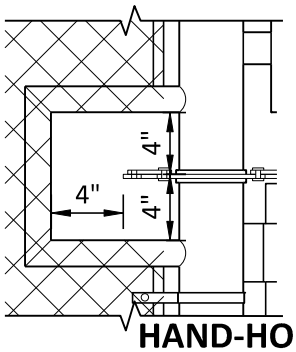


ENLARGED SECTION

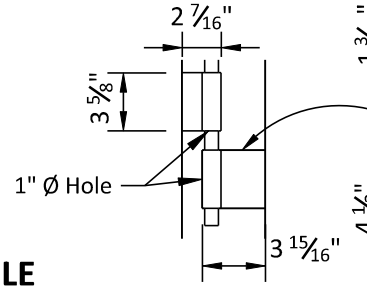
Notes:
1. Gate Frame to be fabricated from 6063 - T6 Aluminum Alloy Extrusions.
2. Gate Track to be fabricated from 6006A Aluminum Alloy Extrusions

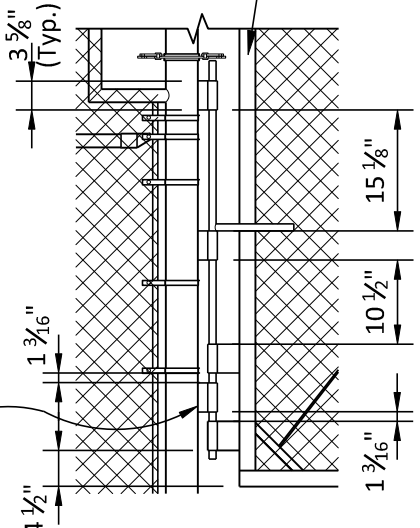
PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	HEAVY DUTY CANTILEVER SLIDE GATE	APPROVED MARCH 2011	REVISED AUG 2019
		DD-903-18	SHEET 1 OF 3



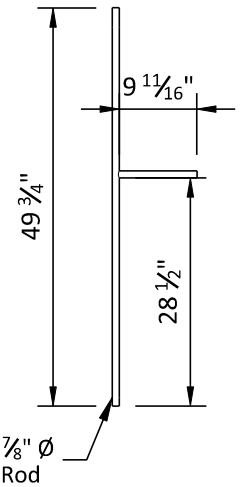


HAND-HOLE





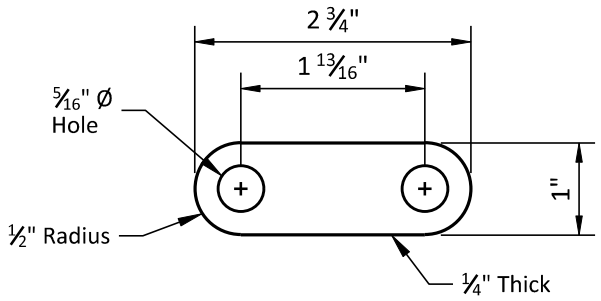
DISC ASSEMBLY DETAIL



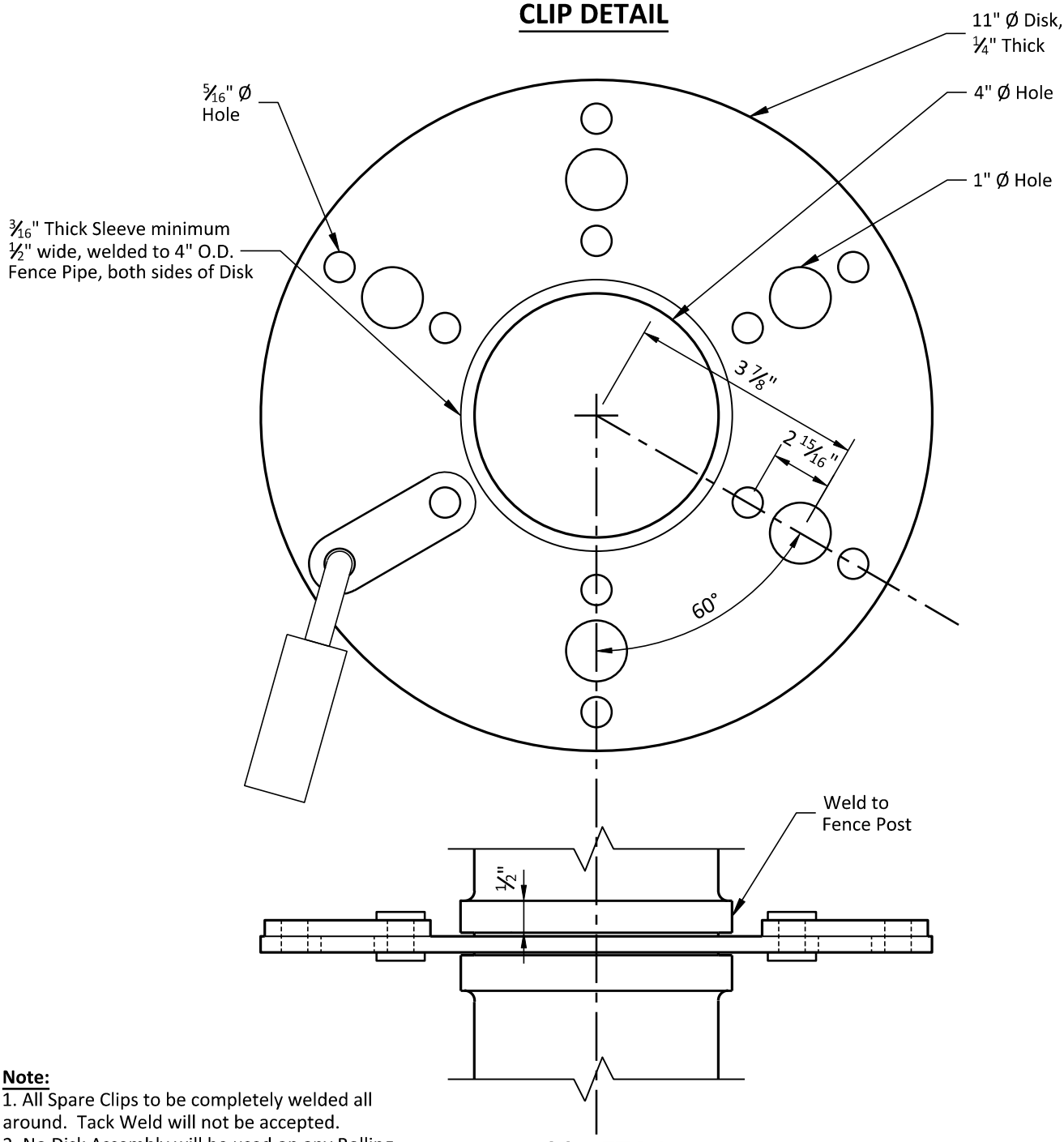
LEVER DETAIL

Note:
All concrete for Mow-Strip and Post Foundations shall be 3,000 PSI

PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	HEAVY DUTY CANTILEVER SLIDE GATE	APPROVED MARCH 2011	REVISED AUG 2019
		DD-903-18	SHEET 2 OF 3



CLIP DETAIL

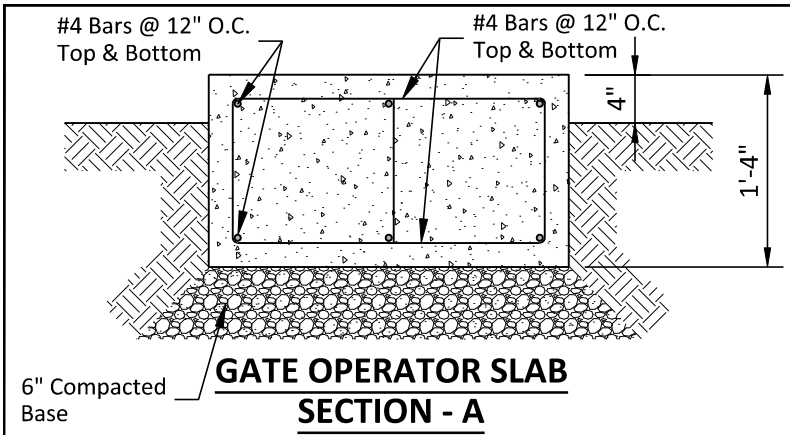


DISC DETAIL

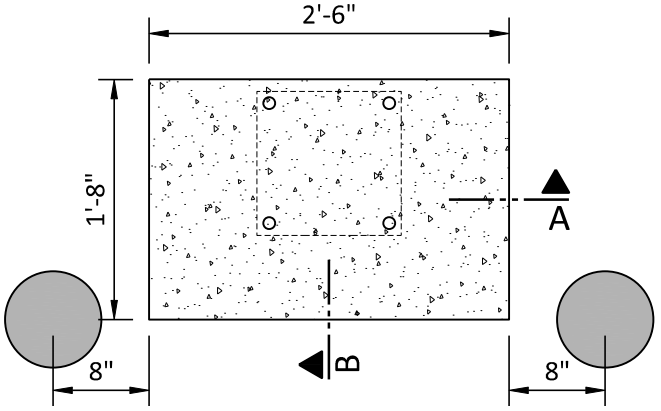
Note:

1. All Spare Clips to be completely welded all around. Tack Weld will not be accepted.
2. No Disk Assembly will be used on any Rolling Gate with an Auto-matic Gate Opener.

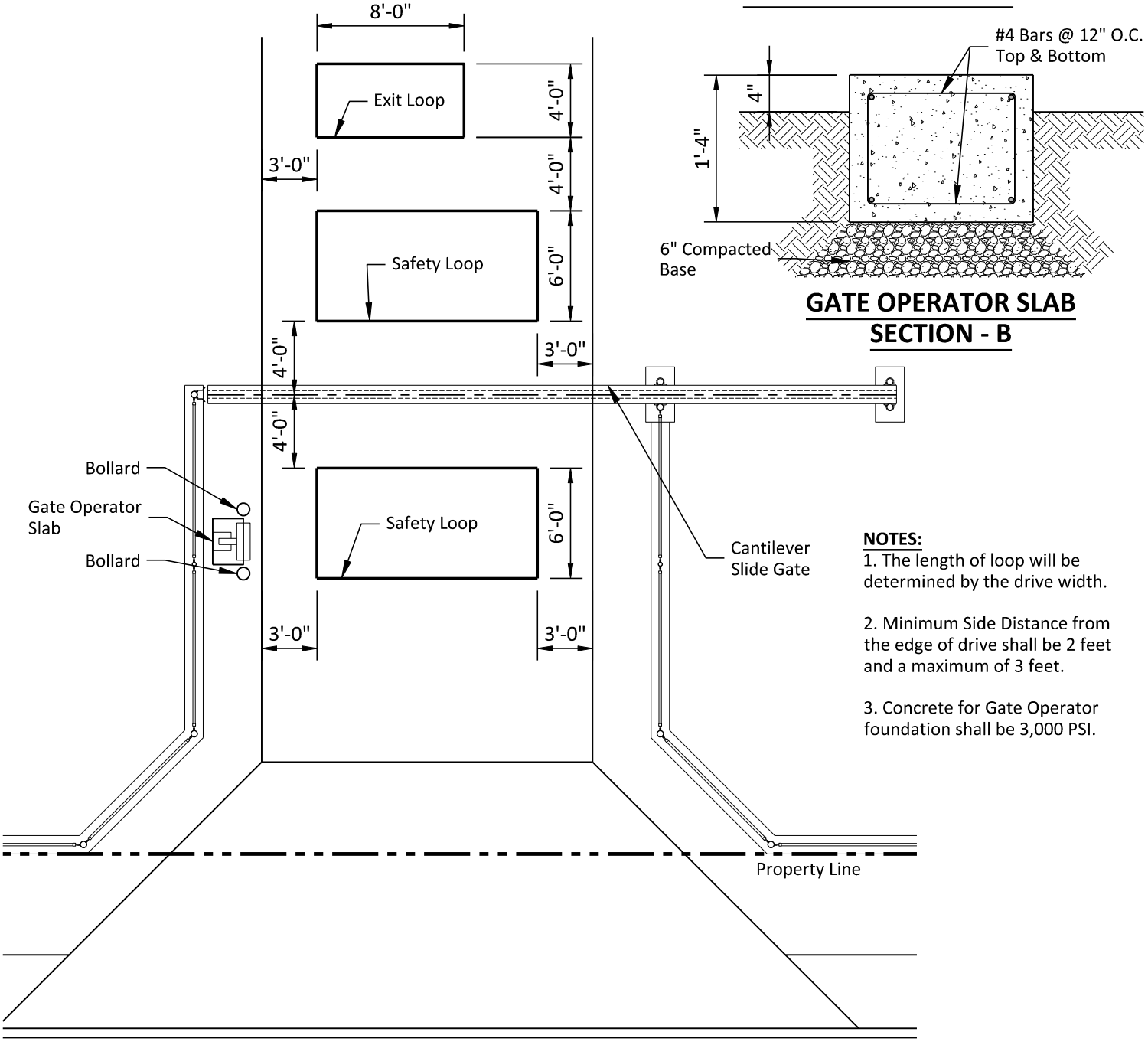
PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	HEAVY DUTY CANTILEVER SLIDE GATE	APPROVED MARCH 2011	REVISED AUG 2019
		DD-903-18	SHEET 3 OF 3



GATE OPERATOR SLAB
SECTION - A



GATE OPERATOR SLAB



GATE OPERATOR SLAB
SECTION - B

NOTES:

1. The length of loop will be determined by the drive width.

2. Minimum Side Distance from the edge of drive shall be 2 feet and a maximum of 3 feet.

3. Concrete for Gate Operator foundation shall be 3,000 PSI.

GATE OPERATOR DRIVEWAY LOOPS

PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	GATE LOOP AND OPERATOR SLAB	APPROVED AUGUST 2019	REVISED
		DD-XXX-XX	SHEET X OF X

ITEM NO. 846

Air Release Assemblies

846.1 DESCRIPTION: This item shall consist of air release assemblies installed in accordance with these specifications and as directed by the Engineer.

846.2 REFERENCED STANDARDS: Reference standards cited in this Specification Item No. 846 refer to the current reference standard published at the time of the latest revision date.

1. San Antonio Water System (SAWS):
   a. Specifications for Water and Sanitary Sewer Construction
   b. SAWS Materials Specifications
2. City Of San Antonio (COSA):
   a. Standard Specifications for Construction
3. American Society for Testing and Materials International (ASTM)
   a. ASTM A 48 - Standard Specification for Gray Iron Castings.
   b. ASTM A 126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
   c. ASTM A 240 - Standard Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels.
   d. ASTM A 276 - Standard Specification for Stainless Steel Bars and Shapes.
   e. ASTM A 313 - Standard Specification for Stainless Steel Spring Wire.
   f. ASTM B 584 - Standard Specification for Copper Alloy Sand Castings for General Applications.

846.3 SUBMITTALS: Contractor shall submit manufacturer's product data, instructions, recommendations, shop drawings, .and certifications. All submittals shall be in accordance with Engineer’s requirements and submittals shall be approved prior to delivery.

846.4 MATERIALS: The materials for air release assemblies installation and adjustment shall conform to the specifications contained within the latest revision of SAWS’ Material Specification 29-01, "Air Release, Vacuum and Combination Air Valves."

846.5 CONSTRUCTION: Air release assemblies shall be installed at the location shown in the contract documents or as directed by the Engineer.

1. Air release assemblies in an open trench water main installation shall be installed in accordance with DD 846 Drawing Series and shall include the valve, valve boxes, pipe, fittings, accessories and appurtenances.
2. It shall include the service line and tap to the main line.
3. Air release assemblies installed in parkways or easements and adjacent to street pavements shall be installed in accordance with DD 846 Drawing Series regardless of size.

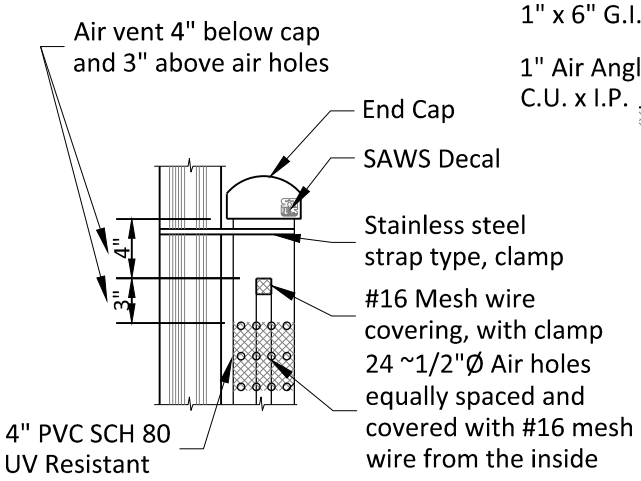
4. Air release, vacuum, and combination air valves shall incorporate an air collection trap in the form of an enlarged pipeline riser installed on the main pipe leading to the air valve connection as depicted in Standard Drawing DD-846 Series.
5. Air release assemblies installed on steel pipe attached to a bridge structure shall include the outlet on the steel pipe, valve, valve box, pipe, fittings, security enclosure, accessories, and appurtenances.

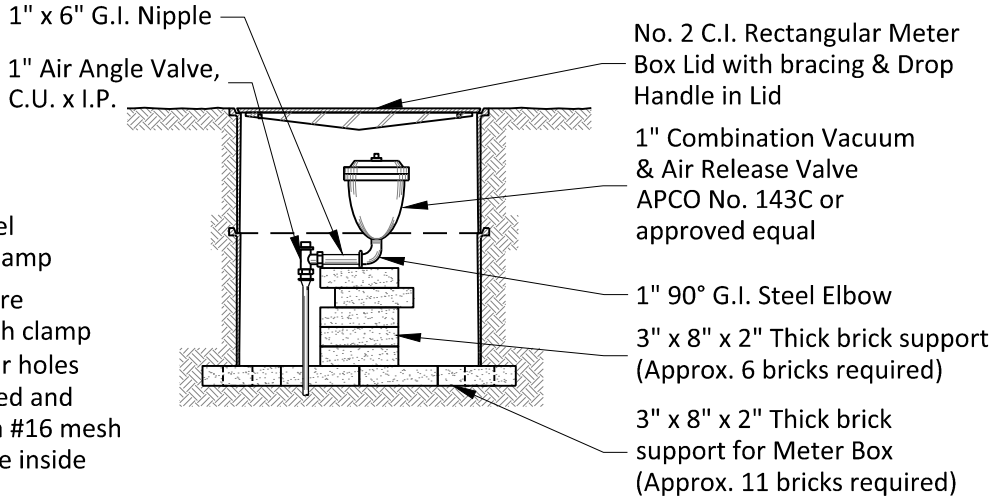
846.6 MEASUREMENT: Air release and combination air release valve assemblies will be measured by the unit of each such assembly of the various sizes of air release assemblies installed.

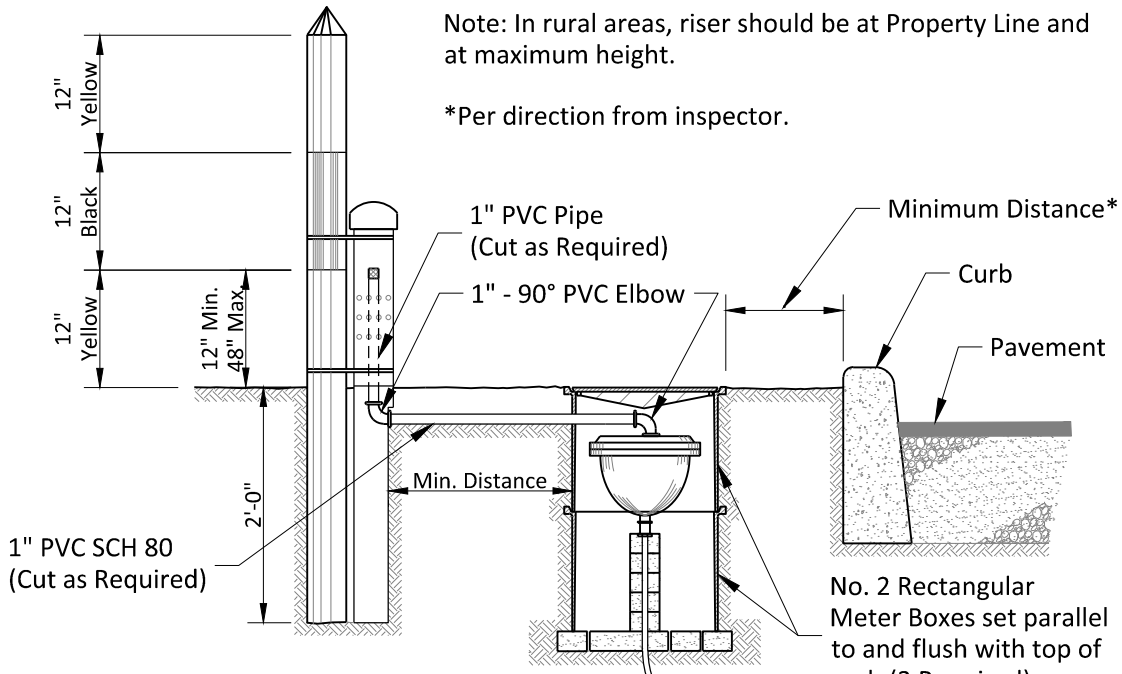
846.7 PAYMENT: Payment for air release valve and combination air release valve assemblies will be made at the unit price bid for each such assembly of the various sizes installed in accordance with the details shown in the DD 846 Drawing Series.

1. Payment shall also include: excavation, selected embedment material, backfill, compaction, compaction testing, anti-corrosion embedment when specified, freeze protection for mains on bridges, blocking, and various types and sizes of meter boxes, fittings, valve marker, valve, valve boxes, pipe, accessories and appurtenances, service line and tap to the main line, security enclosure adapters, couplings, anchors, hauling and disposition of surplus excavated material, including all existing pipe, fittings, appurtenances to be abandoned or removed, surface and pavement restoration, installation of all-weather surface, and other required testing.
2. Materials paid on site will be in accordance with Table 1 of Specification Item No. 100 Mobilization.

-End of Specification-







Note: In rural areas, riser should be at Property Line and at maximum height.

*Per direction from inspector.

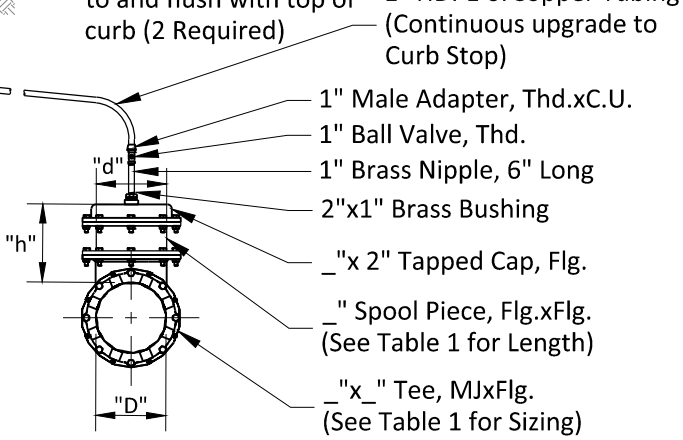


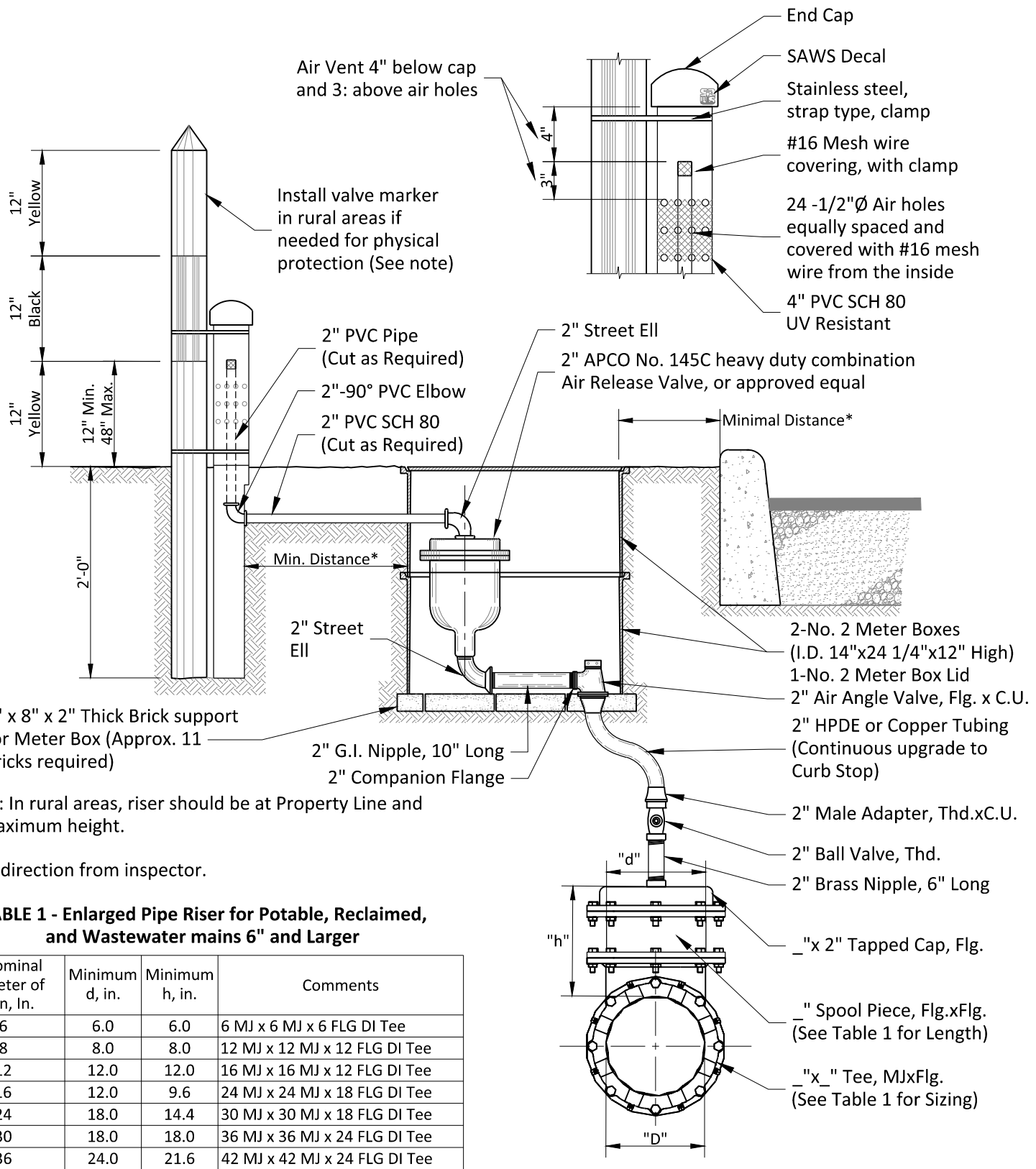
TABLE 1 - Enlarged Pipe Riser for Potable, Reclaimed, and Wastewater mains 6" and Larger

D, Nominal Diameter of Main, In.	Minimumd, in.	Minimumh, in.	Comments
6	6.0	6.0	6 MJ x 6 MJ x 6 FLG DI Tee
8	8.0	8.0	12 MJ x 12 MJ x 12 FLG DI Tee
12	12.0	12.0	16 MJ x 16 MJ x 12 FLG DI Tee
16	12.0	9.6	24 MJ x 24 MJ x 18 FLG DI Tee
24	18.0	14.4	30 MJ x 30 MJ x 18 FLG DI Tee
30	18.0	18.0	36 MJ x 36 MJ x 24 FLG DI Tee
36	24.0	21.6	42 MJ x 42 MJ x 24 FLG DI Tee
42	24.0	25.2	48 MJ x 48 MJ x 24 FLG DI Tee
48	24.0	28.8	Welded-on FLG Outlet
54	30.0	32.4	Welded-on FLG Outlet
60	36.0	36.0	Welded-on FLG Outlet
66	24.0	23.1	Welded-on FLG Outlet
72	24.0	25.2	Welded-on FLG Outlet

Air Collection Traps in Air Valve Piping Notes:

1. Dimensions derived from AWWA Manual 2nd Edition: Chapter 6 M51 Air Valves: Air-Release, Air/Vacuum & Combination

PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	INSTALLATION OF 1" AIR RELEASE VALVE	APPROVED March 2008	REVISED August 2019
		DD-846-01	SHEET 1 OF 1



Note: In rural areas, riser should be at Property Line and at maximum height.

*Per direction from inspector.

TABLE 1 - Enlarged Pipe Riser for Potable, Reclaimed, and Wastewater mains 6" and Larger

D, Nominal Diameter of Main, In.	Minimum d, in.	Minimum h, in.	Comments
6	6.0	6.0	6 MJ x 6 MJ x 6 FLG DI Tee
8	8.0	8.0	12 MJ x 12 MJ x 12 FLG DI Tee
12	12.0	12.0	16 MJ x 16 MJ x 12 FLG DI Tee
16	12.0	9.6	24 MJ x 24 MJ x 18 FLG DI Tee
24	18.0	14.4	30 MJ x 30 MJ x 18 FLG DI Tee
30	18.0	18.0	36 MJ x 36 MJ x 24 FLG DI Tee
36	24.0	21.6	42 MJ x 42 MJ x 24 FLG DI Tee
42	24.0	25.2	48 MJ x 48 MJ x 24 FLG DI Tee
48	24.0	28.8	Welded-on FLG Outlet
54	30.0	32.4	Welded-on FLG Outlet
60	36.0	36.0	Welded-on FLG Outlet
66	24.0	23.1	Welded-on FLG Outlet
72	24.0	25.2	Welded-on FLG Outlet

Air Collection Traps in Air Valve Piping Notes:

1. Dimensions derived from AWWA Manual 2nd Edition:
   Chapter 6 M51 Air Valves:
   Air-Release, Air/Vacuum & Combination

PROPERTY OF
SAN ANTONIO WATER SYSTEM
SAN ANTONIO, TEXAS

INSTALLATION OF
2" AIR RELEASE VALVE

APPROVED	REVISED
March 2008	August 2019

DD-846-02

SHEET 1 OF 1

ITEM NO. 847

Disinfection

847.1 DESCRIPTION: This item shall consist of disinfection of new mains utilizing Calcium Hypochlorite in accordance with these specifications. Machine chlorination shall be performed by SAWS as specified in the contract documents. The Contractor is required to provide all appurtenances to the main(s) to allow machine chlorination.

847.2 REFERENCED STANDARDS: Reference standards cited in this Specification Item No. 847 refer to the current reference standard published at the time of the latest revision date.

1. San Antonio Water System (SAWS):
   a. Specifications for Water and Sanitary Sewer Construction
   b. SAWS Materials Specifications
2. City of San Antonio (COSA) Standard Specification for Construction
3. Texas Commission of Environmental Quality (TCEQ)
   a. Chapter 210 Use of Reclaim Water
   b. Chapter 290 Public Water Systems
   c. Chapter 213 Edwards Aquifer.
4. American Water Works Association (AWWA)
   a. AWWA C 651 - Standard for Disinfecting Water Mains

847.3 SUBMITTALS: All submittals shall be in accordance with most recent version of SAWS's General Conditions requirements. Contractor shall submit manufacturer's product data, instructions, recommendations, shop drawing, and certifications. All submittals shall be in accordance with Engineer's requirements and submittals shall be approved prior to delivery.

847.4 MATERIALS: The materials for disinfection shall conform to the appropriate specifications contained within the latest revision of SAWS' Material Specification Item No. 100-20.

847.5 CONSTRUCTION: After the new mains have successfully passed the pressure test specified in Specification Item No. 841, "Hydrostatic Testing Operations," the SAWS will disinfect only those mains shown in the contract documents or otherwise indicated as "Machine Chlorination by SAWS," and in accordance with the Drawing DD-847 Drawing Series. This disinfection shall include: chlorination, flushing, and placing the mains into service. All other disinfection requirements shall be accomplished by the Contractor. Disinfection by the Contractor is limited to sections of main less than 800 feet in length.

1. Operation of Valves: During and after disinfection of mains less than or equal to 16 inches in diameter, the Contractor shall be notified by the Inspector a minimum 2 work days in advance to enable the Contractor to have a competent representative present whenever valves are to be operated that will affect the pressure in any part of the work for which the Contractor is responsible.
2. Contractor's Personnel and Equipment: The Contractor shall supply labor and equipment necessary to make all excavations required for chlorination, equipment connections,

subsequent flushing, and placing the mains into service.

3. Safeguarding and Backfilling Open Holes: The Contractor shall be responsible for safeguarding any open holes excavated or left open for flushing and disinfection purposes. Following completion of disinfection, the Contractor shall backfill holes in accordance with appropriate provisions of Specification Item No. 804, "Excavation, Trenching and Backfill."
   a. If an open hole is unsafe and does not have proper trench protection, SAWS Chlorination personnel will not disinfect the required pipe and related appurtenances until acceptable trench protection is provided.
4. General: Mains shall be disinfected with dry 70% Calcium Hypochlorite where shown in the contract documents or as directed by the Inspector, and shall not exceed a total length of 800 feet. This method of disinfection will also be followed for main repairs. The Contractor shall utilize all appropriate safety measures to protect his personnel during disinfection operations.
5. Dosage: The Contractor shall disinfect the new or replaced mains with dry 70% Calcium Hypochlorite furnished by the Contractor. Sufficient Calcium Hypochlorite shall be used to obtain a minimum chlorine concentration of 50 ppm. Table 847-1, "Chlorine Dosage," is included for the convenience of the Contractor.
6. Filling the Main: Those sections of main to which the dry HTH has been applied shall be filled slowly to allow for the even distribution of the disinfecting material. The manipulation of valves shall be under the supervision of SAWS Inspector in accordance with Specification Item No. 847, "Operation of Valves."
7. Holding Time: The length of time that sections of main disinfected with HTH shall be allowed to stand undisturbed will depend upon the particular job and Texas Commission on Environmental Quality (TCEQ) criteria.
   a. When circumstances permit a shutdown with no customers out of service, the required minimum detention time will be 24 hours with a 50 ppm chlorine dosage.
   b. When customers are out of service during a shutdown with no leakage past valves, the required minimum detention time will be 3 hours and the chlorine dosage will be 300 ppm.
   c. When customers are out of service with some leakage past valves, the required minimum detention time will be 30 minutes with a 500 ppm chlorine dosage.
8. Flushing: Following the expiration of the specified holding time, the treated section of main shall be flushed thoroughly by the Contractor in accordance with the applicable provisions of Specification Item No. 841, "Hydrostatic Testing Operations." Flushing shall continue until no chlorine remains detectable by taste or odor or until the chlorine residual is less than 0.3 ppm.
9. The Contractor must make provisions for the disposal and runoff of the flushing operations in order to minimize erosion or impact to residents.
10. If flushing requires entrance into water way, dechlorination must be performed.
11. Preventing Reverse Flow: Valves shall be manipulated so that the strong chlorine solution in the line being treated will be flushed out of the main and will not flow back into the line supplying the water.
12. Supervision. All disinfection of mains shall be done under the general supervision of

the SAWS' Inspector.

13. Additional Treatment: Should the new main fail to meet minimum public health standards for bacteriological quality after flushing, further treatment shall be as directed by the Inspector. If further disinfection is required, chlorination shall be done in accordance with the SAWS guidelines for Disinfection of New Mains Utilizing Machine Chlorination at no additional cost to SAWS. In no case, however, shall the new line be acceptable as complete and satisfactory until the bacteriological quality of the water taken from the main meets the standards of the TCEQ.

847.6 MEASUREMENT: Disinfection operations are considered subsidiary to the work and no separate measurement will be made by the Contractor for this work.

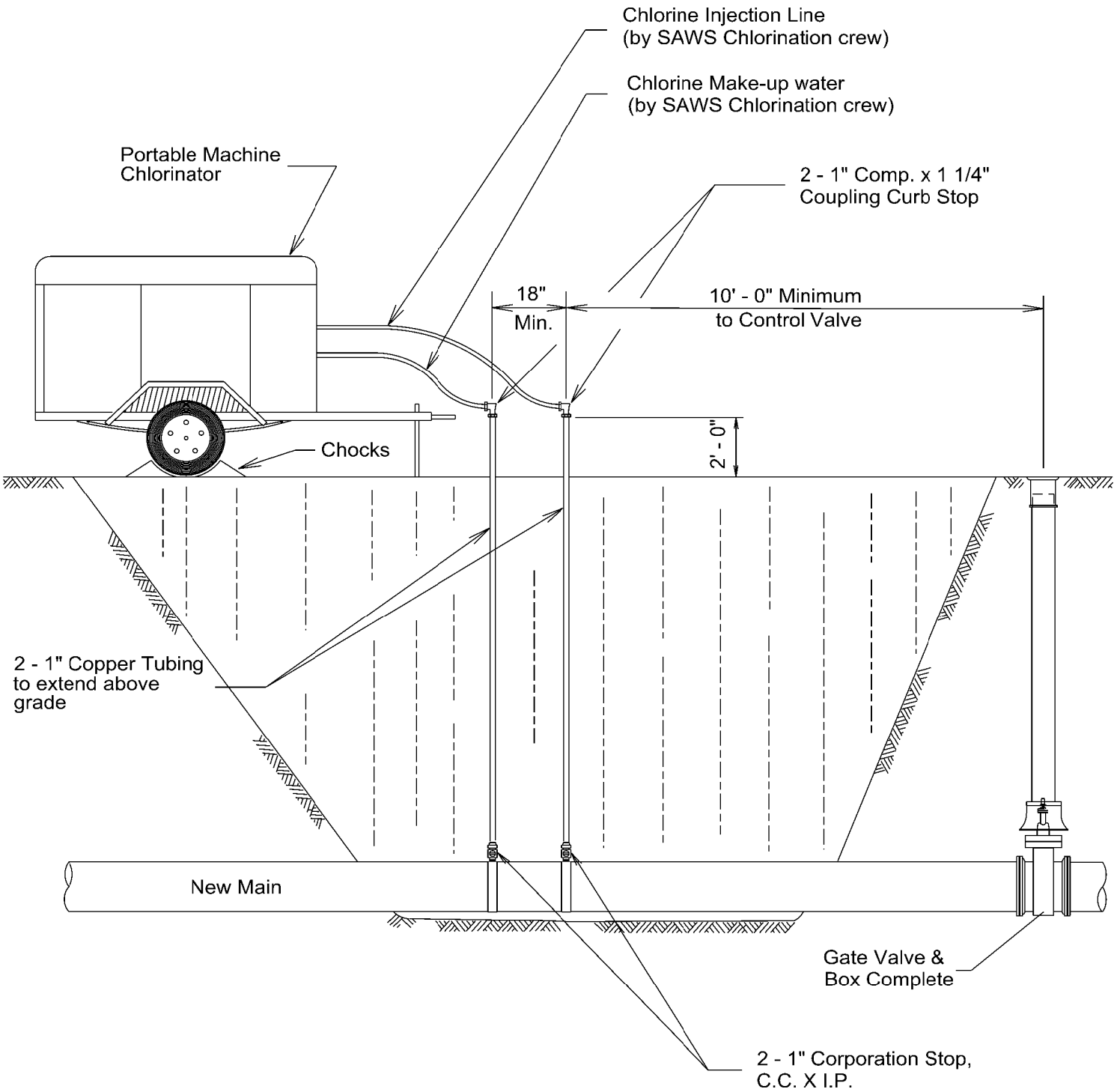
847.7 PAYMENT: Disinfection operations are considered subsidiary to the work and no separate payment will be made to the Contractor for this work. The Contractor is required to provide all appurtenances to the pipe to allow for machine chlorination at no additional cost or separate pay item.

TABLE 847-1

CHLORINE DOSAGE

Diameter of Pipe in Inches	To Obtain 50 ppm Chlorine Dosage
6	0.0138
8	0.0233
10	0.0400
12	0.0523
14	0.0708
16	0.0934
18	0.1175
20	0.1455
24	0.208
30	0.327
36	0.469
42	0.637
48	0.833
54	1.0575
60	1.308

-End of Specification-



Note:
2 - 1 1/4" Solid Cap, Thd. to be installed on
Corporation Stop after chlorination

PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	STANDARD CHLORINATION INSTALLATION	APPROVED	REVISED
		March 2008	AUG 2019
		DD-847-01	SHEET 1 OF 1

ITEM NO. 848

Sanitary Sewers

848.1 DESCRIPTION: This item shall govern the furnishing, installation, adjustment, or replacement of sanitary sewer pipe of the size and type specified in the contract documents.

848.2 REFERENCED STANDARDS: Reference standards cited in this Specification Item No. 848 refer to the current reference standard published at the time of the latest revision date.

1. San Antonio Water System (SAWS):
   a. Specifications for Water and Sanitary Sewer Construction
   b. SAWS Materials Specifications
2. City of San Antonio (COSA) Specifications for Construction
3. Texas Commission of Environmental Quality (TCEQ)
   a. Chapter 217 Design Criteria for Domestic Wastewater Systems
   b. Chapter 213 ("Edwards Aquifer")
4. American Society for Testing and Materials (ASTM)
   a. ASTM C 150 - Standard Specification for Portland Cement.
   b. ASTM C 494 - Standard Specification for Chemical Admixture for Concrete.
   c. ASTM C 618 - Standard Specification for Fly Ash and Raw or Calcinated Natural Pozzolan for use as Mineral Admixture in Portland Cement Concrete.
   d. ASTM C 937 - Standard Specification for Grout Fluidifier for Pre-placed Aggregate Concrete.
   e. ASTM C 940 - Standard Test Method for Expansion and Bleeding of Freshly Mixed Grout for Replaced Aggregate Concrete in the Laboratory.
   f. ASTM C 1017 - Standard Specification for Chemical Admixture for Use in Producing Flowing Concrete.
   g. ASTM C 1107 - Specification for Packaged Dry, Hydraulic-Cement Grout (Non-shrink)
   h. A. ASTM D 618 - Standard Practice for Conditioning Plastics for Testing.
   i. ASTM D 1248 - Standard Specification for Polyethylene Plastics Molding and Extrusion Materials.
   j. ASTM D 1784 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
   k. ASTM D 2122 – Standard Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings.
   l. ASTM D 2241 - Standard Specification for Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).

m. ASTM D 2310 - Standard Classification for Machine-Made Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe

n. ASTM D 2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.

o. ASTM 2412 – Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel Plate Loading

p. ASTM D 2444 - Standard Test Method for Determination of the Impact Resistance of Thermoplastic Pipe and Fittings by Means of a Tup (Falling Weight).

q. ASTM D 2657 - Standard Practice for Heat Fusion Joining Polyolefin Pipe and Fittings.

r. ASTM D 2680 - Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Poly (Vinyl Chloride) (PVC) Composite Sewer Piping.

s. ASTM D 2837 - Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials.

t. ASTM D 2992 - Obtaining Hydrostatic or Pressure Design Basis for "Fiberglass" (Glass-Fiber-Reinforced-Thermosetting) Resin Pipe and Fittings.

u. ASTM D 3034 - Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.

v. ASTM D 3035 - Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter.

w. ASTM D 3139 - Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.

x. ASTM D 3212 - Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.

y. ASTM D 3262 - Standard Specification for “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer Pipe.

z. ASTM D 3350 - Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.

aa. ASTM D 3681 - Method for Determining Chemical Resistance of “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin Pipe in a Deflected Condition.

bb. ASTM D 3754 - Standard Specification for “Fiberglass” (Glass-Fiber Reinforced Thermosetting-Resin) Sewer and Industrial Pressure Pipe.

cc. ASTM D 4161 - Standard Specification for “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Joints Using Flexible Elastomeric Seals.

dd. ASTM F 477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

ee. ASTM F 679 - Standard Specification for Poly (Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings.

ff. ASTM F 714 - Standard Specification for Polyethylene Plastic (PE) Pipe (SDR-PR) Based on Outside Diameter.

gg. ASTM F 794 - Standard Specification for Poly (Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter.

hh. ASTM F 894 - Standard Specification for Polyethylene (PE) Large-Diameter Profile Wall Sewer and Drain Pipe.

ii. ASTM G 62 - Standard Test Methods for Holiday Detection in Pipeline Coatings.

5. American Water Works Association (AWWA)
   a. AWWA C 110 - American National Standard for Ductile-Iron and Gray-Iron Fittings, 3 Inches Through 48 Inches for Water.
   b. AWWA C 111 - American National Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   c. AWWA C 900 - Standard for Polyvinyl Chloride (PVC) Pressure Pipe, 4 Inches Through 12 Inches for Water Distribution.
   d. AWWA C 909 - Standard for Molecularly-Oriented Polyvinyl Chloride (PVCO) Pressure Pipe, 4 Inches through 12 Inches (100mm through 300 mm), for Water Distribution.
   e. AWWA M23 – PVC Pipe – Design and Installation
   f. W. PPI TR3 - Policies and Procedures for Developing Recommended Hydrostatic Design Stresses for Thermoplastic Pipe Materials.
   g. AWWA C 300 - Standard for Prestressed Concrete Pressure Pipe, Steel-Cylinder Type, for Water and other Liquids.
   h. AWWA C 950 – Fiberglass Pressure Pipe
   i. AWWA M 45 – Fiberglass Pipe Design
7. National Science Foundation
   a. NSF Standard 61 - Drinking Water System Components - Health Effects.
8. Society of Protective Coatings
   a. SSPC-SP 6 - Steel Structures Painting Council, Commercial Blast Cleaning.
9. Uni-Bell
   a. UNI-B-13 - Recommended Standard Performance Specification for Joint Restraint Devices for Use with Polyvinyl Chloride Pipe.

848.3 SUBMITTALS: Contractor shall submit manufacturer's product data, instructions, recommendations, shop drawings, and certifications.

1. Contractor to submit cut sheets prior to commencement of open cut work.
2. Submit proposed methods, equipment, materials and sequence of operations for sewer construction.
3. Plan operations so as to minimize disruption of utilities to occupied facilities or adjacent property.
4. Submit all test reports and pre and post sewer television inspection video.
5. Videos become property of SAWS.

848.4 MATERIALS: Materials for sanitary sewer pipe and fittings shall be either rigid or flexible. All pipe not listed shall be subject to pre-approval by the Engineer**.**

1. Rigid Pipe:
   a. Concrete Pipe: Concrete pipe shall not be used.
   b. Concrete Steel Cylinder Pipe: Concrete Steel Cylinder Pipe shall not be used.
   c. Asbestos-Cement (AC) Pipe: AC pipe shall not be used. Refer to Specification Item No. 3000, "Handling Asbestos Cement Pipe."
2. Flexible Pipe: Pipe consisting of materials other than those listed above.
   a. Any flexible pipe having a deflection of the inside diameter greater than 5% after 30 days of installation will not be accepted.
   b. Testing shall be as per SAWS Test Specification Item No. 849 - Sanitary Sewer Testing
   c. Working room for flexible pipe shall be as per Specification Item No. 804 Excavation Trenching and Backfill.
   d. Polyvinylchloride (PVC) Sewer Pipe: Pipe shall be made from class 12454 materials as described in ASTM D1784.
      i. For pipes 4 inches to 15 inches in diameter, fittings and joints shall conform to ASTM D3034 and D3212, with the exception that solvent cement joints shall not be used.
      ii. All pipes that are 18 inches to 24 inches in diameter shall meet the requirements of ASTM F679.
      iii. **All sanitary sewer PVC pipe shall be green. White pipe is prohibited. Contractor will need to submit information to request an exemption to use white pipe such as letters from suppliers that pipe is not available. Once a project is awarded Contractor should bring this exemption to SAWS attention via RFI. If white pipe is approved it must have appropriate markings and be wrapped with green poly wrap. This shall include all lateral piping as well.**
      iv. At waterline crossings and where water and sewer mains are parallel and separation distance cannot be achieved as per 30 TAC 217.53, use extra stiff pipe SDR 26 PVC (ASTM D2241) with a minimum pressure rating of 160 psi.
   e. Fiberglass Reinforced Sewer Pipe, Non-Pressure Type:
      i. Fiberglass reinforced sewer pipe, non-pressure type, shall be a factory-formed conduit of polyester resin, fiberglass and silica sand built up in laminates and shall conform to the requirements of ASTM D3262, including the appendix and subsequent specifications, and in accordance with SAWS' material specifications.
      ii. Depths shall comply with requirement of ASTM D3839.
      iii. Joints for pipe and fittings shall be confined compression rubber gasket bell and spigot type joints conforming to the material and performance requirements of ASTM D4161. Depths shall comply with requirement of ASTM D3681.

iv. Flanges, elbows, reducers, tees, wyes, laterals, and other fittings shall be capable of withstanding all operating conditions when installed. They may be contact molded or manufactured from mitered sections of pipe joined by glass-fiber reinforced overlays.

v. For pipe diameters 15 inches or larger, lateral openings 6 inch or greater in size shall be made using PVC sewer saddles conforming to ASTM D2661 or insert a tee connection conforming to ASTM D3034, approved by the Engineer, and found in SAWS' Material Specifications.

vi. Minimum pipe stiffness shall not be less than SN 72 for direct bury applications

f. High density, High Molecular Weight Polyethylene Pipe (HDPE):

i. HDPE shall meet requirements of Type III, Class C, Category 5, Grade P34, as defined in ASTM D 1248.

ii. Material meeting requirements of cell classification 345434D or E, in accordance with ASTM D 3350, are also suitable for making pipe products under these specifications.

iii. Inner wall of pipe shall be of light or gray color for television inspection purposes.

3. Pressure Pipe/Force Mains:

a. High density, High Molecular Weight Polyethylene Pipe (HDPE):

i. HDPE shall meet requirements of Type III, Class C, Category 5, Grade P34, as defined in ASTM D 1248.

ii. Material meeting requirements of cell classification 345434D or E, in accordance with ASTM D 3350, are also suitable for making pipe products under these specifications.

iii. Inner wall of pipe shall be of light or gray color for television inspection purposes.

b. The pressure rating, size, and pressure class shall be as shown in the contract documents.

c. All required joint restraint shall be approved by the Engineer prior to the work being accepted.

d. Pressure pipe/Force mains are required to have modified grade 5 material used as bedding.

e. Pipes also shall be hydrostatically tested at a minimum of 150 psi after their construction to ensure proper construction.

4. Mechanical or compression joints, concrete jointing collars, or non- reinforced rubber adaptors shall be used only as approved by the Engineer.

5. All sanitary sewer pipe and fittings utilized within the jurisdiction of SAWS shall be tested by a manufacturer-approved laboratory at the source of supply.

6. All shipments of pipe shall be accompanied by a certificate of compliance to these specifications prepared by an independent testing laboratory and signed by a Texas registered professional engineer.

848.5 CONSTRUCTION: All sanitary sewer mains shall be constructed in accordance with the specifications herein outlined and in conformity with the required lines, grades, and details

shown in the contract documents and as directed by the Engineer. Whenever true line and grade is not attained it will be the Contractor's sole responsibility to remove and reinstall any and all sewer pipe deemed required by the Engineer and shall be done at the Contractor's expense.

1. Successful passage of the Hydrostatic, air test and mandrel test (for flexible pipe, 30 days after installation), as described under TCEQ criteria. In addition sewer pipe must also pass settlement test for the final acceptance of the mains. Settlement Testing shall be performed in accordance with Specification Item No. 849 "Sanitary Sewer Testing".
2. Mains shall be properly backfilled as per Specification Item No. 804, "Excavation Trenching and Backfill" prior to the start of the 30 day testing period.
3. Water Main Crossings: Where gravity or force main sewers are constructed in the vicinity of water mains, the requirements of the 30 TAC§ 217.53 shall be met.
4. For excavation, trenching and backfill requirements see Specification Item No. 804, "Excavation, Trenching and Backfill."
5. Pipe Installation: The Inspector will inspect all pipe before it is placed in the trench and will reject any sections found to be damaged or defective to a degree that would affect the structural integrity of the pipe.
6. Rejected pipe shall be immediately removed from the site of the work and replaced with new acceptable pipe.
7. Sewer main installation should be constructed from downstream to upstream as standard practice.
8. No pipe shall be laid within 10 feet of any point where excavation is in progress. Pipe installation shall proceed upgrade with the bell pointing in the upstream direction of flow.
9. Pipe shall be lowered into the trench without disturbing the prepared bedding or the trench sides.
10. The drilling of lifting holes in the field will not be permitted.
11. Pipe shall be installed by means of a concentric pressure being applied to the pipe with a mechanical pipe puller. Pulling or pushing a joint of pipe in place by using a crane, bulldozer, or backhoe will not be permitted.
12. Pipe shall be "pulled home" in a straight line with all parts of the pipe on line and grade at all times.
13. No side movement or up and down movement of the pipe will be permitted during or after the pulling operation.
14. Should coupled joints of pipe be out of line or off grade, they shall be removed one joint at a time in the presence of the Inspector and brought to the proper line and grade.
15. The lifting or moving of several joints of coupled pipe at one time to close a partially open joint or to fine grade under laid joints of pipe will not be permitted.
16. Contractor shall insure that all existing or proposed manholes or structures shall remain visible and accessible at all times.
17. No manhole or structure covers shall be covered by pavement, equipment, or other obstructions other than a removable, steel plate (min thickness of ½ inch and H-20 traffic bearing rated), temporary lid provided for safety.

18. Pipe Separation: Sewer pipe separation distances shall be maintained in accordance with TCEQ rules 30 §217.53. See Drawing Series DD-848.
19. Contractor to obtain the services of a licensed surveyor in accordance with the General Conditions for the purpose of validating the elevations of all sewer main work including the installation of manholes. It is the contractor responsibility to use the latest technology including Laser Beams to establish elevations as per design plans.
    a. Contractor to provide SAWS with the licensed surveyors report validating the all pipe was installed per design plans and upload report in CPMS.
    b. If the sewer main or manholes are not constructed per plans it is the contractors responsibility to relay or replace any sewer work at his cost with no additional days granted.
20. **No horizontal or vertical curves shall be permitted in conformance with appropriate regulatory agency requirements.**
21. Before leaving the work unattended, the upper ends of all pipelines shall be securely closed with a tight fitting plug or closure.
22. The interior of laid pipe shall be kept free from dirt, silt, gravel, or foreign material at all times.
23. All pipes in place must be approved by the Inspector before backfilling.
24. When replacing an existing system in place, Contractor shall maintain screens to prevent the entrance of construction debris into the sewer system.
25. Pipe bursting on AC sanitary sewer pipe is not allowed.

848.6 MEASUREMENT: All sewer pipes will be measured from center of manhole to center of manhole or end of main.

1. Measurement will be continuous through any fittings in the main, even though the fittings are pay items of the contract.

848.7 PAYMENT: Sewer pipe up to 24-inches will be paid for at the contract bid price per linear foot. Sewer pipe larger than 24-inches will be paid for by percentage listed below.

1. For sewer pipe up to 24-inches said price shall be full compensation for furnishing all materials, including pipe, couplings, trenching, pumping, concrete, plugs, laying and jointing, backfilling, select bedding and initial backfill material, tamping, water, labor, tools, equipment, and all weather surface, testing, acceptable densities and must meet all requirement for testing and other incidentals necessary to complete the work.
2. For sewer pipe over 24-inches the contractor will get paid 80% of the bid item cost for furnishing all materials, including pipe, couplings, trenching, pumping, concrete, plugs, laying and jointing, backfilling, select bedding and initial backfill material, tamping, water, labor, tools, equipment, and all weather surface.
3. For sewer pipe over 24-inches the contractor will get paid the remaining 20% percent of the bid item cost for the approved testing results of acceptable densities

and must meet all requirement for all other testing and other incidentals necessary to complete the work.

4. When the minimum separation distances for any water and sewer piping facilities cannot be maintained per 30 TAC §217.53, Contractor shall install SDR-26 PVC pipe (160 psi pressure rated). Payment for this higher pressure rated pipe shall be made the contract bid price per linear foot complete in place for the type, and size constructed as described above.
5. Sewer pipe fittings, as part of the main line such as wyes and tees, are inclusive in the cost of Specification Item No.854, "Sanitary Sewer Laterals."
6. Pay cuts will be measured from the top of ground prior to the Contractor's operation and along the centerline of the pipe to the invert of the pipe, to be submitted with cut sheets.

-End of Specification-

San Antonio Water System Specifications for Construction

ITEM NO. 849

Sanitary Sewer Testing

849.1 DESCRIPTION: This item shall consist of air, infiltration/exfiltration, pipe deflection, and settlement tests in accordance with this specification and as directed by the Engineer.

849.2 REFERENCED STANDARDS: Reference standards cited in this Specification Item No. 849 refer to the current reference standard published at the time of the latest revision date.

1. San Antonio Water System (SAWS)
   a. Specifications for Water and Sanitary Sewer Construction
   b. SAWS Materials Specifications
2. City of San Antonio (COSA) Standard Specification for Construction
3. Texas Commission of Environmental Quality (TCEQ)
   a. 217 Design Criteria for Domestic Wastewater Systems
4. American Society for Testing and Materials (ASTM) International:
   a. ASTM C 828 – Standard Test Method for Low Pressure Air Test of Vitrified Clay Pipe Lines.
   b. ASTM C 924 – Standard Practice for Testing Concrete Pipe Sewer Lines by Low-Pressure Air Test Method.
   c. ASTM D 3034 – Standard Specification for Type PSM Polyethylene (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
   d. ASTM F 794 – Specification for Poly (Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter.
   e. ASTM F 1417 – Standard Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low Pressure Air.
   f. ASTM C 1244 Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill.

849.3 SUBMITTALS: Contractor shall submit manufacturer's product data instructions, recommendations, shop drawings, and certifications.

1. Test Plan: Before testing begins and in adequate time to obtain approval through submittal process, prepare, and submit test plan for approval by Engineer.
2. Include testing procedures, methods, equipment, and tentative schedule. Obtain advance written approval for deviations from Drawings and Specifications.
3. Submit test reports for each test on each segment of sanitary sewer.

849.4 MATERIALS: The materials installed for air and deflection tests shall conform to the appropriate specifications contained within the latest revision of SAWS' Material Specifications.

849.5 TESTING OF INSTALLED PIPE: The Contractor shall perform a low-pressure air test or an infiltration/exfiltration test, and, for pipe installed by open cut method, a settlement test before the installed work shall be considered accepted. If a gravity collection main is composed of flexible pipe, a deflection test will also be required. Flexible pipe is defined as pipe that will deflect at least 2% without structural distress. Contractor shall insure that all testing is performed in the presence of the Inspector, with copies of all written test results made available to the Inspector. Tests shall conform to the following requirements:

1. Low-Pressure Air Test: The procedure for the low-pressure air test shall conform to the procedures described in ASTM C828, ASTM C924, and ASTM F1417 (or other appropriate procedures), except for testing times. The test times shall be as outlined in this section. For sections of pipe less than 36-inch average inside diameter, the following procedure shall apply. The pipe shall be pressurized to 3.5 psi greater than the pressure exerted by groundwater above the pipe. Once the pressure is stabilized, the minimum time allowable for the pressure to drop from 3.5 pounds per square inch gauge to 2.5 pounds per square inch gauge shall be computed from the following equation:

$$T = \frac{0.085 \times D \times K}{Q}$$

T = Time for pressure to drop 1.0 pound per square inch gauge in seconds;

K = 0.000419xDxL, but not less than 1.0;

D = Average inside pipe diameter, in inches;

L = Length of line of same pipe size being tested, in feet;

Q = Rate of loss, 0.0015 cubic feet per minute per square foot internal surface shall be used since a K value of less than 1.0 shall not be used.

The minimum testing times for each pipe diameter is as follows:

Pipe Diameter	Minimum Time	Length for Minimum Time	Time for Longer Length
Inches	Seconds	Feet	Seconds/Ft
6	340	398	0.855
8	454	298	1.520
10	567	239	2.374
12	680	199	3.419
15	850	159	5.342
18	1,020	133	7.693
21	1,190	114	10.471
24	1,360	100	13.676
27	1,530	88	17.309
30	1,700	80	21.369
33	1,870	72	25.856

* Note: Test time starts after the required 60 seconds of stabilization time has transpired.

The test may be stopped if no pressure loss has occurred during the first 25% of the calculated testing time. If any pressure loss or leakage has occurred during the first 25% of the testing period, then the test shall continue for the entire test duration as outlined above or until failure.
Mains with a 27-inch or larger average inside diameter may be air tested at each joint instead of air testing entire pipe.
Mains with a 36-inch average inside diameter and larger must be air tested at each joint. If the joint test is used, a visual inspection of the joint shall be performed immediately after testing. 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 time 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.

2. Infiltration/Exfiltration Test: The total exfiltration, as determined by a hydrostatic head test, must not exceed 10 gallons per inch of diameter per mile of main per 24 hours, at a minimum test head of 2 feet above the crown of the main at an upstream manhole. The Contractor shall use an infiltration test in lieu of an exfiltration test

when mains are installed below the ground water level. In such cases, the total exfiltration, as determined by a hydrostatic head test, must not exceed 10 gallons per inch diameter per mile of main 24 hours at a minimum test head of 2 feet above the crown of the main at an upstream manhole, or at least 2 feet above the existing groundwater level, whichever is greater. For construction work occurring within a 25-year floodplain, the infiltration or exfiltration must not exceed 10 gallons per inch diameter per mile of main per 24 hours at the same minimum test head as stated in the previous sentence. If the quantity of infiltration or exfiltration exceeds the maximum quantity specified, the Contractor shall propose to the Engineer, and receive approval therefrom, all necessary remedial action, solely at the Contractor's own cost, in order to reduce the infiltration or exfiltration to an amount within the limits specified herein.

3. Deflection Testing: As stated in the 30 TAC § 217, deflection test shall be performed on all flexible pipe installed.
   a. For mains with inside diameters less than 36 inches, a rigid mandrel shall be used to measure deflection.
   b. For mains with an inside diameter 36 inches and greater, a method approved by the Engineer shall be used to test for vertical deflections.
   c. For rigid pipe, a manufacturer approved "Go, No Go" deflection rod may be used to test deflection, but must be approved by Engineer or Inspector prior to testing.
   d. The deflection test must be accurate to within ± 0.2% deflection. The test shall be conducted after the final backfill has been in place at least 30 days. No pipe shall exceed a deflection of five percent. If a pipe should fail to pass the deflection test, the problem shall be corrected, and a second test shall be conducted after the failed area's final backfill has been in place an additional 30 days. The tests shall be performed without mechanical pulling devices. The Engineer should recognize that this is a maximum deflection criterion for all pipes and a deflection test less than 5 % may be more appropriate for specific types and sizes of pipe. Upon completion of construction, the Engineer or other Texas Registered Professional Engineer appointed by the owner shall certify to the Inspector, that the entire installation has passed the deflection test. This certification may be made in conjunction with the notice of completion required in 30 TAC § 217.14. (1) of this title (relating to General Provisions). This certification shall be provided for the Owner to consider the requirements of the approval have been met.
   e. Contractor shall provide 24 hr. notice to Engineer and Inspector prior to any testing.
   f. Engineer of Record must witness all tests over the EARZ.
   g. Mandrel Sizing. The rigid mandrel shall have an outside diameter (O.D.) not less than 95% of the inside diameter (I.D.) of the pipe.
   h. 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. All dimensions shall be per appropriate standard. Statistical or other "tolerance packages" shall not be considered in mandrel sizing.

i. Mandrel Design: The rigid mandrel shall be constructed of a metal or a rigid plastic material that can withstand 200 psi without being deformed.

ii. The mandrel shall have nine or more "runners" or "legs" as long as the total number of legs is an odd number.

iii. The barrel section of the mandrel shall have a length of at least 75% of the inside diameter of the pipe.

iv. A proving ring shall be provided and used for each size mandrel in use.

v. Method Options: Adjustable or flexible mandrels are prohibited. A television inspection is not a substitute for the deflection test.

i. Test Reports: Submit reports from tests in accordance with relevant standards.

4. Settlement Testing: For all gravity sanitary sewer pipe installed by open-cut method the Contractor shall conduct settlement testing of the newly installed sewer to determine whether excessive sagging of the pipe has occurred. This test does **not** identify the precise threshold at which pipe is properly installed. Rather, it provides a simple, easily interpretable means to identify grossly unacceptable installation of gravity sewer pipe. As such, passing this test shall not excuse poor workmanship identified by other means. Contractor shall follow construction QC/QA program established for the specified project per SAWS Standard Specification 903 and follow best practices to maintain horizontal and vertical alignment control.

a. This test involves television inspection. Requirement for televising, video format, and submittals shall be governed by SAWS Standard Specification 866. If suitable to the project in question the settlement test televising efforts can be combined with but are in addition to and do not in any way replace or nullify, the efforts or requirements associated with SAWS Standard Specification 866.

b. Unless otherwise directed by Engineer or Owner, no sewer flow should be introduced into the system when performing settlement test.

c. This test shall be conducted no earlier than 30 days after installation of the sanitary sewer pipe and final backfill.

d. For the purpose of this test the term "**segment**" is defined as all pipe between two manholes and/or structures and "**pipe section**" is defined as a single piece of pipe up to and including where it joins adjacent pipe(s).

e. Segment must be isolated and cleaned to ensure no flow through pipe and

that it is free of dirt, rocks, scale, mud, silt, and any other foreign matter prior to performing this test.

f. Contact the Inspector prior to testing so that they may witness flooding of the system and testing.

g. Water shall be introduced into the pipe to provide meaningful observations. To accomplish this, after cleaning, and immediately before performing this test, contractor shall flood system with an amount of water sufficient to flow from the upstream manhole through the segment to be tested and be observed flowing into the downstream manhole. Introduction of water will then be stopped and any standing water allowed to remain in the segment being tested. Testing shall commence when flow is no longer observed in downstream manhole. The established unit cost for settlement testing shall be inclusive of any and all water and work necessary to deliver water to test site and shall thus be provided by contractor at no additional cost to Owner.

h. Settlement testing varies by pipe diameter:

i. **For pipes from 8 to 42 inches in diameter:** After advancing television unit through pipe to be tested, connect golf ball with rigid wire and string as necessary for golf ball to be fully visible within CCTV footage and maintain contact with bottom of pipe as golf ball is pulled back through each segment. The golf ball shall have a diameter of 1.68 inches or 42.7 mm. Any and all points along the pipe segment at which the golf ball becomes fully submerged in standing water shall be defined as excessive sag.

ii. **For pipes 48 inches in diameter and larger:** Manned entry to the pipe will be made. A rigid steel ruler with zero (0) inch mark at the extreme end shall be placed in all areas of standing water in the pipe such that it is in contact with the lowest portion of the pipe's circumference and a reading of the depth of standing water shall be taken. All such readings shall be documented, including, at a minimum, the depth of water and location (STA or upstream or downstream distance from manhole/structure) of each reading taken. Any and all points along the pipe segment at which the measured depth of standing water exceeds 4.0% of the nominal diameter of the pipe in question shall be defined as excessive sag.

i. Any and all pipe section(s) of gravity sanitary sewer in which excessive sag is identified shall be rejected. Contractor shall correct each and every such pipe section, including as many upstream or downstream sections or segments as necessary to eliminate excessive sag(s) while maintaining grade required by the contract documents.

j. No segment, regardless of length, shall have more than three (3) excessive sags. Identification of more than three (3) excessive sags in a segment of pipe shall be cause for rejection and Contractor shall reinstall the segment in its entirety at no cost to Owner.

k. All corrected sections and/or segments of pipe shall be retested at no additional cost to Owner until all pipe segments pass this and other tests required by SAWS Standard Specifications and contract documents for the project in question.

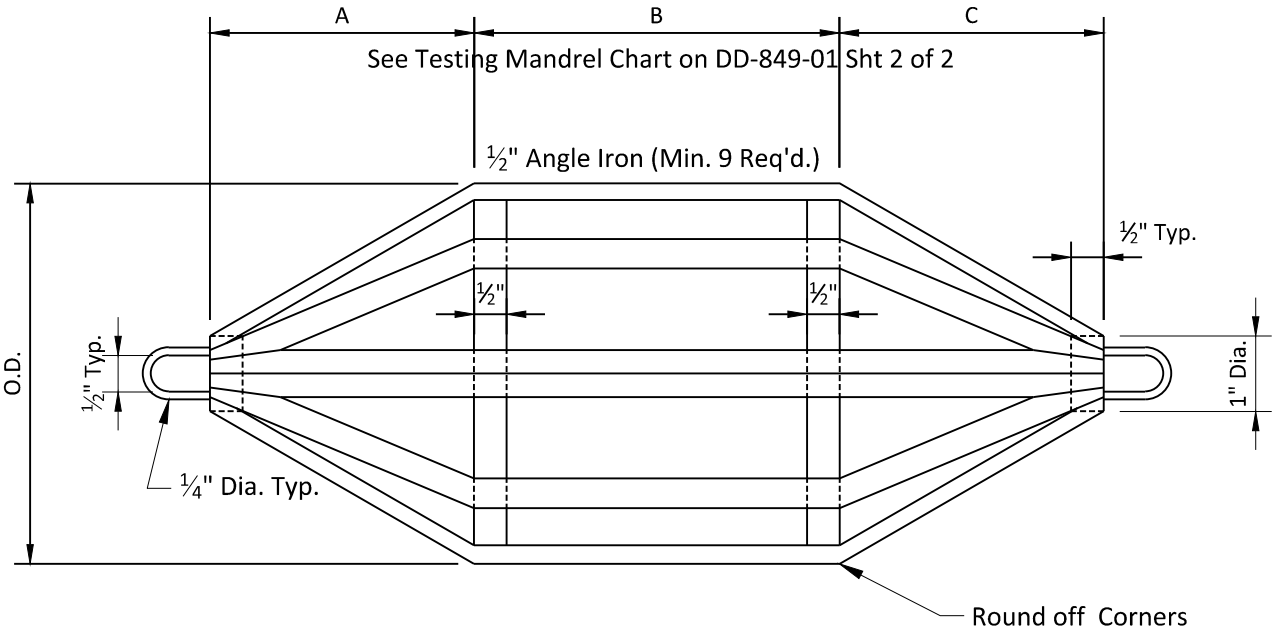
l. Excessive sags shall be documented in video and shall be in accordance with NASSCO-(PACP) requirements per SAWS Specification Item No. 866.

m. Provide televising and associated reports documenting the occurrence of the test and its results to Owner no later than 3 days following the test.

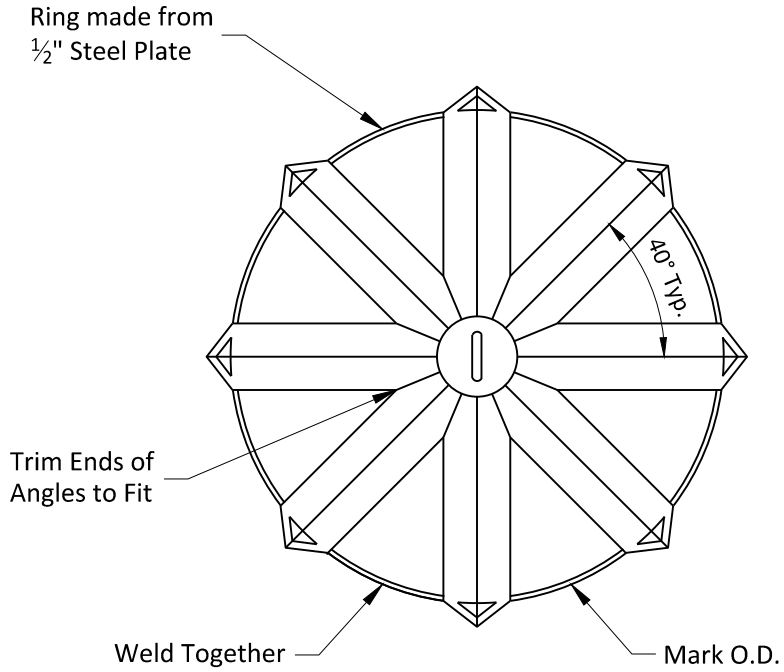
849.6 MEASUREMENT: Air/Infiltration/Exfiltration, and Deflection Testing will not be measured for payment.

849.7 PAYMENT: No direct payment shall be made for Air/Infiltration/Exfiltration and Deflection Testing and all costs in connection therewith shall be included in the applicable contract price for the item to which the work pertains. Refer to Specification 866 for payment of settlement testing.

-End of Specification-



SIDE OR TOP VIEW



END VIEW

Note:
All Mandrels must be Approved by SAWS Construction Inspection Dept. and Stamped before Use.

PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	GO, NO GO DEFLECTION TESTING MANDREL	APPROVED March 2008	REVISED December 2019
		DD-849-01	SHEET 1 OF 2

			MANDREL O.D.	RING O.D.
SIZE	A	B*	PVC (SDR -26)	PVC (SDR -26)
6"	4.0"	4.5"	5.50	4.79
8"	5.5"	6"	7.37	6.66
10"	7.0"	7.5"	9.21	8.50
12"	8.0"	9"	10.96	10.25
15"	10.0"	11"	13.42	12.71
18"	12.0"	13.5"	———	———
21"	14.0"	16"	———	———
24"	16.0"	18"	———	———
27"	18.0"	20"	———	———

*Minimum Length

CHART

Notes:
PVC Pipes and Fittings 6" to 15" in Diameter shall Conform to ASTM D-2241
PVC PIpes and Fittings 18" to 27" in Diameter shall Conform to ASTM F-679

This information is provided as a reference. All deflection testing shall be done in accordance with TCEQ Capter 217.

ITEM NO. 850

Polymer Concrete Sanitary Sewer Structures

850.1 DESCRIPTION: This item shall govern for the construction of all polymer concrete sanitary sewer structures other than standard sanitary sewer structures (Specification Item No. 852). Structures shall be required for all sewer main larger than 24 inches. Structures are defined as greater than 4 ft. in diameter.

850.2 REFERENCED STANDARDS: Reference standards cited in this Specification Item No. 850 refer to the current reference standard published at the time of the latest revision date:

1. San Antonio Water System (SAWS):
   a. Specifications for Water and Sanitary Sewer Construction
   b. SAWS Materials Specifications
2. City of San Antonio (COSA) Standard Specification for Construction
3. Texas Commission of Environmental Quality (TCEQ)
   a. 217 Design Criteria for Domestic Wastewater Systems
   b. 213 ("Edwards Aquifer Recharge Zone")
4. ASTM – American Society for Testing and Materials:
   a. ASTM A 307 Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile
   b. A536: Standard Specification for Ductile Iron Castings.
   c. ASTM A 615 Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
   d. ASTM C 33 Standard specification for concrete aggregates
   e. ASTM C 443 Standard Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.
   f. ASTM C 478 Standard Specification for Precast Reinforced Concrete Manhole Sections
   g. ASTM C 497 Test Methods for Concrete Pipe, Manhole Sections, or Tile.
   h. ASTM C 579 Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic, Surfacing, and Polymer Concretes
   i. ASTM C 580 Standard Test Method for Flexural Strength and Modulus of Elasticity of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes
   j. ASTM C 857 Standard Practice for Minimum Structural Design Loading for Underground Utility Structures.

k. ASTM C 890 Standard Practice for Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures
l. ASTM C 913 Standard Specifications for Precast Concrete Water and Wastewater Structures.
m. ASTM C 923 Standard Specifications for Resilient Connectors between Concrete Manholes Structures and Pipe.
n. ASTM C 990 Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants
o. ASTM D 638 Test Method for Tensile Properties of Plastics.
p. ASTM D 648 Standard Test Method for Deflection Temperature of Plastics under Flexural Load in the Edgewise Position.
q. ASTM D 698 Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lb/ft.)
r. ASTM D 790 Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
s. ASTM D 1238 Standard Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer.
t. ASTM D 1505 Standard Test Method for Density of Plastics by the Density-Gradient Technique.
u. ASTM D 1693 Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics.
v. ASTM D 2584 Test Method for Ignition Loss of Cured Reinforced Resins.
w. ASTM D 2665 Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste and Vent Pipe and Fittings
x. ASTM D 2996 Standard Specification for Filament-Wound "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe
y. ASTM D 2997 Standard Specification for Centrifugally Cast "Fiberglass" (Glass-Fiber-Reinforced Thermosetting Resin) Pipe
z. ASTM D 6783 Standard Specification for Polymer Concrete Pipe.

5. American Concrete Institute
   a. ACI 350-06 Code Requirements for Environmental Engineering Concrete Structures & Commentary
   b. ACI 440.1R-15 Guide for the Design and Construction of Structural Concrete Reinforced with Fiber-Reinforced Polymer (FRP) Bars
   c. ACI 548.6R-96 Polymer Concrete-Structural Applications State-of-the-Art Report
6. American Society of Mechanical Engineers
   a. ASME B 16.1 Cast Iron Pipe Flanges and Flanged Fittings

850.3 SUBMITTALS: Contractor shall submit manufacturer's product data, instructions, recommendations, shop drawings, and certifications. All submittals shall be in accordance with Engineer's requirements and submittals shall be approved by the Engineer prior to delivery.

1. Submit shop drawings for each structure.
2. Drawings shall include station number, location, rim and invert elevations, dimensions, reinforcing details, joint details, and component parts, base units and construction details, jointing methods, materials, and dimensions.
3. Summary of criteria used in structure design including, as minimum, material properties, loading criteria, and dimensions.
4. Include certification from manufacturer that polymer concrete structure design meets or exceeds the load and strength requirements and are manufactured in accordance with ASTM C 478, ASTM C 857, and ASTM D 6783, and when applicable reinforced in accordance with ACI 440.1R-15.
5. Submit calculations signed by a Professional Engineer Registered in the State of Texas demonstrating the structures meets the design criteria established in plans.
6. Structures shop drawings shall be sealed by a licensed Professional Engineer Registered in the State of Texas.
7. Submit Manufacturer's certification for each type of cast iron frame, grate, cover, or hatch.
8. Materials to be used in fabricating pipe drop connections (must be approved by Director of Engineering).
9. Materials to be used for pipe connections.
10. Materials to be used for stubs and stub plugs, if required.
11. Proof of independent chemical resistance testing conducted in accordance with the standard specifications.
12. Current ISO 9001 Certification or SAWS approved certification.
13. Submit proposed methods, equipment, materials and sequence of operations for sewer construction.
14. Submit all test reports and pre and post sewer television inspection video.
15. Videos become property of SAWS.

850.4 MATERIALS:

1. All fabrication will take place in an all polymer concrete fabrication facility.
2. All structures shall be watertight and polymer concrete manufacturer must be listed in SAWS current Approved Products List (APL).
3. Structure covers shall be watertight. Depending upon their specific location, Design Plans and Specifications shall designate locations of vented structures/structures.
4. Every structure cover located in the Edward's Aquifer Recharge Zone, shall be watertight.
5. Sewer structure ring and cover castings shall meet the current requirements of

AASHTO Designation M306-10 and must be listed in most current SAWS APL.

6. Compressive strength: Polymer concrete shall have a minimum unconfined compressive strength of 9,000 psi when measured in accordance with ASTM C 497.
7. Polymer Concrete Mix Design shall consist of thermosetting resin, sand, and aggregate.
    a. All aggregate, sand, and quartz powder shall meet the requirements of ASTM C 33, where applicable.
    b. No Portland cement shall be allowed as part of the mix design matrix.
    c. All sand and aggregate shall be inert in an acidic environment.
8. Reinforcement – Shall use steel reinforcement or acid resistant reinforcement (FRP Bar in accordance with ACI 440.1R) for polymer concrete design.
9. Thermosetting Resin - The resin shall have a minimum deflection temperature of 158° F when tested at 264 psi following Test Method D 648.
    a. The manufacturer shall use only polyester or vinyl ester resin systems designed for use with this particular application.
    b. The resin content shall not be less than 7% of the weight of the sample as determined by test method D 2584.
    c. Resin selection shall be suitable for applications in the corrosive conditions to which the polymer concrete manhole structures will be exposed.
    d. Resin additives, such as curing agents, pigments, dyes, fillers and thixotropic agents, when used, shall not be detrimental to the structure.
10. Provide resilient connectors conforming to requirements of ASTM C 923 or other options as available.
    a. All connectors are to be water tight.
    b. Install approved resilient connectors at each pipe entering and exiting structures in accordance with manufacturer's instructions
11. Elastomeric Gaskets shall be suitable for the service intended. All gaskets shall meet the requirement of ASTM C 443.
12. Round structures shall utilize spigot and bell type joints incorporating either a confined o-ring or single step profile joint.
13. Square and rectangular structures shall utilize a ship-lap joint and be sealed with a butyl rope sealant per ASTM C990 as recommended by the structure manufacturer.
14. Pipe to Structure Connections: Pipes shall be directly connected to all structures using resilient flexible pipe to structure connector per ASTM C923.
15. In cases where cold joint pipe stubs are shown, they shall be grouted using a corrosion resistant grout and rubber water stop grout ring.
16. Cones, reducer slabs, base slabs, and adjusting rings shall be of the same material as adjoining riser sections.
17. Structures shall be designed to withstand all live loads and dead loads as described in project plans and specifications.

a. Dead loads shall include overburden load, soil side pressure and hydrostatic loading conditions.
b. Structures wall thickness shall be designed to resist hydrostatic pressures with a minimum safety factor of 2.0 for full depth conditions from grade to invert.
c. In no cases shall the wall thickness be less than manufacturer recommended thicknesses.
d. Design wall sections for depth and loading conditions with wall thickness as designed by polymer concrete manufacturer
e. Polymer structures will be designed based upon live and dead load criteria in ASTM C 857 and ACI 350
f. Polymer Concrete structures shall be designed by manufacturer to meet loading requirements

18. Structures shall be designed with sufficient bottom anchorage and side friction to resist buoyancy.
19. Field cast floatation collars are acceptable.
20. Joints shall meet the requirements of ASTM C 443.
21. All materials needed for grouting and patching will be a compound provided by the manufacturer or as recommended by the manufacturer.
22. The structure ring and cover shall be of ductile iron construction.
23. The cover shall be solid with no vent or pick holes; hinged with underlying special hinge area leakage protection; the cover secured with four (4) stainless steel bolts; and shall have a recessed "pick bar" for cover opening.
    a. Cam lock type covers shall not be allowed.
    b. Approved manufacturers, are listed in the SAWS APL, have previously completed required inflow leakage shop testing.
    c. The nominal cover diameter shall be 32 inches, with a 30 inch clear opening, as required by TCEQ
    d. Vented structure covers will be specified by the engineer.
24. "Throat/grade rings" shall be made of HDPE and have a maximum thickness of 2 inches.
    a. No concrete throat/grade rings shall be used.
    b. The internal diameter shall match that of the ring and cover's opening.
    c. HDPE "throat/grade rings" are to be used in conjunction with a UV stabilized internal polyethylene liner for the purpose of providing an infiltration/inflow (I/I) barrier.
    d. Approved I/I barrier is listed in SAWS APL.
    e. Note of Clarification: A minimum of two and a maximum of six "throat/grade rings" may be used at each adjusted existing structure.
    f. "Throat/grade rings" are limited to a minimum of two and a maximum of four rings for new structure construction.
    g. Bitumastic Joint Sealant, flat tops, and between the ductile iron ring (frame)

and the uppermost adjustment ring or flat top: See approved APL.

850.5 CONSTRUCTION: All polymer concrete sanitary sewer structures shall be constructed in accordance with these specifications and in conformity with the required lines, grades, sections, and details shown in the contract documents or as directed by the Engineer.

1. Plan operations so as to minimize disruption of utilities to occupied facilities or adjacent property.
2. Construction methods shall conform to manufacturer's recommendations.
3. Where portions of structures are shown in the contract document details, such portions shall be constructed in accordance with applicable provisions of Specification Item No. 850, "Polymer Concrete Sanitary Sewer Structures."
4. Sanitary sewer structures constructed to function as structures or maintenance access appurtenances to gravity sewer systems shall be constructed to accommodate influent and effluent pipes greater than 24 inches in diameter as shown in Standard Drawing DD-850 Series.
5. Structure components shall be manufactured by the vibratory vertical casting process resulting in a dense, non-porous, corrosion-resistant, homogeneous, composite structure.
6. Each polymer concrete structure component shall be free of all defects, including indentations, cracks, foreign inclusions and resin starved areas that, due to their nature and degree or extent, detrimentally affect the strength and serviceability of the component part.
7. The nominal internal diameter of structures components shall not vary more than 2%.
8. Marking and Identification: Each piece or component of the manholes and structures shall be marked in letters no less than 1 inch in height with the following information. Markings shall be legible and located in a place within the manhole or structure.
   - Tag and/or stamp shall be placed in a location that can clearly be seen within the manhole or structure.
   - Manufacturer's name or trademark;
   - Manufacturer's factory location;
   - Manufacturer's serial number;
   - Production date
   - Manhole length;
   - ASTM Designation;
   - Installation assist marks (vertical lines 90^{o} apart at base of manhole).
9. Minimum clearance between wall penetrations and joints shall be per manufacturer's design

10. Construct invert channels to provide smooth flow transition with minimal disruption of flow at pipe-manhole connections.
11. Invert slope through structure as indicated on drawings.
12. All precast base sections to be cast monolithically.
13. Polymer bench and channel are to be constructed with all polymer concrete material.
14. Extended ballast slab requirements for buoyancy concerns can be addressed with cementitious concrete material.
15. Structures shall have engineered and rated lifting devices that shall not penetrate through the wall.
16. Handling and shipping shall be performed in accordance with the manufacturer's instructions.
17. Installation: The installation of structures shall be in accordance with the project plans and specifications and the manufacturer's recommended practices.
18. Handling: Properly rated slings and spreader bar shall be used for lifting.
19. The type of rigging used shall be per the manufacturer's recommendation.
20. Sealing surfaces and joint components shall be inspected for damage and cleaned of all debris.
21. Apply joint lubricant to elastomeric seals. Use only lubricants approved by the manufacturer.
22. Use suitable equipment handle and set structure.
23. Placement and compaction of surrounding backfill material shall be as per Specification Item No. 804 "Excavation, Trenching and Backfill."

850.6 TESTING: The Contractor shall notify Inspector and Engineer 48 hours prior to beginning of structure testing.

1. The Contractor shall perform the testing for all sanitary sewer structures in accordance with the following:
2. All structures must pass a leakage test.
3. The Contractor shall test each structure (after assembly and backfilling) for leakage, separate and independent of all other sanitary sewer piping, by means of either a hydrostatic test, vacuum test, or other methods approved by the Engineer.
4. The Contractor is hereby instructed to conduct either of the two identified tests in the following manner:
    a. Hydrostatic testing shall be conducted by utilizing approved plugs to seal all influent and effluent pipes in the structure and filling the structure to the top of the cone with water.
        (1) Additional water may be added over a 24-hour period to compensate for absorption and evaporation losses.
        (2) At the conclusion of the 24-hour saturation period, the structure shall be filled to the top and observed.

(3) Any measurable loss within a 30 minute period shall be considered an unsuccessful test and thus require the Contractor to assess the needed repairs, perform such repairs (subject to the approval of the Engineer), and notify the Inspector when the retest will be performed.

(4) All effort, materials, or other costs shall be solely at the Contractor's expense.

b. Vacuum Testing: Structures shall be tested after construction/installation and backfilling with all connections (existing and/or proposed) in place.

(1) Drop-connections and gas sealing connections shall be installed prior to testing.

(2) The lines entering the structure shall be temporarily plugged with the plugs braced to prevent them from being drawn into the structure.

(3) The plugs shall be installed in the lines beyond drop connections, gas sealing connections, etc.

(4) Prior to performing the test, the Contractor shall plug all lift holes and exterior joints with a non-shrink grout and plug all pipes entering the structure.

(5) No grout shall be placed in horizontal joints prior to testing.

(6) Contractor shall use a minimum 60 inch-lb. torque wrench to tighten the external clamps that secure the test cover to the top of the structure.

(7) The test head shall be inflated in accordance with the manufacturer's recommendations.

(8) A vacuum of 10 inches of mercury shall be drawn, and the vacuum pump will be turned off.

(9) With the valve closed, the level vacuum shall be read after the required test time.

(10) If the drop in the level is less than 1 inch of mercury (final vacuum greater than 9 inches of mercury), the structure will have passed the vacuum test.

(11) The required test time is 2 minutes.

c. Acceptance: Any structure which fails the initial test must be repaired per manufacturer's recommendation with a suitable material based on the material of which the structure is constructed.

d. The structure shall be retested as described above until a successful test is attained.

e. After a successful test, the temporary plugs will be removed.

f. To ensure that the plugs have been removed, Contractor shall only do so in the presence of the Inspector.

g. The Owner may elect to simply remove and replace the existing structure

with a new one.

h. Any structure excavated for repairs or excavated for tie in, shall be backfilled with minimum of 12 inches thickness of flowable fill to one foot below the top of the cone section to allow for the concrete ring encasement.

i. The Contractor also has the option of backfilling with approved secondary materials, subject to the provisions of Specification Item No. 804, "Excavation, Trenching and Backfill."

5. If a sanitary structure fails to pass one of the above tests, it shall be repaired in accordance with the manufacturer's recommendations and re-tested.

6. It shall not be accepted until it passes all tests.

7. All repairs and re-testing shall be at no additional cost to SAWS.

850.7 MEASUREMENT: Polymer Concrete Sanitary Sewer Structures will be measured as each structure complete in place.

850.8 PAYMENT: The work, as prescribed by this item, will be paid for at a Lump Sum unit price bid for each "Polymer Concrete Sanitary Sewer Structures,"

1. Sanitary sewer structures shall be paid at the contract lump sum unit price bid for each such structure. Percentages for completion shall be as outlined below and will be based on the completion of the following milestones:

a. Milestone 1: 40% of LS - Structure setting to include for each such structure, excavation, compaction, setting structure base setting to include concrete base encasement with reinforcements, saw cutting of surfaces as required and connection of new or existing sewer pipes to the structure as described in this specification. After curing the structure flowline elevation shall be verified by Licensed Surveyor in the State of Texas and a certified report furnished to Inspector, prior to payment and uploaded to CPMS. Furnishing and placing all materials necessary to complete the work is included in Milestone 1 and must be completed prior to payment (40%).

b. Milestone 2: 40% of LS – Structure Riser Installation and Flowable fill (up to 1 foot above cone section), drop pipes, reinforced concrete, fittings, labor, tools, equipment, tees, wyes, I&I barrier, and incidentals trench protection, and disposal of material excavated backfilling and compaction. Furnishing and placing all materials necessary to complete the work is included in Milestone 2 and must be completed prior to payment (40%).

c. Milestone 3: 20% of LS - Sanitary Sewer Structure Encasement and Testing. This pay item includes: structure concrete encasement, rebar, HDPE throat/grade rings, ring and cover, surface restoration, includes all structure testing in accordance for leakage, separate and independent of the all other sanitary sewer piping. Furnishing and placing all materials necessary to complete the work is included in Milestone 3 and must be

completed prior to payment (20%).

2. Materials paid on site will be in accordance with Table 1 of Specification Item No. 100, “Mobilization.”
3. Concrete cradles for pipes shall be measured and paid for at the contract unit price bid as provided for in Specification Item No. 858, "Concrete Encasement, Cradles, Saddles and Collars."
4. Gravel subgrade filler for structures shall not be measured separately for payment.

Pay Item	Description	Units
	Polymer Concrete Structure	Lump Sum
850.6.1.a	Milestone 1: Structure setting	40% of LS
850.6.1.b	Milestone 2: Structure Riser Installation and Flowable Fill	40% of LS
850.6.1.c	Milestone 3: Sanitary Sewer Structure Encasement and Testing	20% of LS

-End of Specification-

San Antonio Water System Standard Specifications for Construction

ITEM NO. 852

Sanitary Sewer Manholes

852.1 DESCRIPTION: This item shall govern the construction of standard sanitary sewer manholes complete in place and the materials therein, including manhole rings and covers.

852.2 REFERENCED STANDARDS: Reference standards cited in this Specification Item No. 852 refer to the current reference standard published at the time of the latest revision date.

1. San Antonio Water System (SAWS):
   a. Specifications for Water and Sanitary Sewer Construction
   b. SAWS Materials Specifications
2. City of San Antonio (COSA) Specifications for Construction
3. Texas Commission of Environmental Quality (TCEQ)
   a. Chapter 217 Design Criteria for Domestic Wastewater Systems
   b. Chapter 213 ("Edwards Aquifer")
4. AASHTO – American Association of State Highway and Transportation Officials:
   a. M306: Standard Specification for Drainage, Sewer, Utility, and Related Castings.
5. ASTM – American Society for Testing and Materials:
   a. ASTM A 307 - Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile
   b. A536: Standard Specification for Ductile Iron Castings.
   c. ASTM A 615 - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
   d. ASTM C 443 - Standard Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.
   e. ASTM C 478 - Standard Specification for Precast Reinforced Concrete Manhole Sections
   f. ASTM C 890 - Standard Practice for Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures
   g. ASTM C 913 – Standard Specifications for Precast Concrete Water and Wastewater Structures.
   h. ASTM C 990 – Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants
   i. ASTM D638: Test Method for Tensile Properties of Plastics.
   j ASTM D648: Standard Test Method for Deflection Temperature of Plastics under Flexural Load in the Edgewise Position.
   k ASTM D 698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lb/ft.)

l. ASTM D790: Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.

m ASTM D1238: Standard Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer.

n ASTM D1505: Standard Test Method for Density of Plastics by the Density-Gradient Technique.

o ASTM D1693: Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics.

p. ASTM D 2665 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste and Vent Pipe and Fittings

q ASTM D 2996 - Standard Specification for Filament-Wound "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe

r. ASTM D 2997 - Standard Specification for Centrifugally Cast "Fiberglass" (Glass-Fiber-Reinforced Thermosetting Resin) Pipe

6. American Society of Mechanical Engineers

a. ASME B 16.1 - Cast Iron Pipe Flanges and Flanged Fittings

852.3 SUBMITTALS: Contractor shall submit manufacturer's product data, instructions, recommendations, shop drawings, and certifications. All submittals shall be in accordance with Engineer's requirements, and submittals shall be approved by the Engineer prior to delivery.

1. Plan operations so as to minimize disruption of utilities to occupied facilities or adjacent property.
2. Submit all test reports and pre and post sewer television inspection video.
3. Videos become property of SAWS.

852.4 MATERIALS: All constructed manholes shall be watertight and equipped with pre-tested and approved ring and covers. Sewer manhole ring and cover castings shall meet the current requirements of the American Association of State Highway and Transportation Officials (AASHTO) Designation M306-10.

1. Concrete Manhole Components: For new concrete manholes, all concrete manhole components (cast-in-place or precast manhole base, precast risers, precast cone sections, cast-in-place or precast flat tops, and as applicable) for new manholes shall conform to the applicable requirements of ASTM Designation C478, except as modified below.

a. Concrete Grout: All concrete grout used for patching or other similar fill-in work shall be of non-shrink type made with the Komponent® admixture specified above, or approved alternate, in accordance with the manufacturer's recommended formulation with Portland cement, fine aggregate, water, and water reducer to produce a compressive strengths of approximately 4,800 psi within 7 days and 7,250 psi within 28 days at a 70 ^{0}F baseline temperature.

2. The manhole ring and cover shall be of ductile iron or gray cast iron construction. The cover shall be solid with no vent or pick holes; hinged with underlying special hinge area leakage protection; the cover secured with four (4) stainless steel bolts; and shall have a recessed "pick bar" for cover opening. Cam lock type covers shall not be allowed.
    a. Approved manufacturers, as listed in the SAWS Approved Products List (APL), have previously completed required inflow leakage shop testing and have met a maximum allowable leakage rate criterion of 1 gallon per minute (gpm) at 12 inches of water submergence above the manhole cover.
    b. Nominal cover diameter shall be 32 inches, with 30 inch clear opening, as required by TCEQ
    c. Vented Manhole Covers will be specified by Engineer.
3. "Throat rings" shall be made of HDPE and have a maximum thickness of 2 inches. No concrete throat rings shall be used.
    a. The internal diameter shall match that of the ring and cover's opening. HDPE "throat rings" are to be used in conjunction with a UV stabilized internal polyethylene liner for the purpose of providing an infiltration/inflow (I/I) barrier.
    b. The I/I Barrier shall be as manufactured by Strike Tool Products of Cannon Falls, MN. See SAWS APL.
    c. Note of Clarification: A minimum of two and a maximum of six "throat rings" may be used at each adjusted manhole. "Throat rings" are limited to a minimum of two and a maximum of four rings for new manhole construction. Throat rings shall be a maximum thickness of two (2) inches.
4. Bitumastic Joint Sealant, flat tops, and between the ductile or gray cast iron ring (frame) and the uppermost adjustment ring or flat top: See Approved APL.
5. For rehabilitated manholes; first, apply a combination of cementitious coatings followed by an approved epoxy coating. Kerneos SewperCoat 2000 HS and PG, applied at the required one inch thick application, is the only product approved which does not require a subsequent epoxy coating.
6. Other approved materials are located on SAWS website under SAWS Approved Products List. The list is periodically updated and should be checked by Contractor prior to start of construction.
7. For reconstructed manholes; first, apply a combination of cementitious coatings followed by an approved epoxy coating with the cementitious coating first. Kerneos SewperCoat 2000 HS and PG, applied at the required one inch thick application, is the only product approved which does not require a subsequent epoxy coating.
8. Other approved materials are located on SAWS website under SAWS Approved Products List. The list is periodically updated and should be checked by Contractor prior to start of construction.
9. New Manholes shall be precast manholes. Pre-cast manholes shall have an

antimicrobial additive introduced to the concrete mix in order to provide protection

against Microbial Induced Corrosion (MIC). Antimicrobial additive will not be required for doghouse manholes unless they are to remain permanently.

a. The liquid antimicrobial additive shall be an EPA registered material and the registration number shall be submitted for approval prior to use in the project.
b. Manufacturer shall also provide a State of Texas registration for the antimicrobial additive.
c. Manufacturer shall be approved by SAWS Products Standard Committee and be on the APL.
d. The antibacterial additive shall be used to render the concrete uninhabitable for acid producing bacterial growth.
e. The antimicrobial shall only be used by precast producers that have been certified by the manufacturer of the antimicrobial additive.
f. Dosage of the antimicrobial shall be per manufacturer's recommendations.
g. A ferrous oxide tinting agent shall be used to identify all antimicrobial concrete precast, and shall be dosed per manufacturer's recommendations producing a terracotta tint to the cured concrete.

10. Shallow manholes have a depth of 4 feet or less measured from the top of cover to sewer invert.
11. Each manhole joint shall be sealed with Infi-Shield ® Gator Wrap external rubber sleeve as manufactured by Sealing Systems, Inc. The seal shall be made of Stretchable, Self-Shrinking, Intra-Curing Halogenated based rubber with a minimum thickness of 30 mils. The back side of each unit shall be coated with a cross-linked re-enforced butyl adhesive. The butyl adhesive shall be non-hardening sealant, with a minimum thickness of 30 mils. The seal shall stretch around the substrate then overlapped creating a cross-link and fused bond between the rubber and butyl adhesive.

852.5 CONSTRUCTION:

1. Manholes shall be constructed of materials and workmanship as described by these specifications, at such places shown in the contract documents or as designated by the Engineer, and in conformity with the typical details and sketches shown.
2. Unless otherwise shown in the contract documents or approved by the Engineer, standard sanitary sewer manholes shall be constructed with influent and effluent piping less than or equal to 24 inches in diameter with precast reinforced concrete manhole sections.
3. A standard sanitary sewer manhole shall be a single entrance cylindrical structure, having a minimum internal diameter of 4 feet between the cone and base sections.
4. The base of the structure shall include the load bearing portion beneath and exterior of the structure, invert channels and the fill or bench portions adjacent to the lower sewer pipes within the structure.
5. When the manhole depth is 4 feet or less, but not less than three (3) feet, provide a shallow type manhole. Maximum pipe size for shallow type manholes is 12-inch

diameter.

6. Special shallow cone sections, or flat cover slabs, shall be used for shallow manholes.
7. The maximum vertical height of the diameter adjustment section or cone shall be 36 inches.
   a. Adjustment of throat rings may be used for final elevation adjustment of the manhole ring and cover.
   b. Concrete encasement of the manhole's ring shall be as shown in the DD-852 Standard Drawing Series.
   c. Ring and cover shall be attached to the diameter adjustment flat top section or cone.
   d. Manholes which differ from the above description shall be governed by Specification Item No. 850, "Polymer Concrete Sanitary Sewer Structures."
   e. An External drop manhole shall be provided for a sewer entering a manhole more than 30 inches above the invert, as per TCEQ Rules and Regulations Chapter 217 Design Criteria for Domestic Wastewater Systems.
8. Footings or bases of manholes shall be a minimum of 6 inches in depth below the bottom of the pipe.
9. All invert channels shall be constructed and shaped accurately so as to be smooth, uniform and cause minimum resistance to flow.
10. The bench shall be finished smooth with a slope of ½ inch per foot from the manhole walls to the edges of the invert.
11. The top half of all sewer pipes within the invert channel or bench zone shall be removed flush to the inside manhole walls.
12. Joints on sewer pipes shall not be cast or constructed within the wall sections of manholes.
13. Concrete cradles shall be required for new pre-cast manholes.
14. Concrete cradles shall extend beyond the outside walls of the manhole a minimum of 36 inches.
15. Voids between exterior pipe walls and manhole walls at all pipe connections in manholes shall be filled with a non-shrink grout, as specified above, or as approved by the Engineer, or as shown in the contract documents and inspected prior to backfilling.
16. Where connections to existing manholes are required, the adjacent pipe bedding shall be prepared to proper grade, the existing manhole neatly cored and the new pipe inserted so that the end is projecting 2 inches from the inside wall.
17. The invert shall then be reshaped to properly channel new flows.
18. Debris of any kind shall be kept out of new or existing manholes or mains.
19. Joints between cones, risers, adjustment rings, flat tops, and between the ductile cast iron ring and the uppermost adjustment ring or flat top, as applicable, shall be thoroughly sealed in accordance with manufacturer's recommendations with adhesive bitumastic products as specified above.

Where precast concrete risers are used, any gaps in the outer joint surfaces shall be

additionally coated with non-shrink grout to a minimum thickness of ¼ inch.

20. All manhole rings shall be encased with 4,000 psi reinforced concrete as shown in the contract documents or as approved by the Engineer.
    a. Concrete manhole ring encasement shall extend 6 inches below the top of the cone and have a minimum width when measured at the manhole ring of 1 foot. The surface of the encasement shall be flush with the top of the manhole ring.
21. All new manholes shall be encased with a minimum of 12 inches thickness of flowable fill to one foot above the top of the cone section to allow for the concrete ring encasement. See DD-852 drawing series.

852.6 TESTING: The Contractor shall notify Inspector and Engineer 48 hours prior to beginning of manhole testing and only after a successful pretest has been performed.

1. The Contractor shall perform the testing for all sanitary sewer manholes in accordance with the following:
2. All manholes must pass a leakage test.
3. The Contractor shall test each manhole (after assembly and backfilling) for leakage, separate and independent of all other sanitary sewer piping, by means of either a hydrostatic test, vacuum test, or other methods approved by the Engineer.
4. The Contractor is hereby instructed to conduct either of the two identified tests in the following manner:
    a. Hydrostatic testing shall be conducted by utilizing approved plugs to seal all influent and effluent pipes in the manhole and filling the manhole to the top of the cone with water.
        (1) Additional water may be added over a 24-hour period to compensate for absorption and evaporation losses.
        (2) At the conclusion of the 24-hour saturation period, the manhole shall be filled to the top and observed.
        (3) Any measurable loss within a 30 minute period shall be considered an unsuccessful test and thus require the Contractor to assess the needed repairs, perform such repairs (subject to the approval of the Engineer), and notify the Inspector when the retest will be performed.
        (4) All effort, materials, or other costs shall be solely at the Contractor's expense.
    b. Vacuum Testing: Manholes shall be tested after construction/installation and backfilling with all connections (existing and/or proposed) in place.
        (1) Drop-connections and gas sealing connections shall be installed prior to testing.
        (2) The lines entering the manhole shall be temporarily plugged with the plugs braced to prevent them from being drawn into the manhole.
        (3) The plugs shall be installed in the lines beyond drop connections,

gas sealing connections, etc.

(4) Prior to performing the test, the Contractor shall plug all lift holes and exterior joints with a non-shrink grout and plug all pipes entering the manhole.

(5) Only a cementitious coating may be applied.

(6) Contractor shall use a minimum 60 inch-lb. torque wrench to tighten the external clamps that secure the test cover to the top of the manhole.

(7) The test head shall be inflated in accordance with the manufacturer's recommendations.

(8) A vacuum of 10 inches of mercury shall be drawn, and the vacuum pump will be turned off.

(9) With the valve closed, the level vacuum shall be read after the required test time.

(10) If the drop in the level is less than 1 inch of mercury (final vacuum greater than 9 inches of mercury), the manhole will have passed the vacuum test.

(11) The required test time is 2 minutes.

c. Acceptance: Any manhole which fails the initial test must be repaired with a non-shrink grout or other suitable material based on the material of which the manhole is constructed.

d. The manhole shall be retested as described above until a successful test is attained.

e. After a successful test, the temporary plugs will be removed.

f. To ensure that the plugs have been removed, Contractor shall only do so in the presence of the Inspector.

(1) Repairs to Existing Manholes: Any existing manhole which fails to pass the hydrostatic/vacuum test shall be closely examined by the Inspector and the Contractor to determine if the manhole can be repaired.

g. Thereafter, the Contractor shall either repair or remove and replace the manhole as directed.

h. Any manhole excavated for repairs or excavated for tie in, shall be backfilled with a minimum of 12 inches thickness of flowable fill to one foot above the top of the cone section to allow for the concrete ring encasement.

i. After abrading and cleaning, additional protective coating material shall be applied to the repair area.

j. All touch-up repair procedures shall follow the protective coating manufacturer’s recommendations

5. If a sanitary manhole fails to pass one of the above tests, it shall be repaired in accordance with the manufacturer’s recommendations and re-tested. Should the test fail a second time, Contractor shall perform another leak test utilizing the other

testing option in this specification Should the test fail the third time, Contractor shall remove and replace the manhole and perform all the necessary test at no additional cost to SAWS. Manholes shall not be accepted until it passes all tests.

6. Engineer of Record must witness all tests over the EARZ.

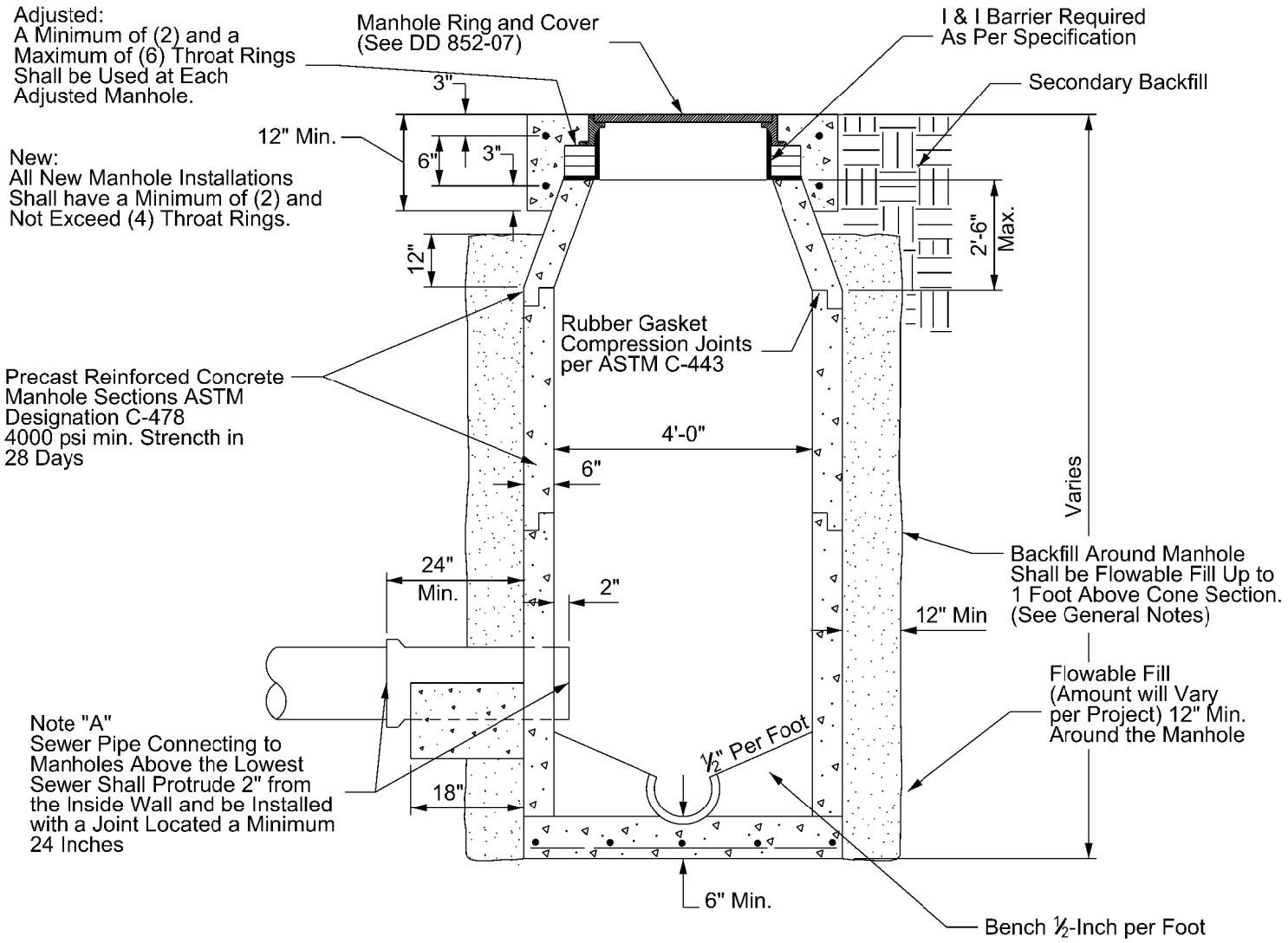
852.7 MEASUREMENT: All manholes zero feet to 6 feet deep and designated in the contract documents will be measured as the total number of such manholes constructed, including those exceeding 6 feet in depth from the lowest invert elevation to the top of the ring.

1. Manholes deeper than 6 feet shall be measured by the number of vertical feet in excess of 6 feet.

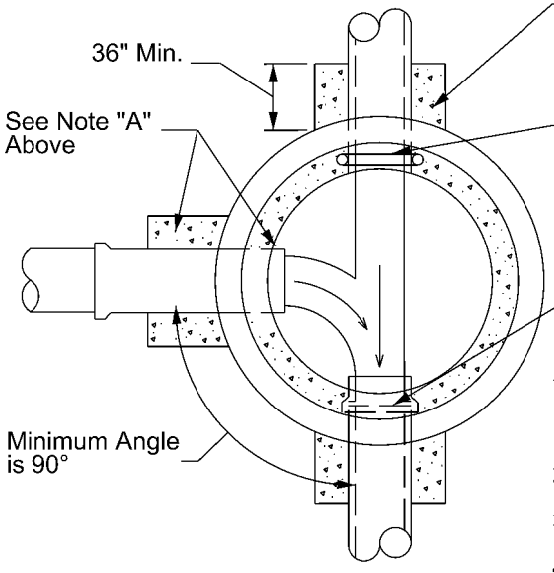
852.8 PAYMENT:

1. All manholes shall be paid at the contract unit price bid for each such manhole, which price shall be full compensation for all precast sections or throat rings, UV stabilized polyethylene liner, cones, bases, rings and covers, manhole ring, anti-microbial agent, encasement, manhole rubber joint seal, flowable fill, mortar, drop pipes, saws cutting of surfaces, surface restoration, and fittings, labor, tools, equipment, testing, tees, wyes, and incidentals necessary to complete the work.
2. Extra depth manholes shall be paid for at the contract unit price bid per vertical foot as measured above.
3. Shallow manholes shall be paid at the contract unit price.
4. Concrete cradles for pipes shall be measured and paid for at the contract unit price bid as provided for in Specification Item No. 858, "Concrete Encasement, Cradles, Saddles and Collars."
5. Gravel subgrade filler for manholes shall not be measured separately for payment.

- End of Specification-



PRECAST MANHOLE



Concrete Cradle to Nearest Point of all Lines Leaving or Entering Manholes

All Pipe is Used, Provide Rubber Gasket One Size Smaller than Pipe at Each Wall Crossing of Manhole, If HDPE Pipe is Used a Non-Shrink Grout to be Applied within the Wall Sections, Gasket is also, Required.

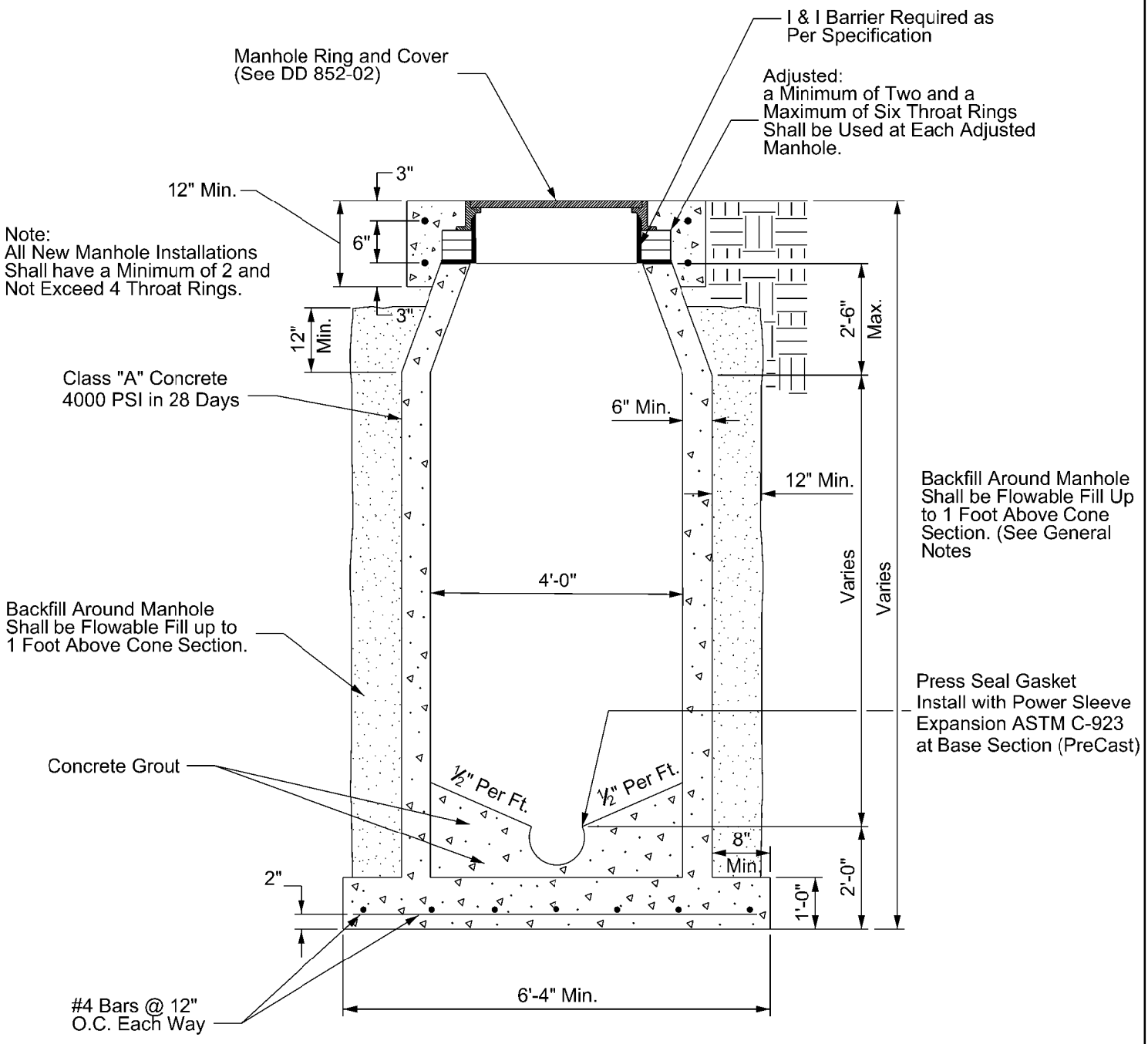
No Joints for Pipe will be Allowed within Wall Section

General Notes:

1. Material for Sanitary Sewer Pipe must be the Same from Manhole to Manhole. Changes in Type of Pipe may be Made Only at Manholes, or Special Structures, except as Approved by the SAWS Inspector.
2. Adapters and Concrete Collars shall be Used as Directed and Approved by theSAWS Inspector.
3. Watertight Manhole Rings and Covers shall be Trans-Tex A77 "O" Ring or Approved Equal.
4. The Minimum Angle of Flow for a Connecting Sewer to the Direction of Flow Defined by a Collection System is 90 Degrees, unless Approved by the Engineer.

PRECAST MANHOLE

PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	STANDARD PRECAST MANHOLE	APPROVED MAY 2013	REVISED AUG 2019
		DD-852-01	SHEET 1 OF 2



MONOLITHIC MANHOLE

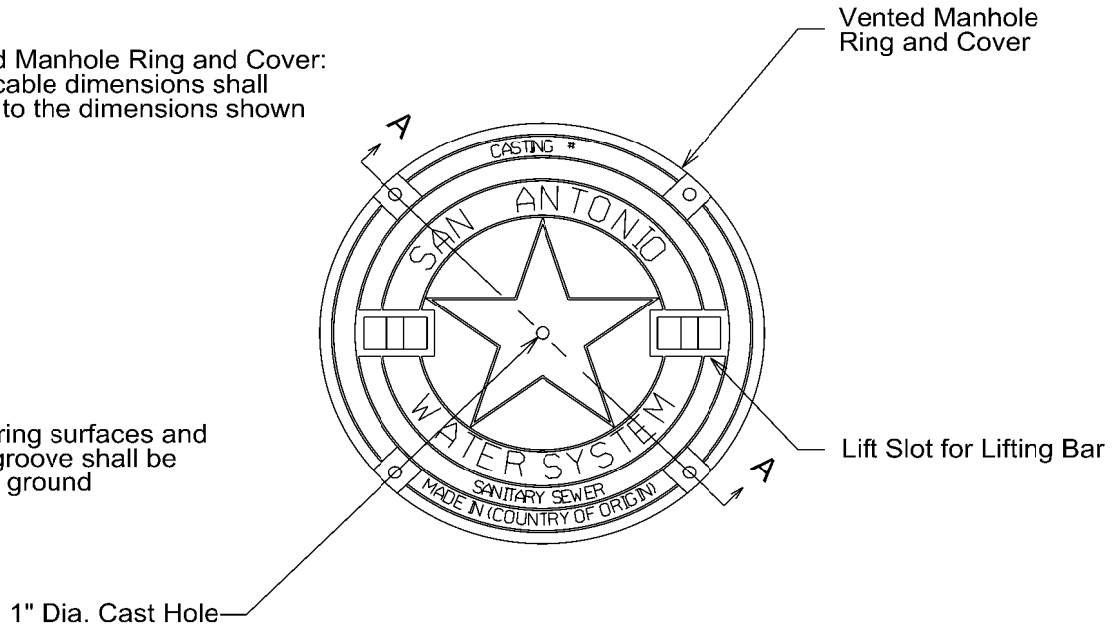
General Notes:

1. Material for Sanitary Sewer Pipe Must be the Same from Manhole to Manhole. Changes in Type of Pipe May be Made only at Manholes, or Special Structures, Except as Approved by the Project Engineer.
2. Adaptors and Concrete Collars shall be used as approved by the SAWS Project Engineer.
3. Watertight Manhole Rings and Covers shall be Trans-Tex A77 "O" Ring or Approved Equal.

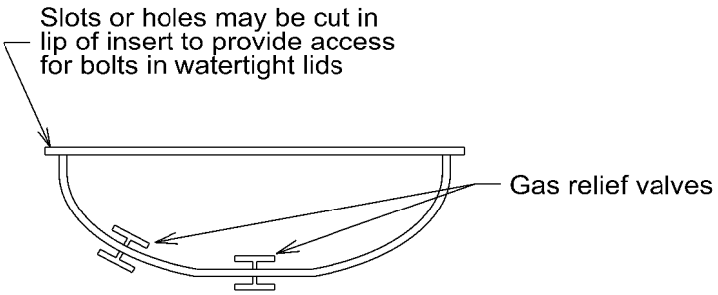
PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	STANDARD MONOLITHIC MANHOLE	APPROVED March 2008	REVISED AUG 2019
		DD 852-01	SHEET 2 OF 2

Note:
Standard Manhole Ring and Cover:
All applicable dimensions shall conform to the dimensions shown here

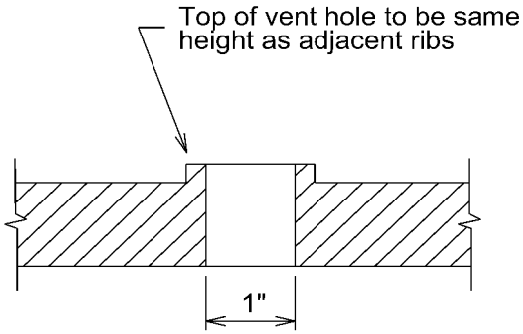
Note:
The bearing surfaces and O-Ring groove shall be Machine ground



VENTED MANHOLE RING AND COVER



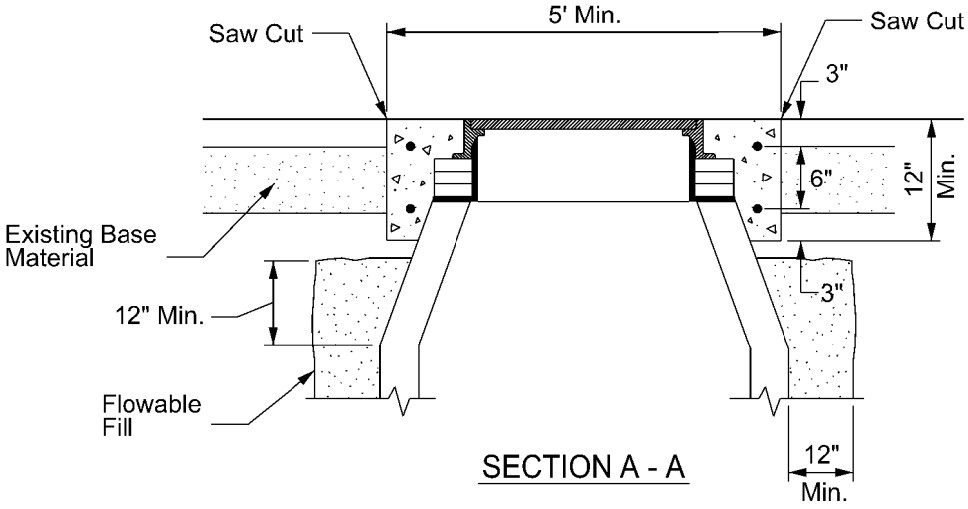
WATERTIGHT MANHOLE INSERT DETAIL



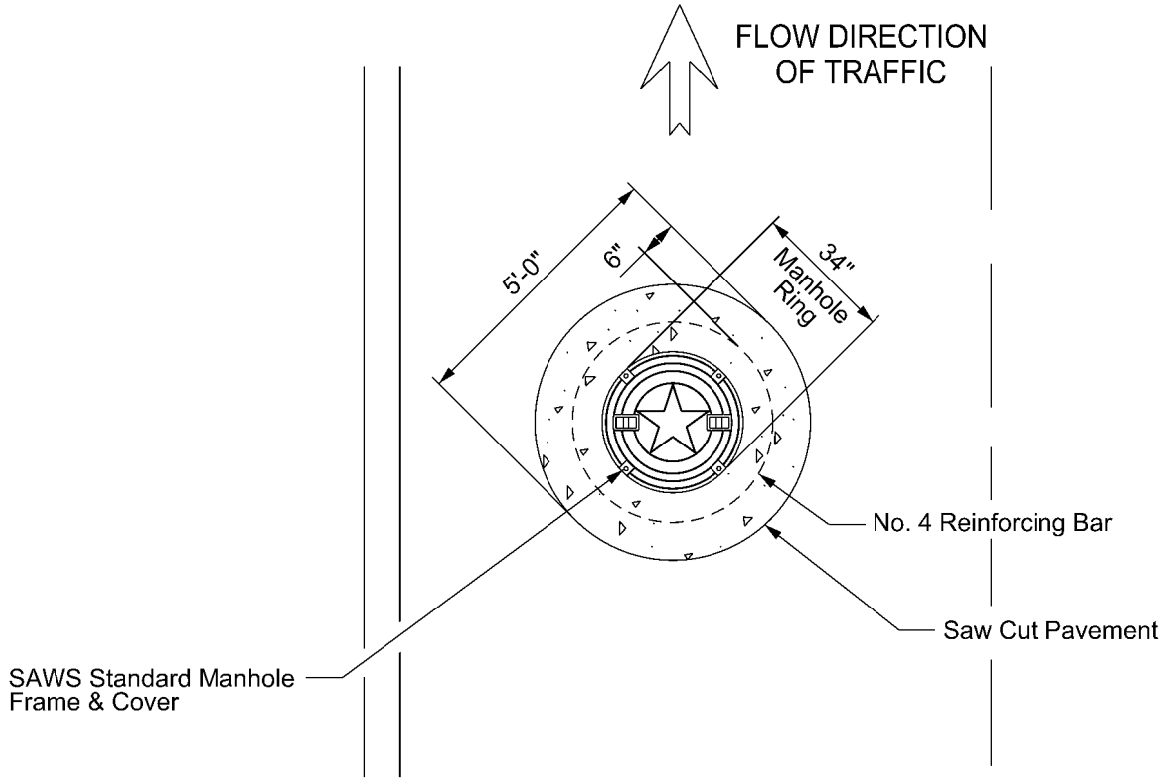
VENT HOLE DETAIL SECTION A-A

Manhole cover inserts shall be installed in strict accordance with the manufacturer's recommendations. The contractor shall be responsible for making the necessary field measurements for the manufacturer prior to production.

PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	VENTED MANHOLE RING AND COVER DETAIL	APPROVED JANUARY 2005	REVISED AUG 2019
		DD-852-02	SHEET 1 OF 1

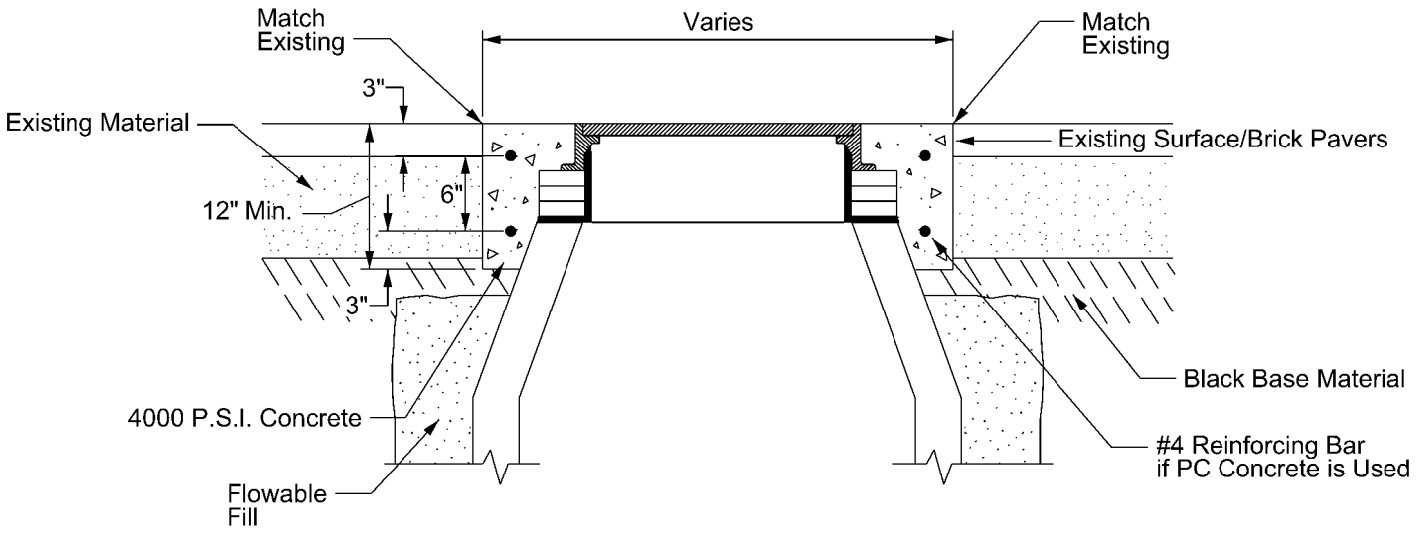


SECTION A - A

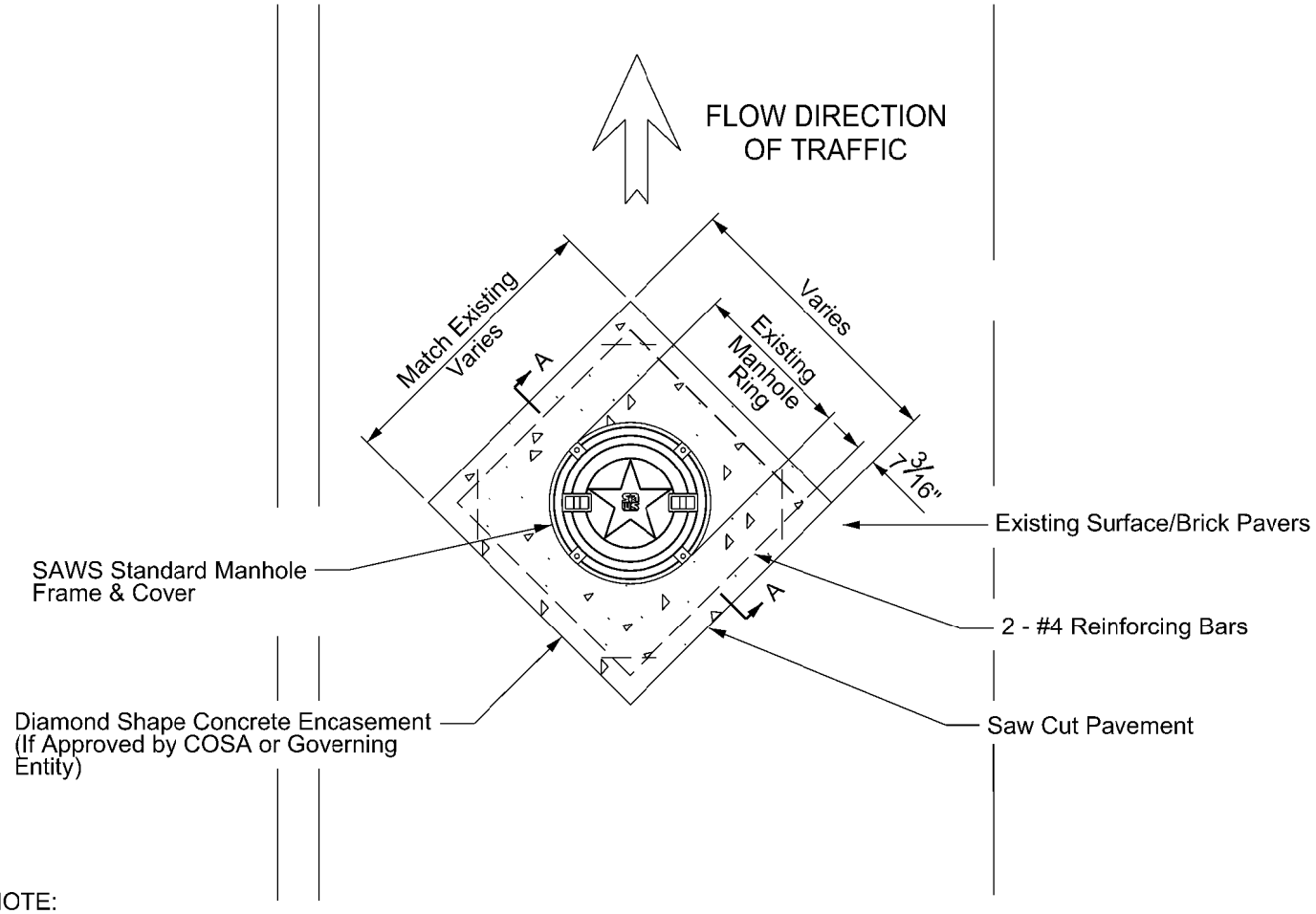


NOTE:
1. The Concrete Shall be 4000 PSI Minimum and Reinforced with No. 4 Bars as Shown.
2. The Concrete Shall Extend to Edge of Saw Cut Pavement.
3. Manhole Ring Encasement is Required on all Manholes.
4. Manhole Lid shall Open in the Direction of Traffic or Downstream in Parkway

PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	MANHOLE RING ENCASEMENT DETAIL	APPROVED AUGUST 2009	REVISED AUG 2019
		DD 852-03	SHEET 1 OF 2

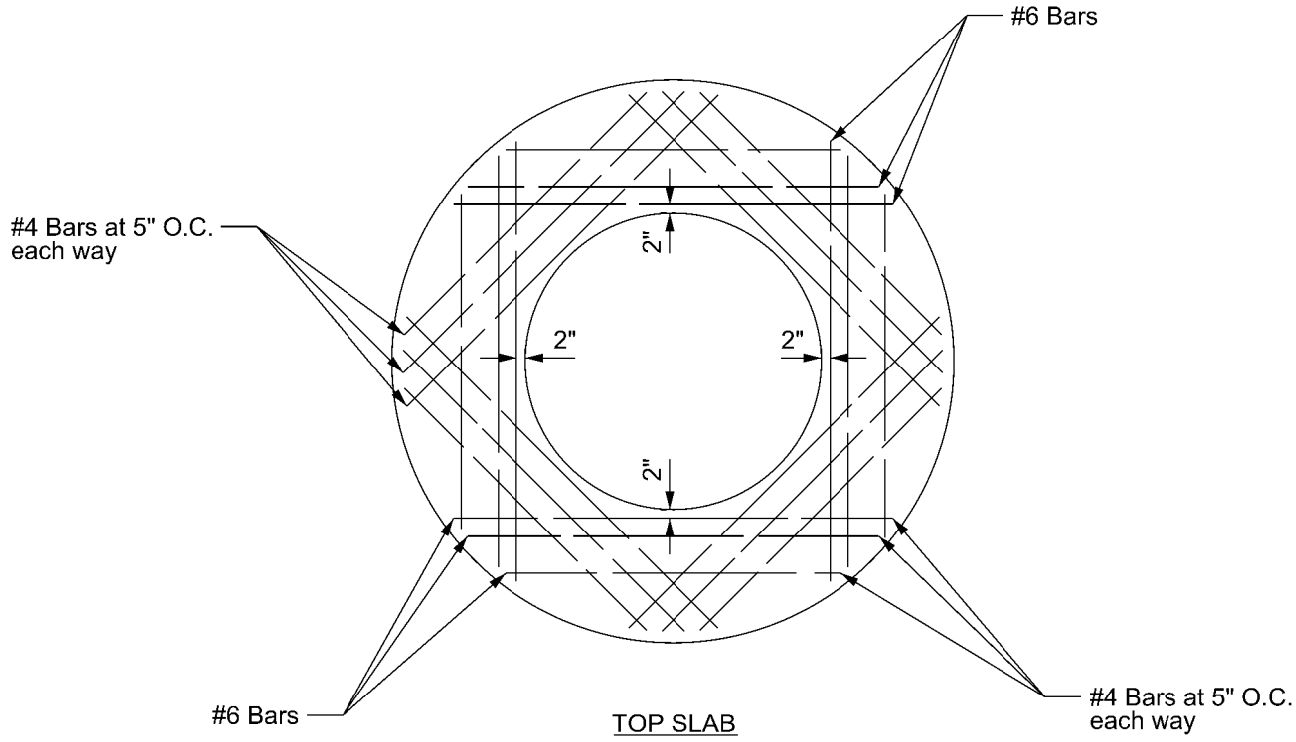


SECTION A - A

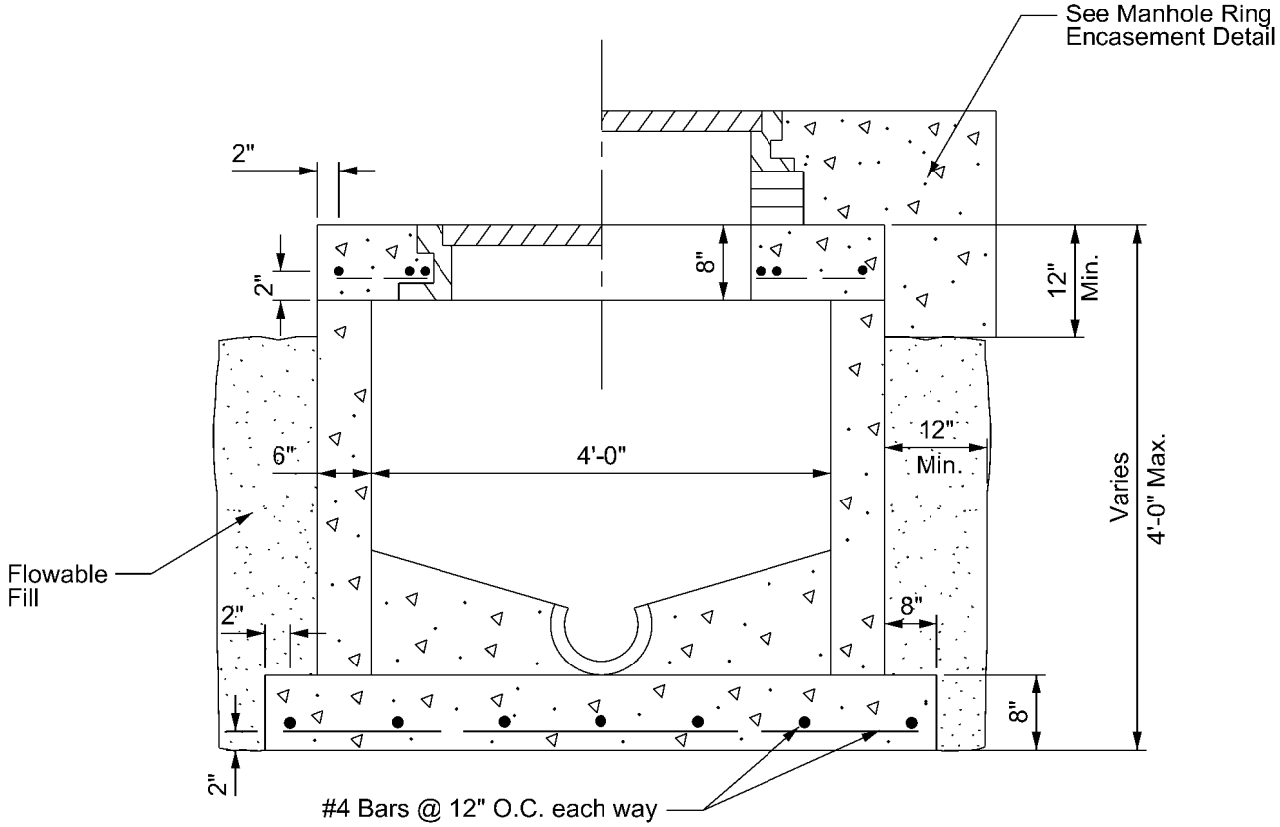


NOTE:
1. The Concrete Shall be 4000 PSI, Minimum and Reinforced with 2 - #4 Bars as Shown.
2. The Concrete Shall Extend to Edge of Saw Cut Pavement.
3. Manhole Ring Encasement is Required on all Manholes.
4. Manhole Lid Shall Open in the Direction of Traffic or Downstream in Parkway.

PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	MANHOLE RING ENCASEMENT DETAIL DOWNTOWN	APPROVED MARCH 2008	REVISED AUG 2019
		DD 852-03	SHEET 2 OF 2

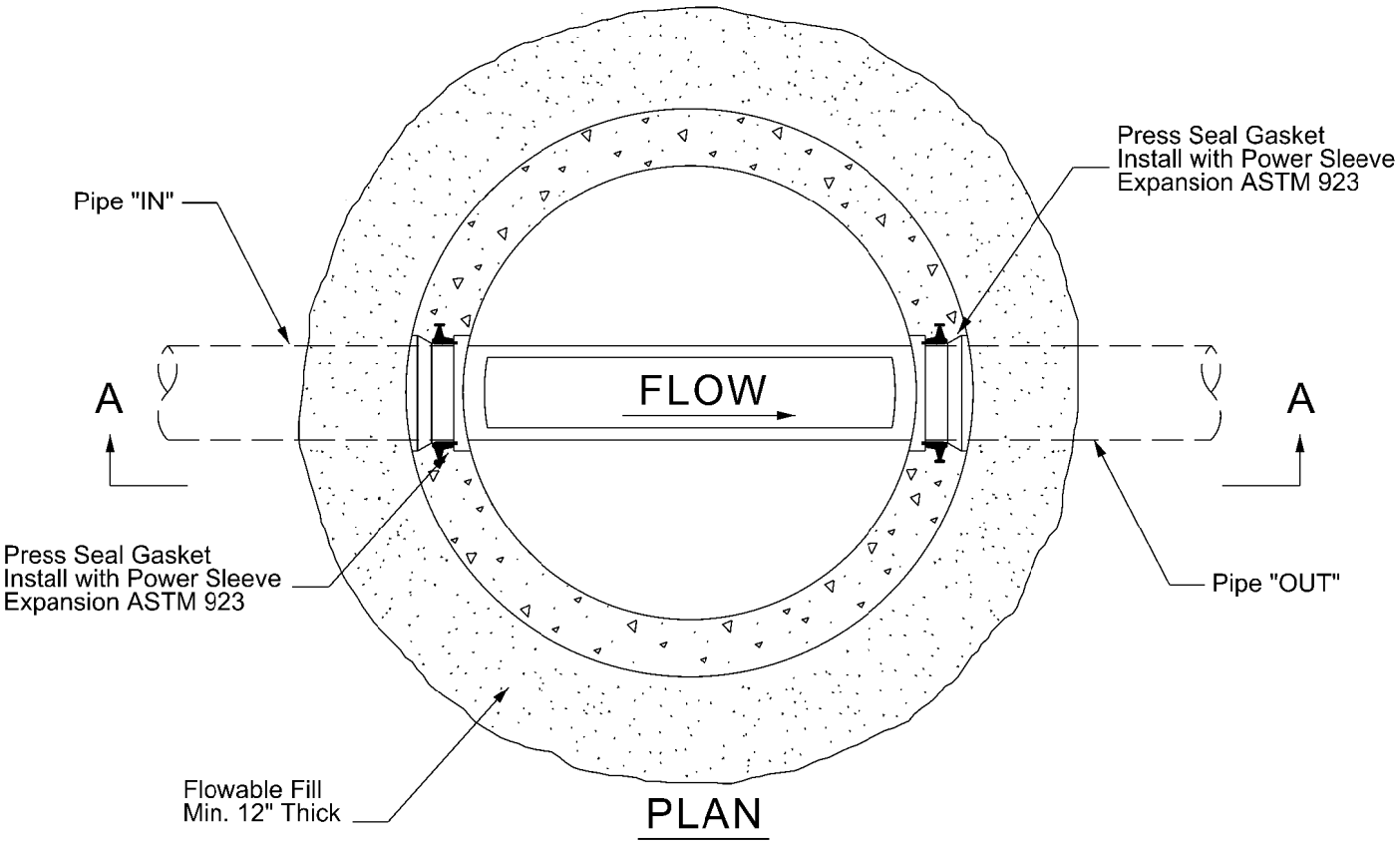


TOP SLAB

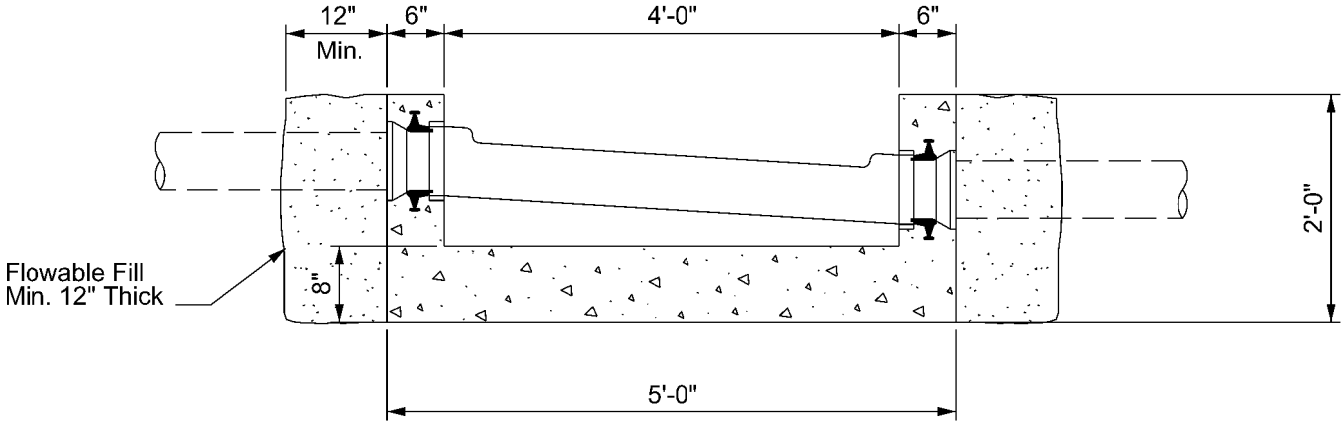


SHALLOW MANHOLE
PRECAST OR MONOLITHIC

PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	SHALLOW MANHOLE DETAIL	APPROVED MARCH 2008	REVISED AUG 2019
		DD 852-04	SHEET 1 OF 1

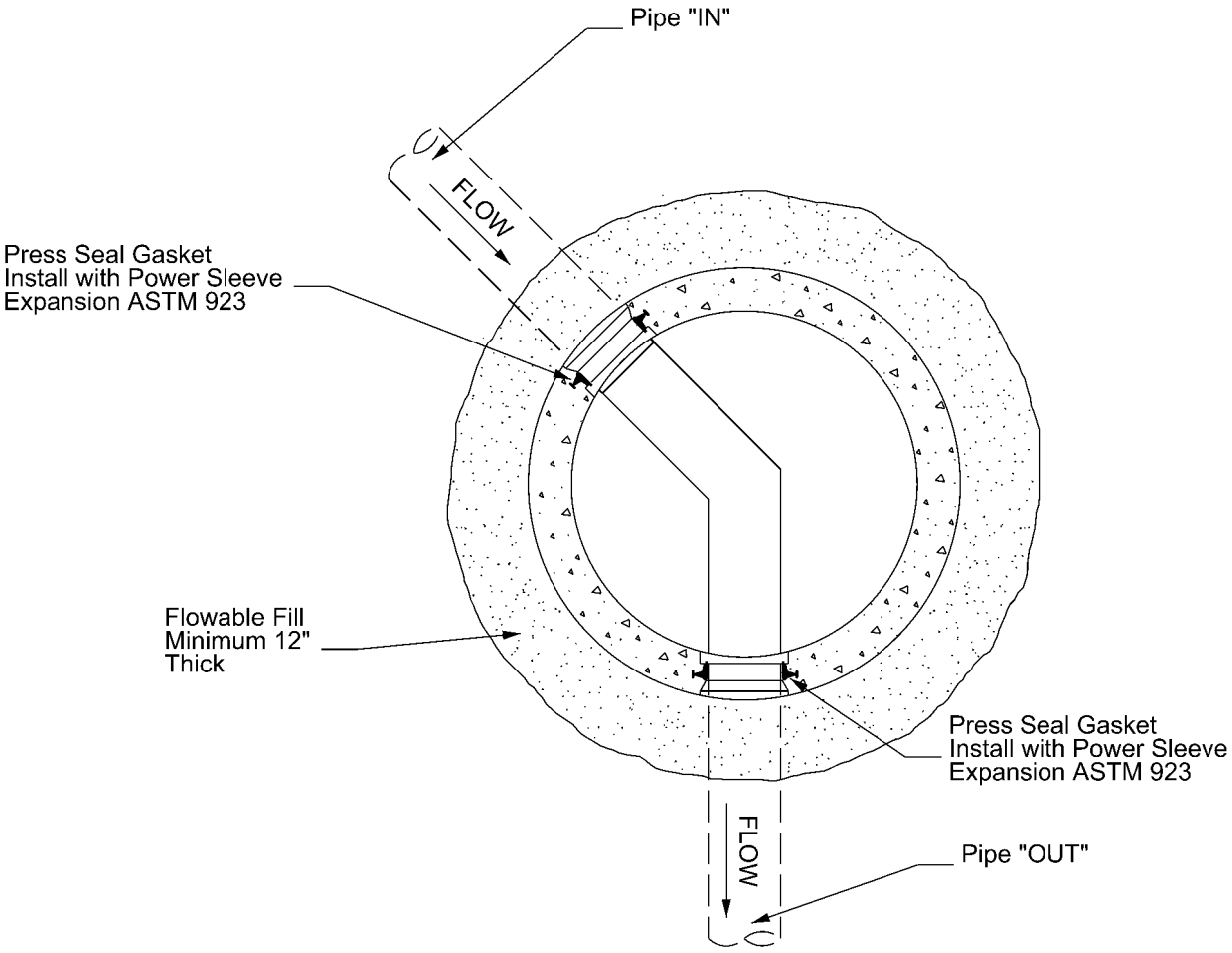


PLAN

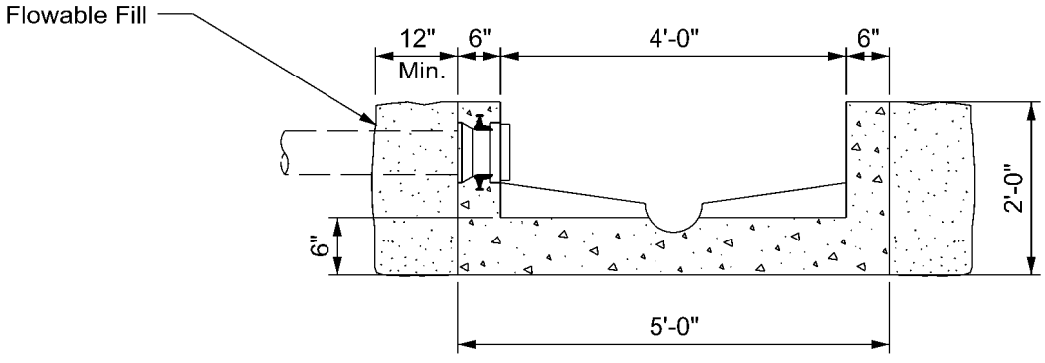


SECTION A-A

PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	PRECAST MANHOLE BASE STRAIGHT THROUGH	APPROVED MARCH 2008	REVISED AUG 2019
		DD-852-05	SHEET 1 OF 1

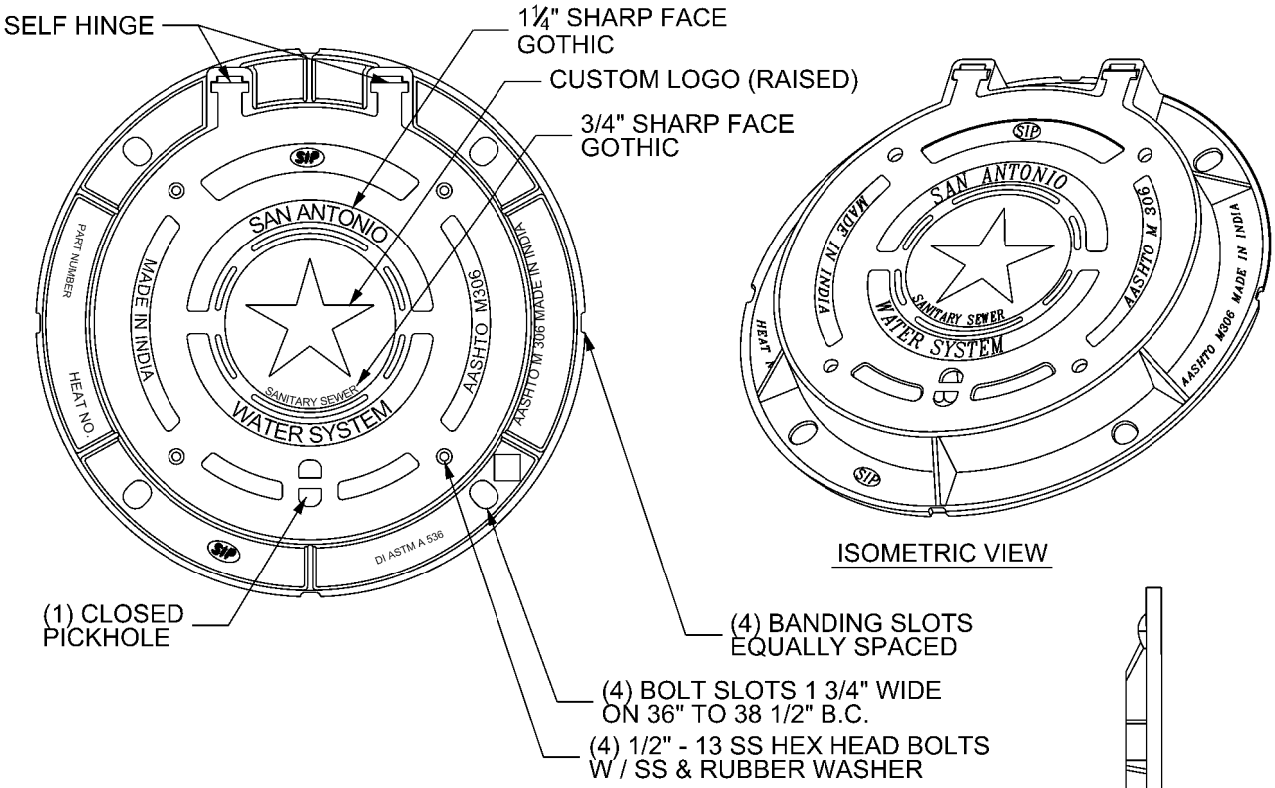


PLAN

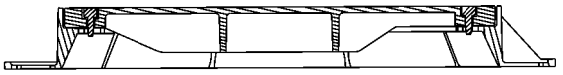


SECTION A-A

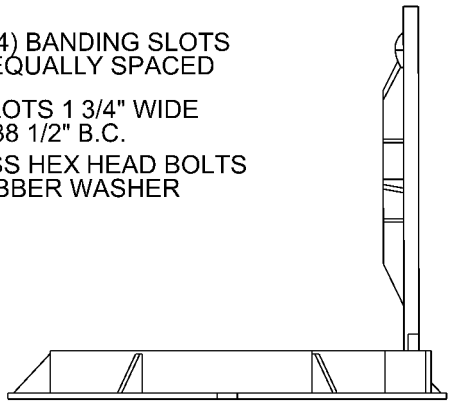
PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	PRECAST MANHOLE BASE 45° ANGLE	APPROVED MARCH 2008	REVISED AUG 2019
		DD-852-06	SHEET 1 OF 1



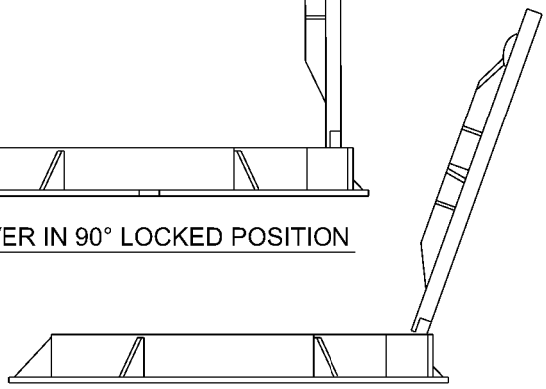
ISOMETRIC VIEW



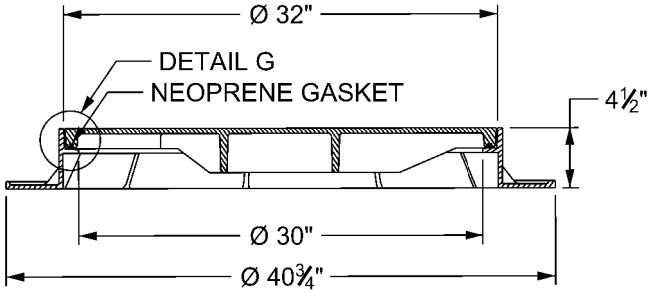
SECTION B-B (BOLTING DETAIL)



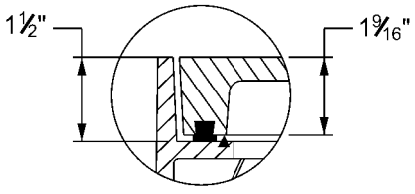
COVER IN 90° LOCKED POSITION



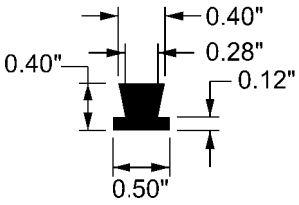
COVER IN 120° RESTING POSITION



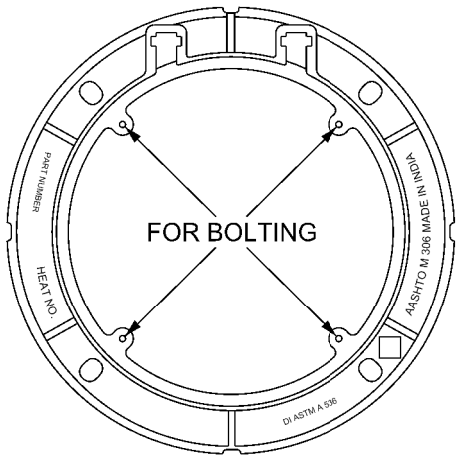
SECTION A-A



DETAIL G



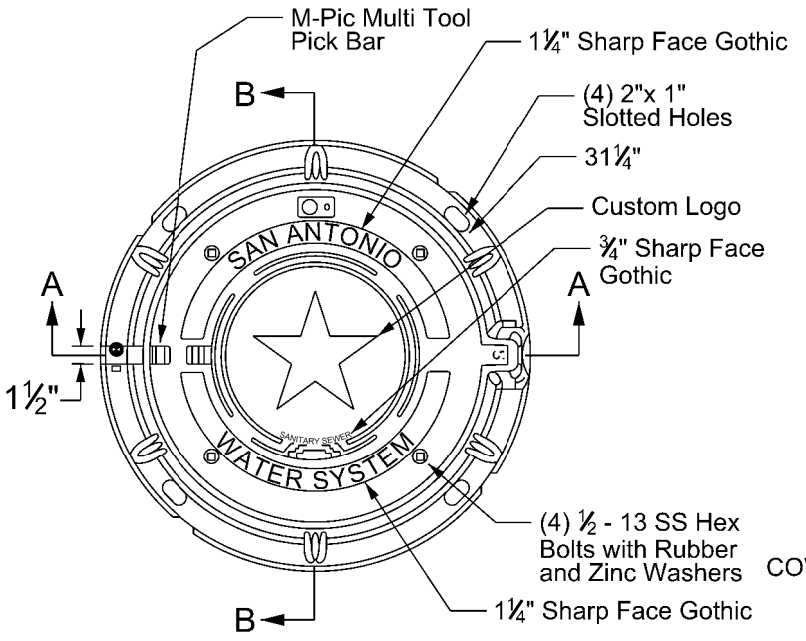
NEOPRENE GASKET DETAIL

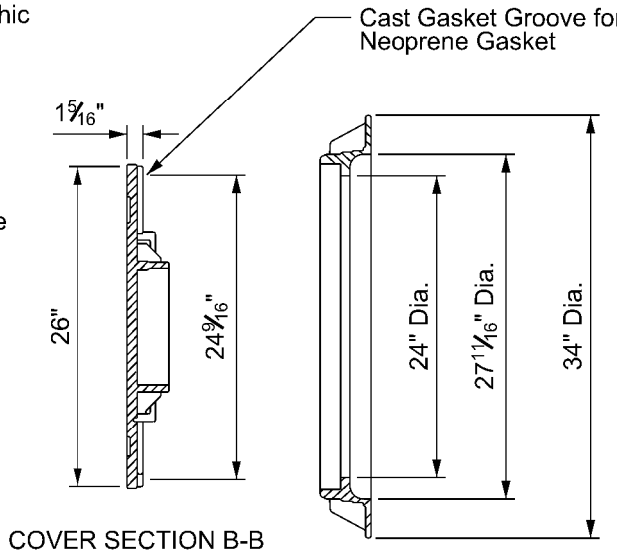


FRAME TOP VIEW

SIP Industries

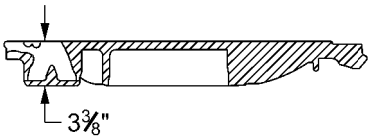
PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	30" MANHOLE RING AND COVER DETAIL	APPROVED	REVISED AUG 2019
		DD 852-07	SHEET 1 OF 5



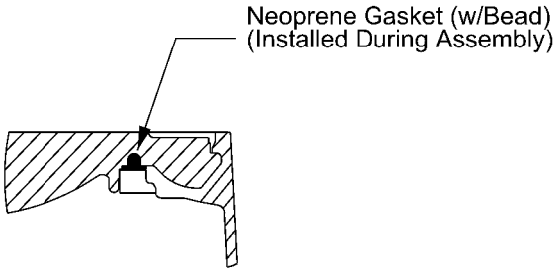


COVER SECTION B-B

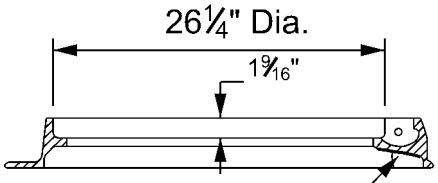
FRAME SECTION B-B



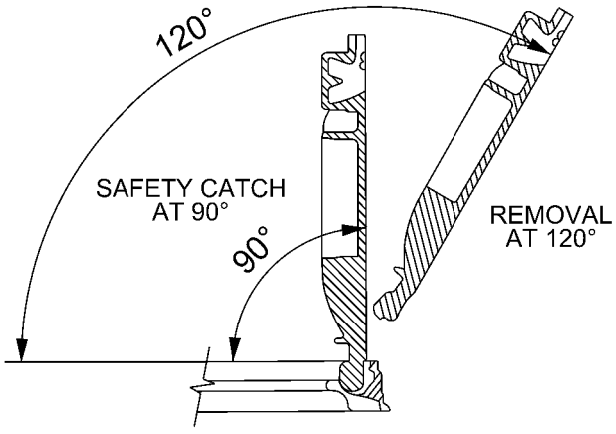
COVER SECTION A-A



HINGE & GASKET VIEW



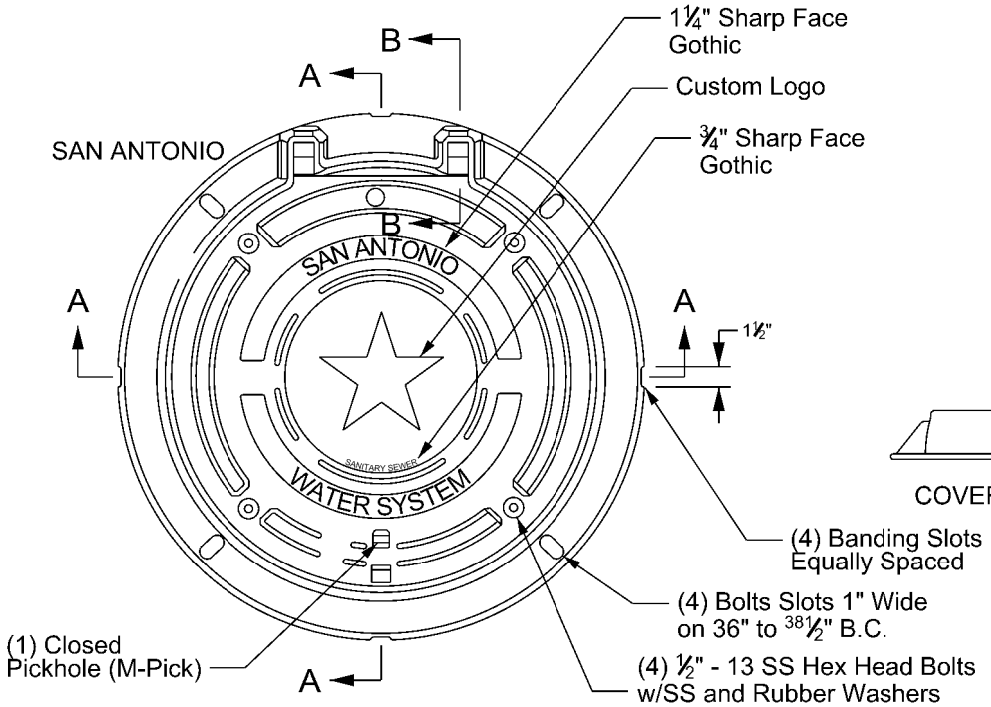
FRAME SECTION A-A

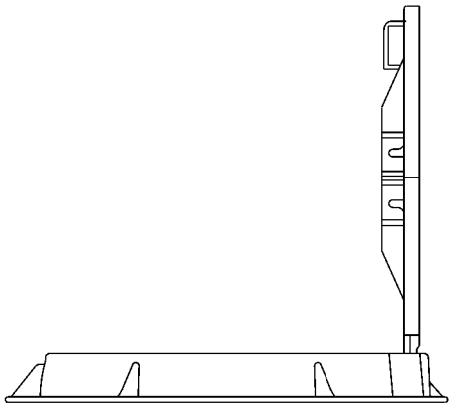


HINGE POSITIONS

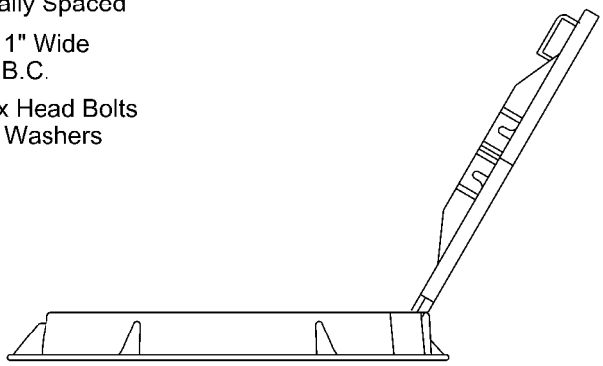
ERGO Assembly

PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	MANHOLE RING AND COVER DETAIL	APPROVED MARCH 2008	REVISED AUG 2019
		DD 852-07	SHEET 2 OF 5

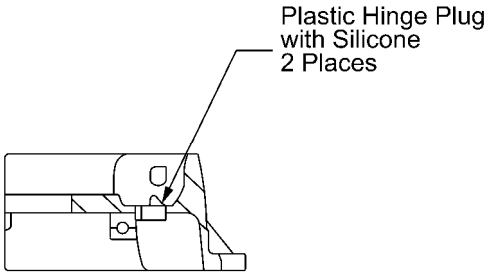




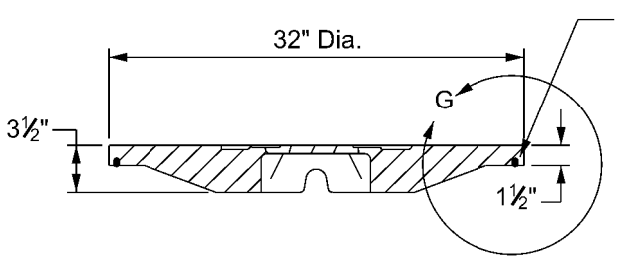
COVER IN 90° LOCKED POSITION

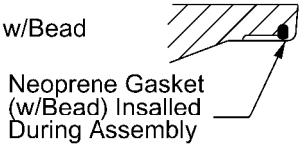


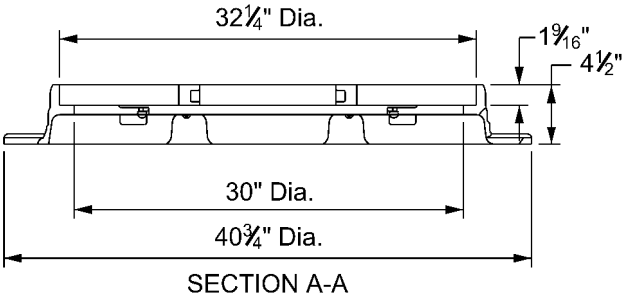
COVER IN 120° RESTING POSITION



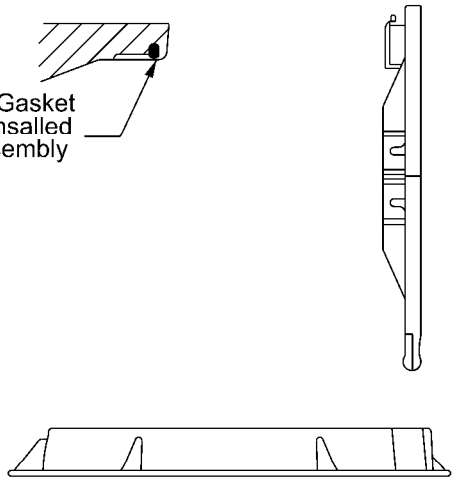
SECTION B-B







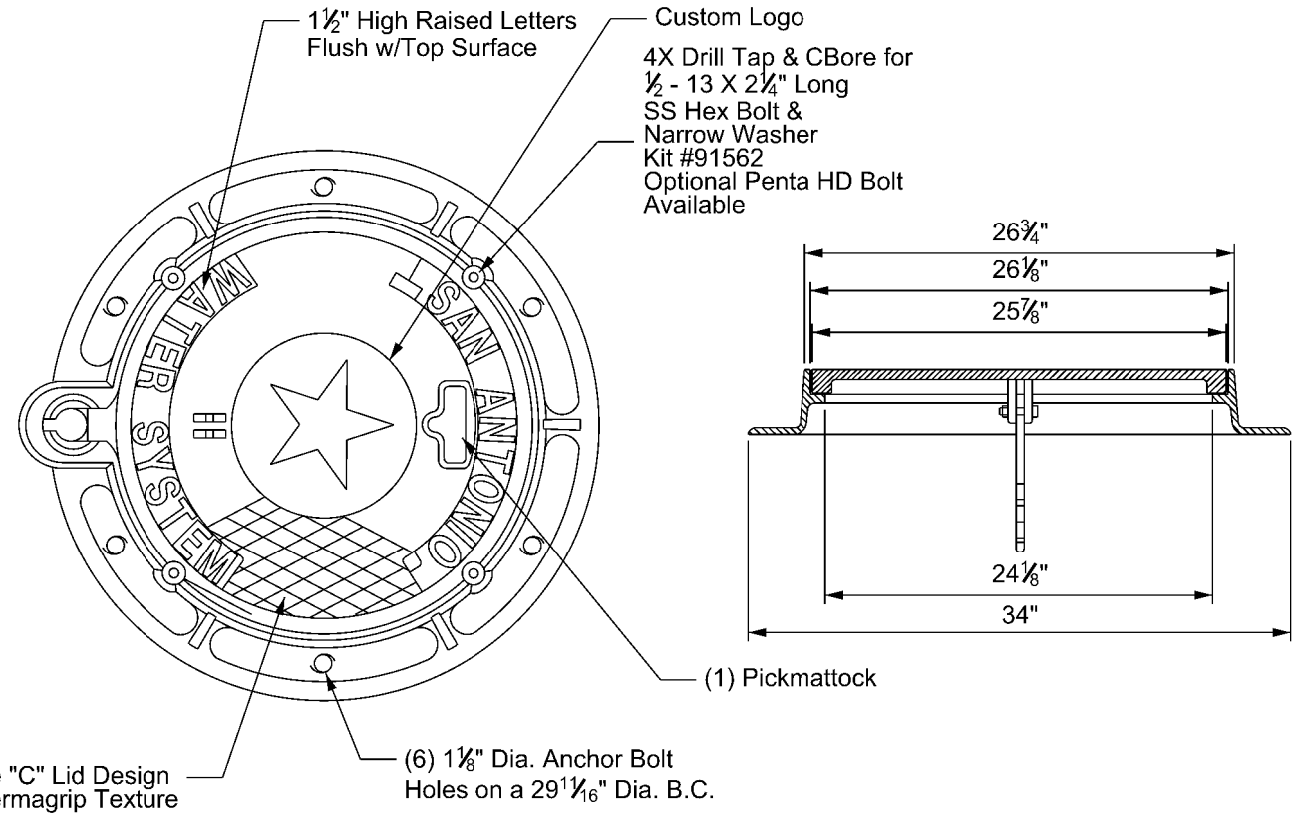
SECTION A-A

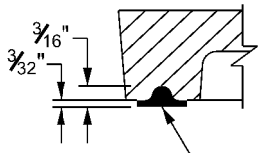


REMOVE LIFT ASSIST BOLT & REMOVE COVER @ 90°

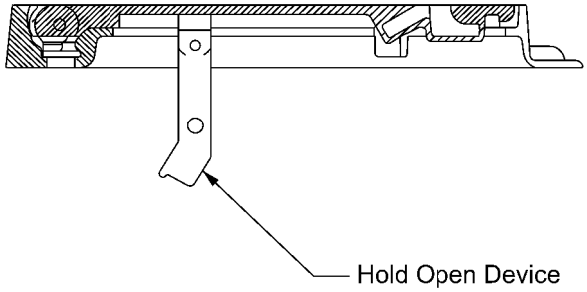
ERGO XL Assembly

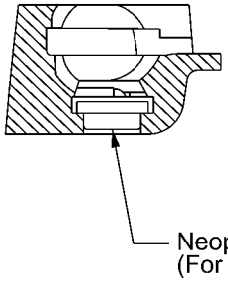
PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	MANHOLE RING AND COVER DETAIL	APPROVED MARCH 2008	REVISED AUG 2019
		DD 852-07	SHEET 3 OF 5





"T-SEAL" GASKET DETAIL

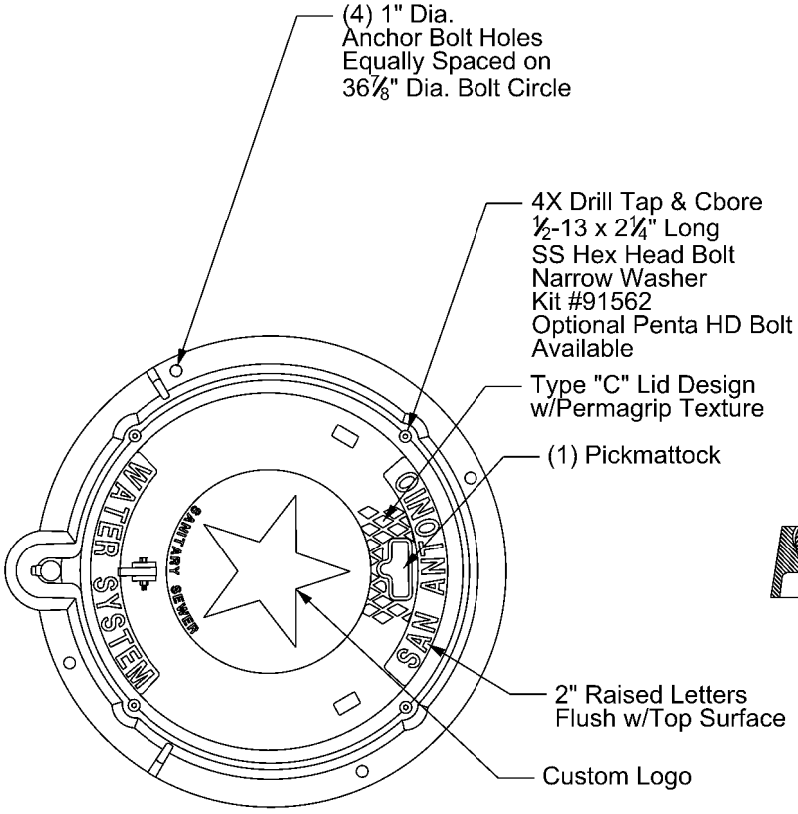


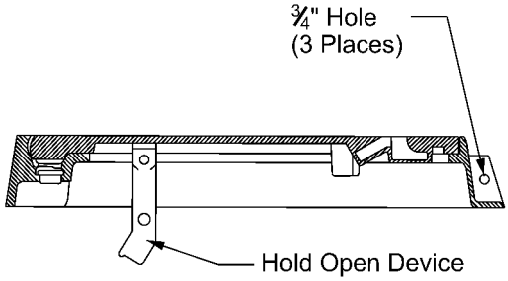


FRAME SHOWING HINGE PLUG

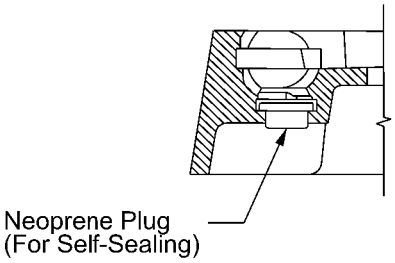
NEENAH FOUNDRY

PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	MANHOLE RING AND COVER DETAIL	APPROVED MARCH 2008	REVISED AUG 2019
		DD 852-07	SHEET 4 OF 5

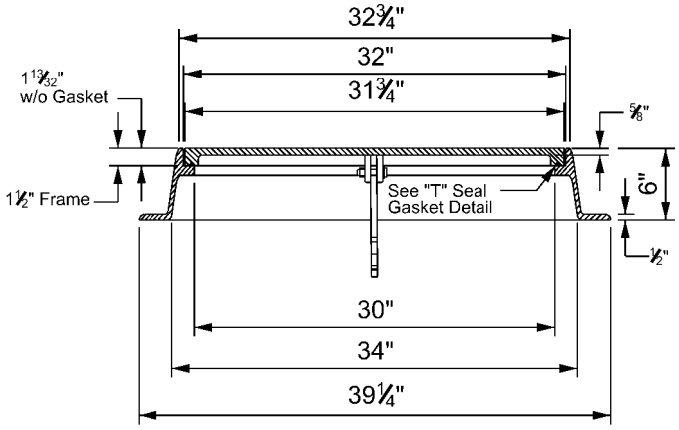




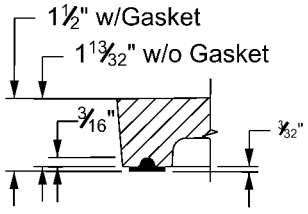
SECTION A - A



FRAME SHOWING
HINGE PLUG



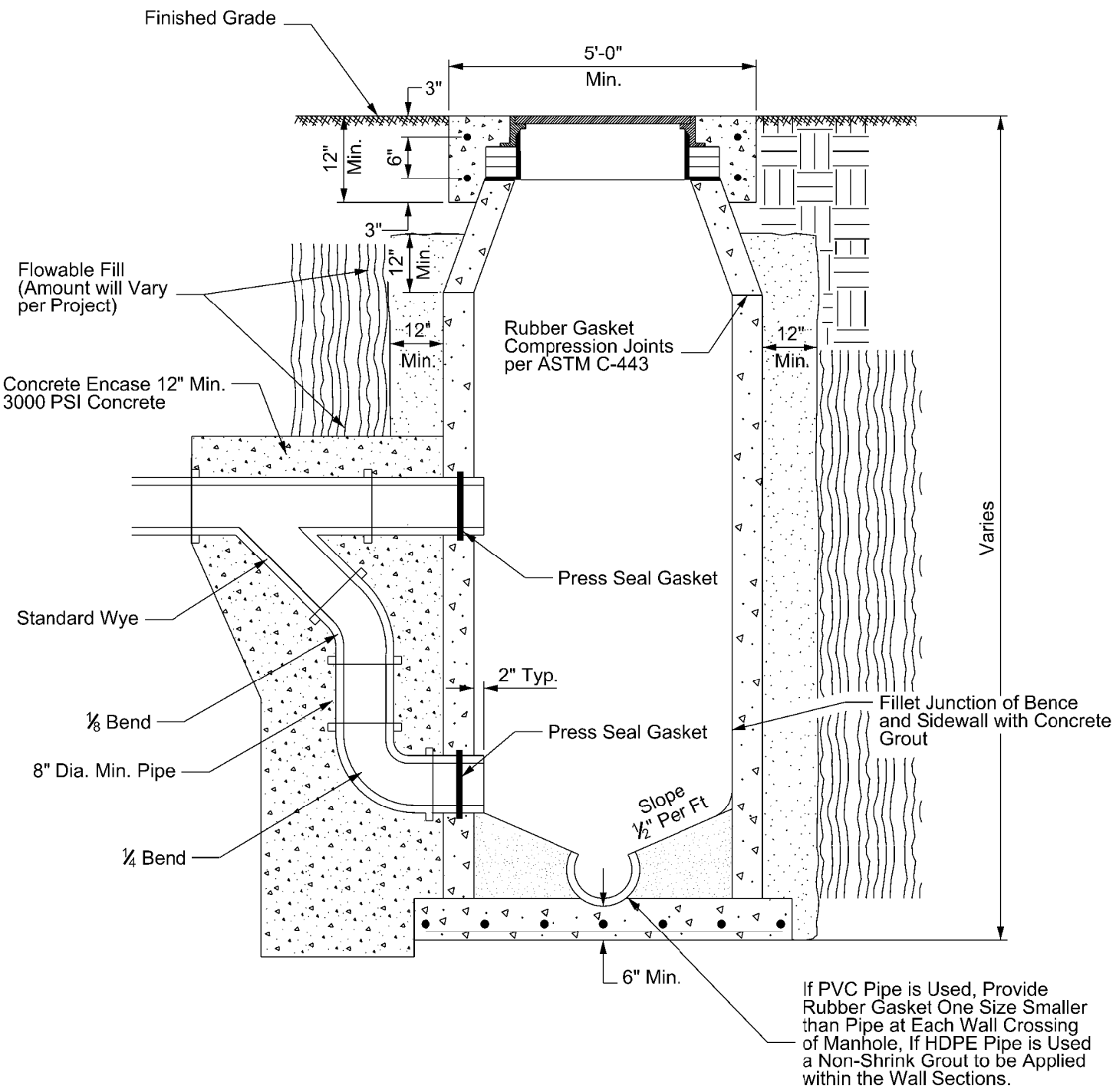
SECTION B - B



"T" SEAL GASKET DETAIL

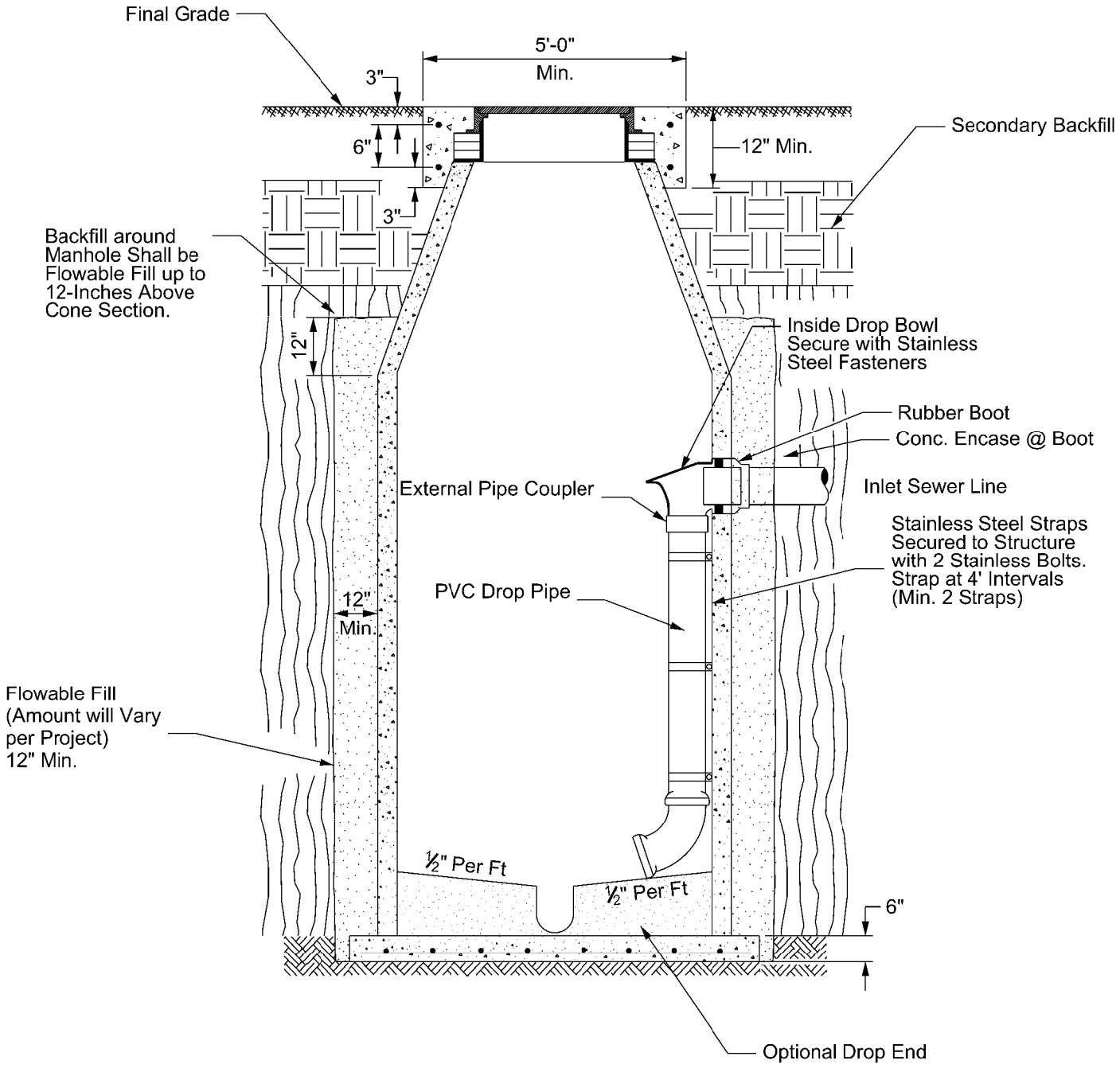
NEENAH FOUNDRY

PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	MANHOLE RING AND COVER DETAIL	APPROVED MARCH 2008	REVISED AUG 2019
		DD 852-07	SHEET 5 OF 5



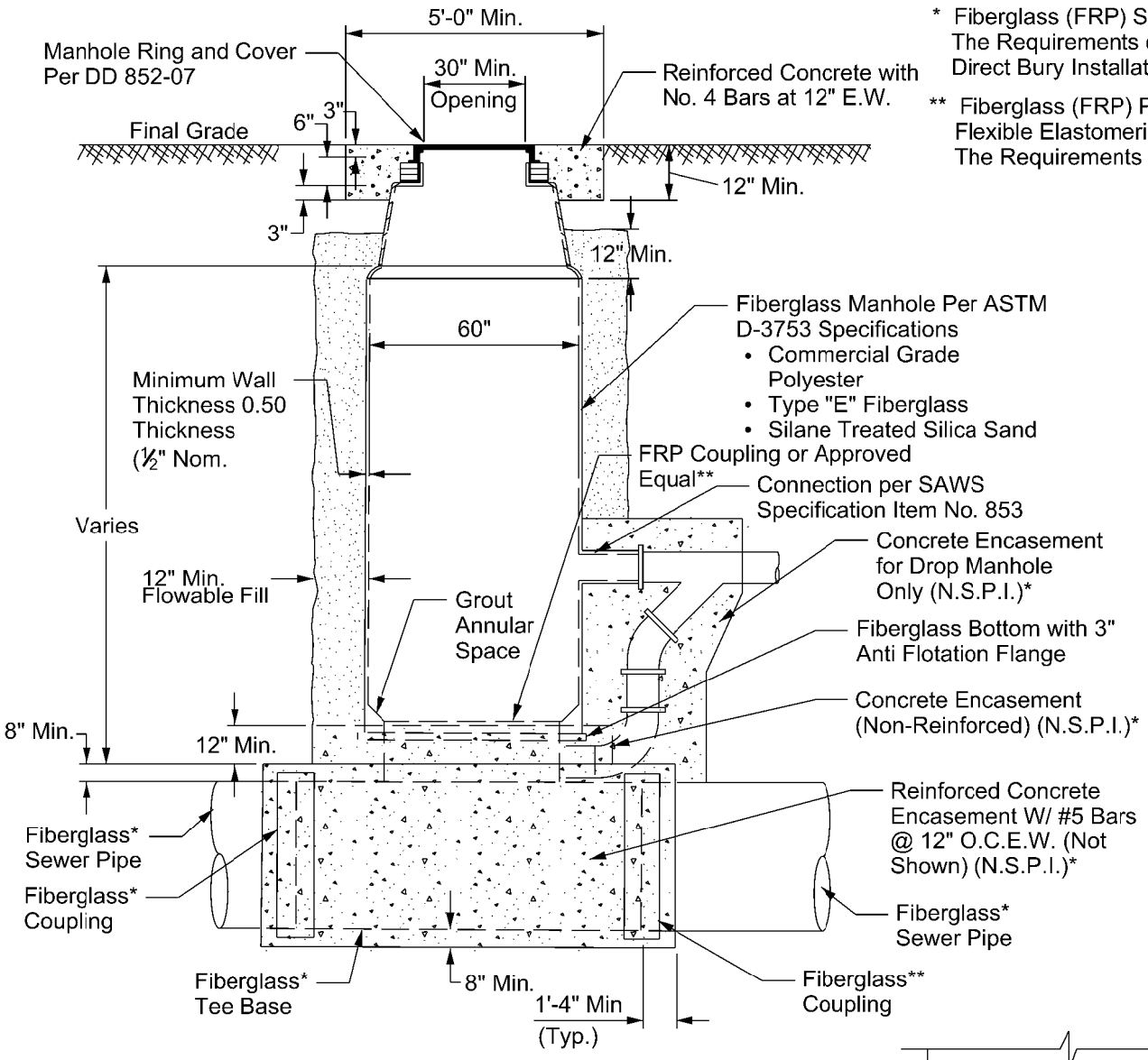
NOTE: Price for Drop Fittings and Encasement to be Included with the Price of Manhole.

PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	DROP MANHOLE DETAIL	APPROVED MARCH 2008	REVISED AUG 2019
		DD-852-08	SHEET 1 OF 1



NOTE:
THIS MANHOLE IS TO BE APPROVED BY SAWS DIRECTOR OF ENGINEERING PRIOR TO CONSTRUCTION.

PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	MANHOLE INSIDE DROP SYSTEM	APPROVED	REVISED
		SEPT 2018	AUG 2019
		DD-852-09	SHEET 1 OF 1



* Fiberglass (FRP) Sewer Pipe Meeting The Requirements of ASTM D3743 for Direct Bury Installation

** Fiberglass (FRP) Pipe Joints Using Flexible Elastomeric Seals Meeting The Requirements of ASTM D4151

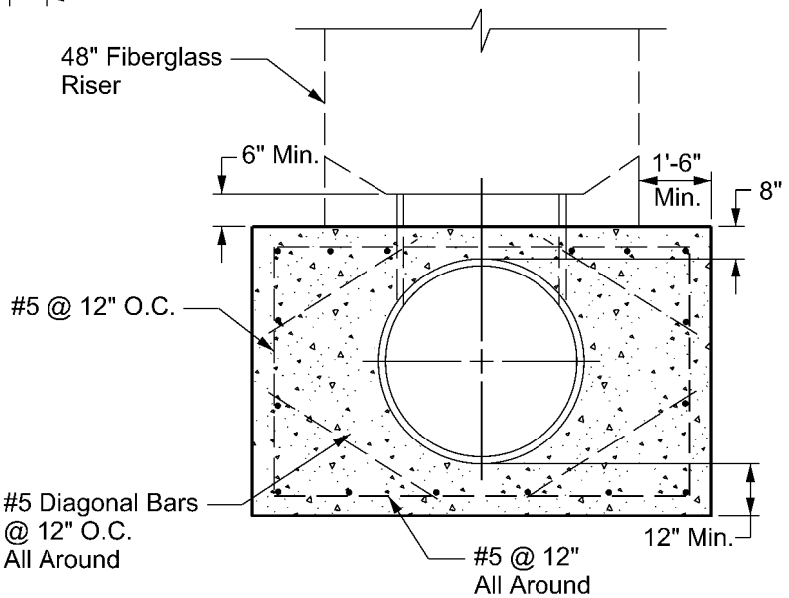
Notes:

1. Encasement to be Designed to Resist all Tee Base Deformations and is to Extend Past the First Joint on Either Side of the Tee Base by 1' to 3'

2. All Concrete Encasement Required for Tee Base Manholes Shall be Considered Incidental to the Cost of the Manholes.

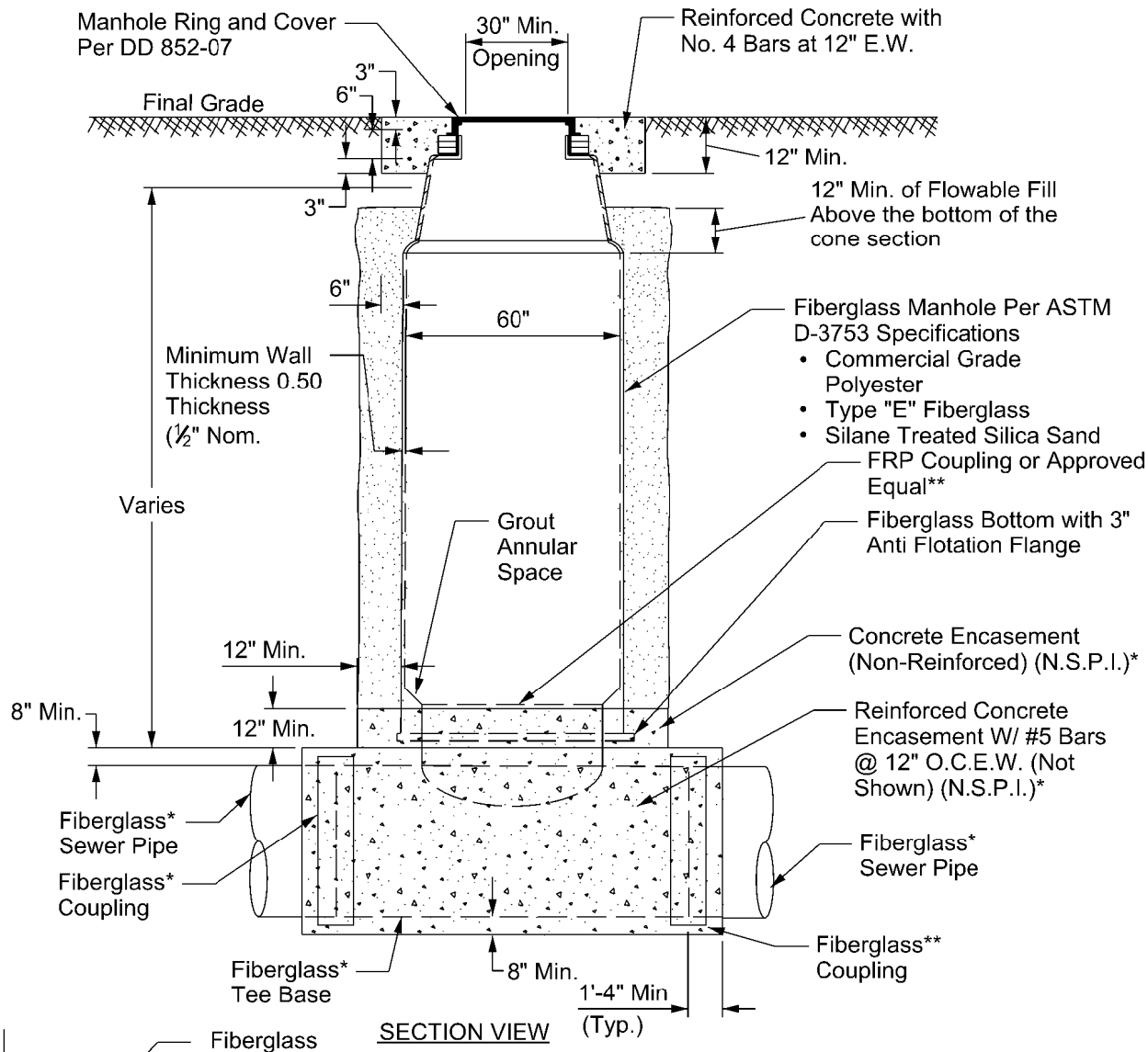
3. Backfill Around Manhole Shall be Flowable (low Strenght) with a Min. Thickness of 12-Inches and Fill Shall be Placed to within 12-Inches of Final Grade. This Cost Shall be Incidental to the Cost of the Manhole.

4. Over Excavation within Areas for Placement of Sanitary Sewer Manholes and Structures Shall be Backfilled Per Detail This Sheet with Regards to Flowable Fill and ASTM D448 Aggregate. This Cost Shall be Incidental to the Cost of the Manhole or Structure.

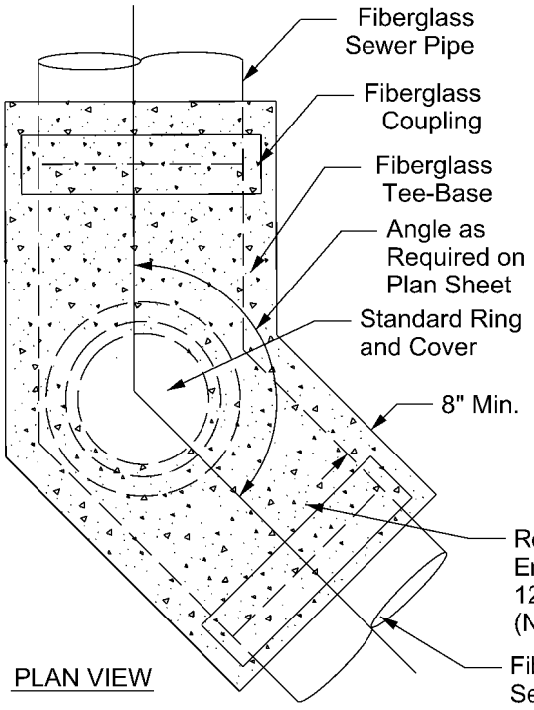


TEE BASE CONCRETE REINFORCEMENT SECTION THROUGH PIPE

PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	TEE-BASE FIBERGLASS DROP MANHOLE	APPROVED AUG 2019	REVISED
		DD-852-10	SHEET 1 OF 1



SECTION VIEW



PLAN VIEW

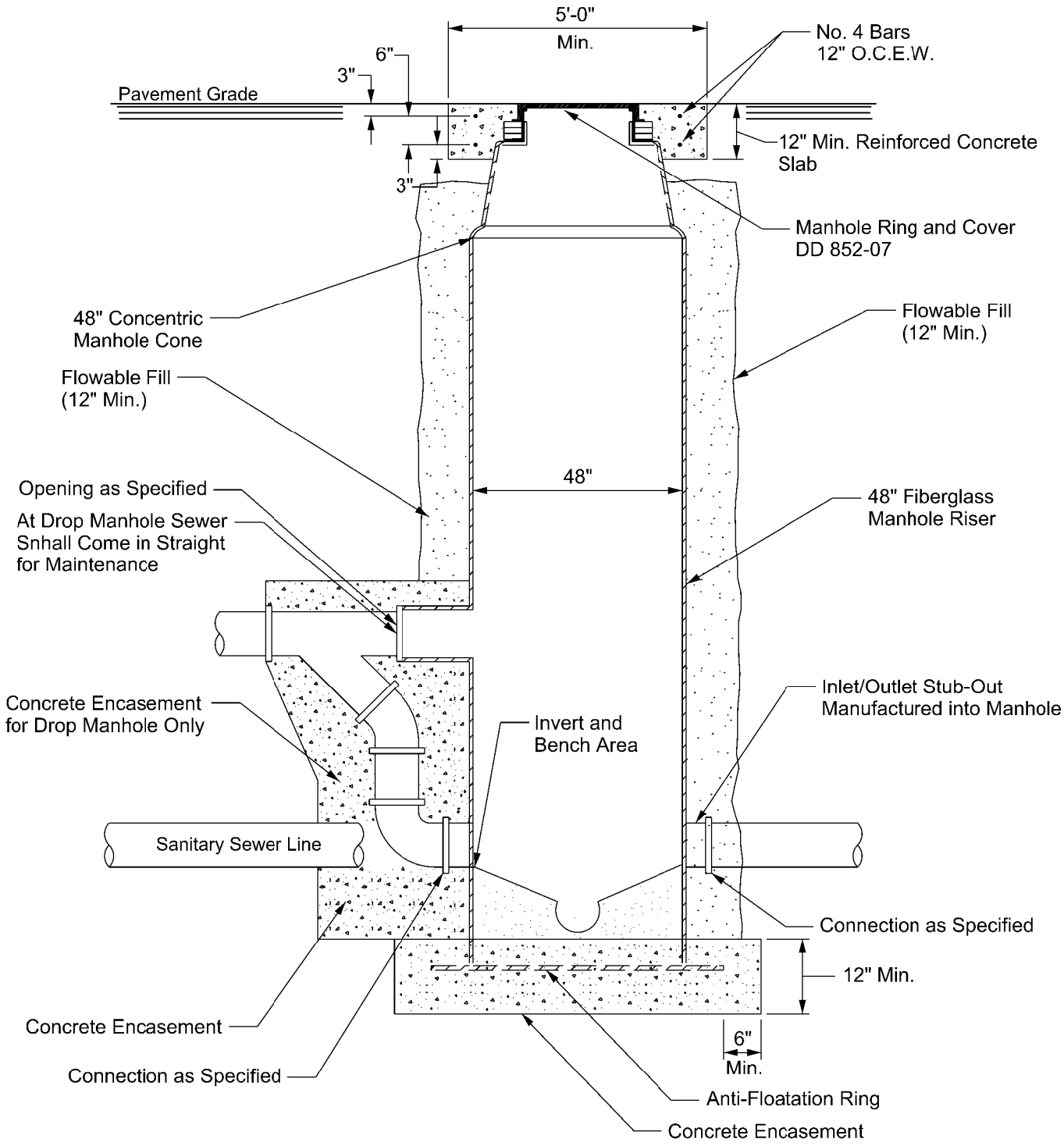
Notes:

1. Encasement to be Designed to Resist all Tee Base Deformations and is to Extend Past the First Joint on Either Side of the Tee Base by 1' to 3'
2. All Concrete Encasement Required for Tee Base Manholes Shall be Considered Incidental to the Cost of the Manholes.
3. Backfill Around Manhole Shall be Flowable with a Min. Thickness of 12-Inches and Fill Shall be Placed to within 12-Inches of Final Grade. This Cost Shall be Incidental to the Cost of the Manhole.
4. Over Excavation within Areas for Placement of Sanitary Sewer Manholes and Structures Shall be Back filled Per Detail This Sheet with Regards to Flowable Fill and ASTM D448 Aggregate. This Cost Shall be Subsidiary to the Cost of the Manhole or Structure.

* Fiberglass (FRP) Sewer Pipe Meeting The Requirements of ASTM D3743 for Direct Bury Installation

** Fiberglass (FRP) Pipe Joints Using Flexible Elastomeric Seals Meeting The Requirements of ASTM D4151

PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	TEE - BASE FIBERGLASS MANHOLE	APPROVED AUG 2019	REVISED
		DD-852-11	SHEET 1 OF 1



PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	TYPICAL FIBERGLASS MANHOLE DETAIL	APPROVED AUG 2019	REVISED
		DD-852-12	SHEET 1 OF 1

ITEM NO. 856

Pipe Jacking

856.1 DESCRIPTION: This item shall govern the furnishing and installation of casing and/or pipe by the method of pipe jacking. Such method to include auger boring, guided boring, pilot pipe jacking, hand mined pipe jacking, and direct pipe jacking as shown in the contract documents and in conformity with this specification. This specification does *not* cover tunneling of any kind such as would involve liner plate or any other method employing a fixed in place liner. This specification does *not* cover microtunneling. All methods not included in this specification require separate special specifications to be developed that are unique to each individual project.

856.2 REFERENCED STANDARDS: Reference standards cited in this Specification Item No. 856 refer to the current reference standard published at the time of the latest revision date.

1. San Antonio Water System (SAWS)
    a. Specification for Water and Sanitary Sewer Construction
    b. SAWS Material Specifications
2. City of San Antonio (COSA)
    a. Utility Excavation Criteria Manual.
    b. Standard Specifications for Construction
3. AASHTO – American Association of State Highway and Transportation Officials
4. American Association of State Highway and Transportation Officials (AASHTO)
5. American Railway Engineering and Maintenance-of-Way Association (AREMA) Manual for Railway Engineering
6. American Society for Testing and Materials (ASTM)
    a. ASTM A 36 - Standard Specifications for Carbon Structural Steel
    b. ASTM A 134 Standard Specification for Pipe, Steel, Electric-Fusion (Arc)-Welded (Sizes NPS 16 and Over)
    c. ASTM A 283 - Standard Specifications for Low and Intermediate Tensile Strength Carbon Steel Plates.
    d. ASTM A 307 - Standard Specifications for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
7. Occupational Safety and Health Administration (OSHA)
8. Design Guidance Document for Pipe Jacking Versus Tunneling Methods

856.3 SUBMITTALS: Contractor shall submit manufacturer's product data, instructions, recommendations, shop drawings, and certifications including, but not limited to, shop drawings identifying proposed pipe jacking method, installation of pits or shafts, installation of jacking supports/back stop, arrangement and position of jacks and pipe guides, runners, casing spacers, and grouting plan.

856.4 MATERIALS:

1. Carrier Pipe: Carrier pipe shall be of the types and sizes shown in the contract documents and shall conform to the requirements of these specifications.
2. If PVC pipe is to be utilized as carrier pipe, installation shall conform to Item Specification No. 818, "PVC (C-900 and C-909) Pipe Installation" and shall be fully restrained in casing.
3. Sanitary sewers, materials shall conform to Specification Item No. 848, "Sanitary Sewers," or as specified in the contract documents by the Engineer, and in accordance with DD-856 of the Standard Drawing Series.
4. Casing Pipe: Casing, if required, shall be as follows for water and sewer mains:
    a. Steel
5. Grout: Grout for annular spaces shall be sand cement slurry containing a minimum of 7 sacks of Portland Cement per cubic yard of slurry.
    a . All slurry shall be plant batched and transit mixed.

856.5 CONSTRUCTION:

1. Pipe Jacking: Suitable pits or trenches shall be excavated for the purpose of jacking operations for placing end joints of the pipe.
    a. When trenches are cut in the side of embankment, such work shall be securely sheeted and braced.
    b. Jacking operations shall in no way interfere with the operation of railroads, streets, highways or other facilities and shall not weaken or damage such facilities.
    c. The pipe to be jacked shall be set on guides to support the section of pipe being jacked and to direct it in the proper line and grade in accordance with submittal.
    d. Embankment material shall be excavated just ahead of the pipe and material removed through the pipe, and the pipe forced through the opening thus provided.
    e. The excavation for the underside of the pipe, for at least ⅓ of the circumference of the pipe, shall conform to the contour and grade of the pipe.
    f. A clearance of not more than 2 inches may be provided for the upper half of the pipe.
    g. The distance that the excavation shall extend beyond the end of the pipe shall depend on the character of the material, but it shall not exceed 2 feet in any case.
    h. The pipe shall be jacked from the downstream end.
    i. Permissible lateral or vertical variation in the final position of the pipe from line and grade will be as shown in the contract documents or as determined by the Engineer.
    j. Any pipe that cannot be repaired to its original condition or is damaged in jacking operations shall be removed and replaced at the Contractor's expense. Jacking pits shall be backfilled immediately upon completion of jacking operations.
    k. Boring operations may include a pilot hole which shall be bored the entire length of crossing and shall be used as a guide for the larger hole to be bored. Water or drilling fluid may be used to lubricate cuttings.
2. Joints: Joints for pipe for Pipe Jacking shall be as specified in Specification Item No. 848, "Sanitary Sewers," Specification Item No. 857 "Fiberglass Reinforced Pipe for

Large Diameter Gravity Sanitary Sewer," Specification Item No. 816 "Steel Pipe Installation," or Specification Item No. 820 "Concrete Steel Cylinder Pipe Installation" or as shown in the contract documents, shop drawings, or as per additional pipe manufacturer's recommendations.

3. Grouting of Casing and/or Direct Jack Pipe: The annular space between casing pipe or direct jack pipe and limits of excavation (borehole) shall be pressure grouted unless otherwise specified in the contract documents.
4. Grouting of Annular Space between Casing and Carrier Pipe: For sewer pipe, the annular space between casing and carrier pipe shall be pressure grouted unless otherwise specified in the contract documents.

856.6 MEASUREMENT: Pipe Jacking shall be measured by the linear foot of bore as measured from face to face of jacking pits.

1. Carrier pipe used in bores or jacked into place shall be measured by the linear foot of pipe installed from end to end of pipe to the limits shown on the plans.
2. Casings, where required by the plans, of the size and material required shall be measured by the linear foot actually installed in accordance with the plans.

856.7 PAYMENT: The work performed and materials furnished as specified herein, measured as provided above, shall be paid for at the contract unit bid price per linear foot of pipe jacking which price shall be full compensation for furnishing all materials including carrier pipe and casings (as indicated for each appropriate bid item listed below), casing spacers, grout, labor, tools, equipment and incidentals necessary to complete the work, including excavation, grouting, backfilling, restoration to original ground conditions, end caps, and disposal of surplus materials.

1. Carrier pipe shall be paid for at the contract unit price bid for "Carrier Pipe for Pipe Jacking" per linear foot of pipe installed and measured as described above.
2. Casings shall be paid for at the contract unit price bid for "Casing" per linear foot of casing installed and measured as described above.

-End of Specification-

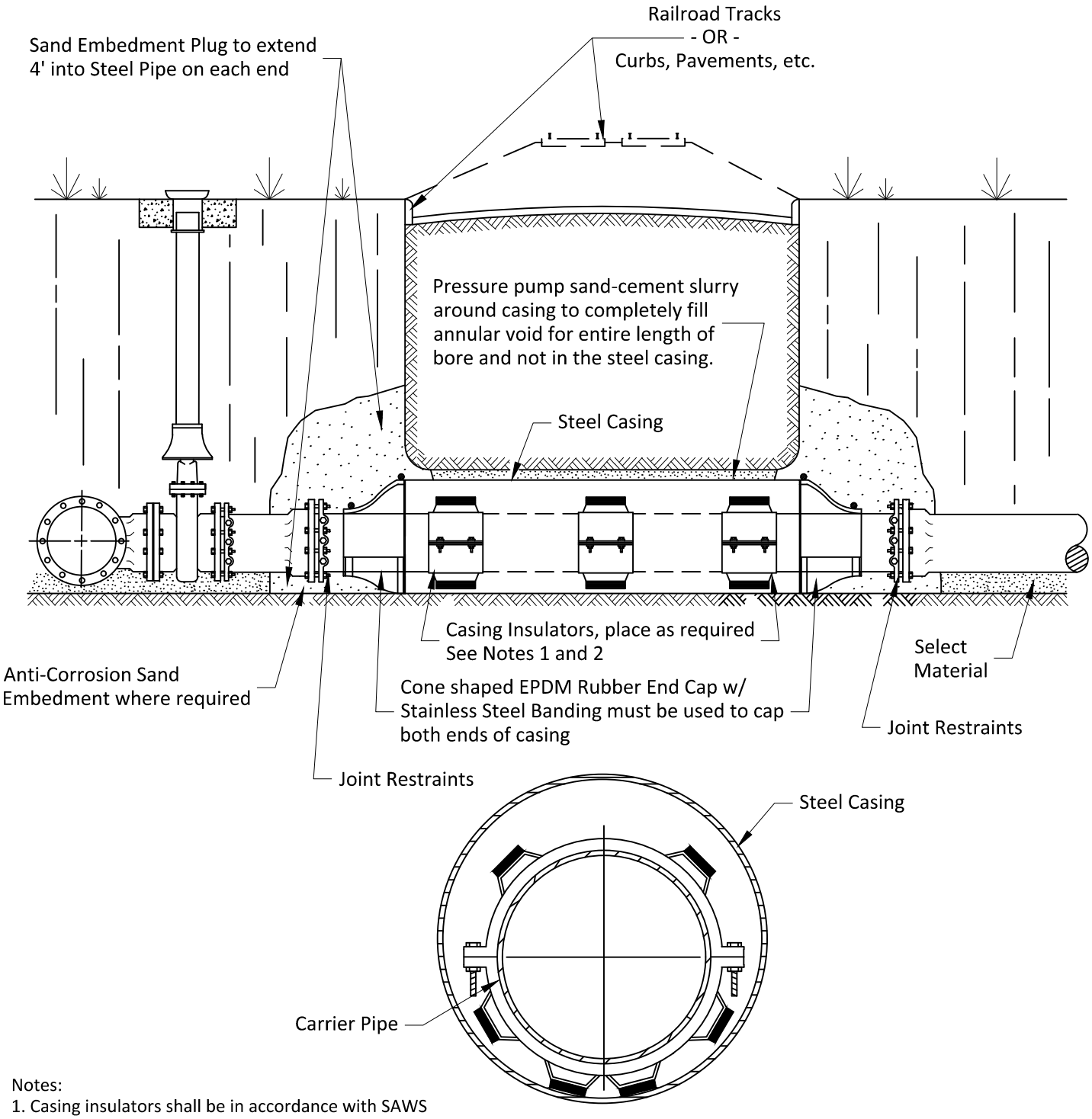
All requirements in the tables below are minimum requirements that apply unless otherwise specified in the contract documents. The engineer of record for each project is responsible for determining the appropriate requirements suitable to each instance and, if more stringent than the minimums stated herein or involving larger diameter pipe and/or casing, shall present such requirements in the contract documents.

Casing Minimum Requirements - General			
Water Main Diameter (Inches)	Nominal Steel Casing Diameter (Inches)	Steel Casing Thickness (Inches)	Steel Casing Weight (Pounds per Foot)
6	18	0.375	70.59
8	24	0.375	94.62
12	24	0.375	94.62
16	30	0.375	118.65
20	36	0.438	166.19
24	42	0.438	194.02
30	48	0.500	259.02
36	54	0.500	291.07

Casing Minimum Requirements - Under Railroad		
Nominal Steel Casing Diameter (Inches)	Steel Casing Thickness (Inches)	Steel Casing Weight (Pounds per Foot)
18	0.375	70.59
24	0.438	110.22
30	0.500	157.53
36	0.562	212.70
42	0.625	276.18
48	0.625	316.53

Railroad notes:

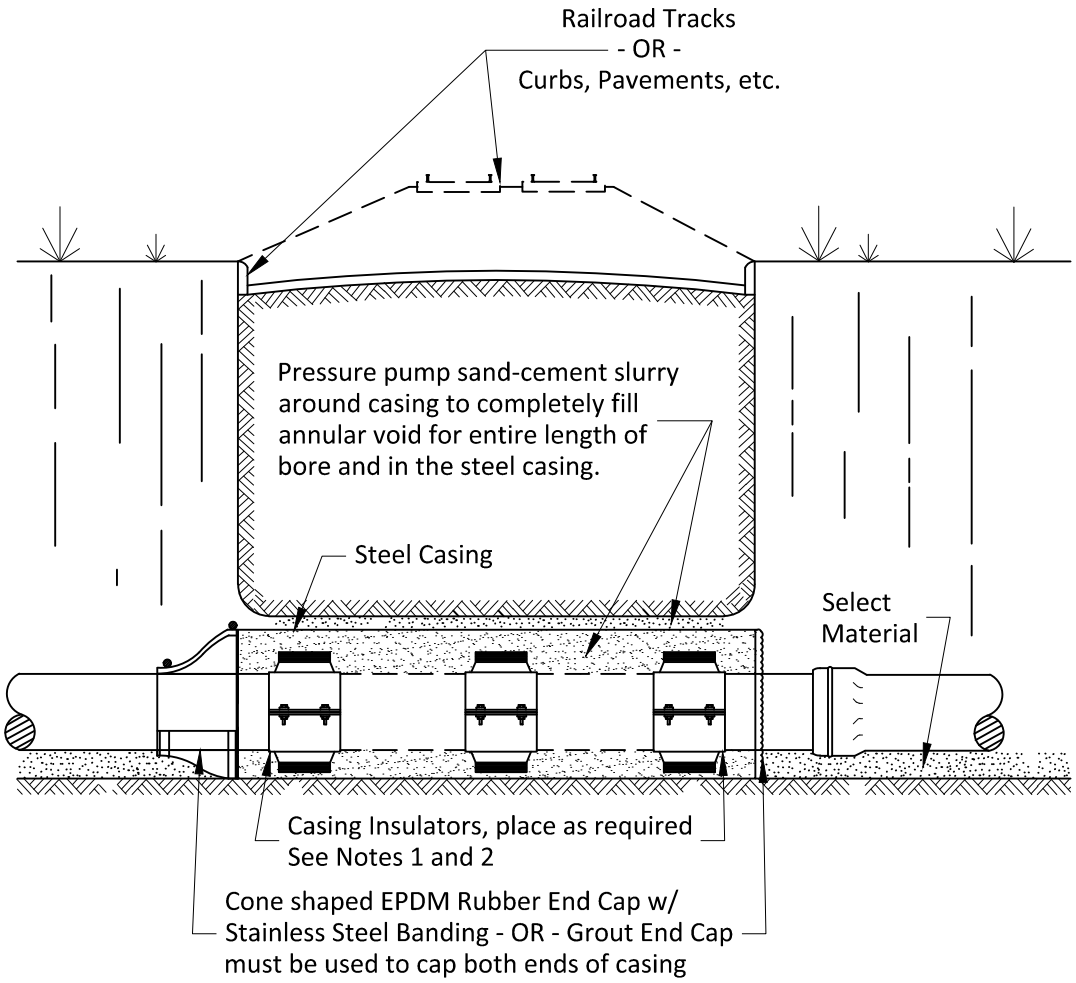
1. Steel casing shall have a minimum yield strength of 35,000 pounds per square inch.
2. Casing pipes larger than 48” diameter or with any portion deeper than 20' shall be submitted to chief engineer of the railroad for approval.

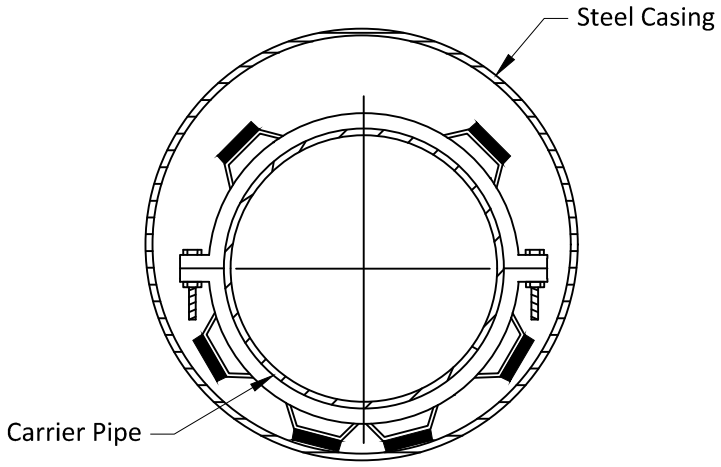


CARRIER PIPE IN CASING

Notes:
1. Casing insulators shall be in accordance with SAWS Standard Material Specification 05-31
2. The number of runners, configuration, and spacing of casing insulators shall comply with manufacturer's stated specifications in approved submittal.
3. Fittings shall be paid for by separate payment item.
4. Joint restraints shall be approved, as specified in SAWS Standard Material Specification 95-10
5. All joints within casing shall be restrained unless otherwise specified in the contract documents.

PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	INSTALLATION OF WATER PIPE IN CASING WITH JOINT RESTRAINTS	APPROVED	REVISED
		March 2008	November 2019
		DD-856-02	SHEET 1 OF 1





CARRIER PIPE IN CASING

Notes:
1. Casing insulators shall be in accordance with SAWS Standard Material Specification 05-31

2. The number of runners, configuration, and spacing of casing insulators shall comply with manufacturer's stated specifications in approved submittal.

PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	INSTALLATION OF SEWER PIPE IN CASING	APPROVED March 2008	REVISED November 2019
		DD-856-03	SHEET 1 OF 1

ITEM 866

Sanitary Sewer Main Television Inspection

866.1 DESCRIPTION: The Contractor shall furnish all labor, materials, equipment, and incidentals to provide the televising and a NASSCO-(PACP) compliant standard video, recorded in MPEG-4 (MP4) format. In accordance with NASSCO PACP requirements, all inspections shall be conducted by a NASSCO certified CCTV operator and shall include respective certification number on each video and a NASSCO PACP database shall be submitted and uploaded onto SAWS Contract and Project Management System (CPMS) or SAWS most current program management system. All digital video files shall be color, closed-circuit TV in MPEG-4 (MP4) format. The video shall include an inclinometer, visible on the video being viewed, noting the slope of the main being televised. The Contractor shall provide inclination reports detailing the inclinometer data found in the main being televised. The Contractor shall provide all inspection data of mains and manholes written to a single storage device. The video Contractor maybe required to televise both pre and post project.

866.2 REFERENCED STANDARDS: Reference standards cited in the Specification Item No. 866 refer to the current reference standard published at the time of the latest revision date.

1. San Antonio Water System (SAWS):
    a. Specifications for Water and Sanitary Sewer Construction
    b. SAWS Materials Specifications
2. COSA – City of San Antonio:
    a. Utility Excavation Criteria Manual.
    b. City of San Antonio (COSA) Specifications for Construction
3. Texas Commission of Environmental Quality (TCEQ)
    a. Chapter 217 Design Criteria for Domestic Wastewater Systems
    b. Chapter 213 (“Edwards Aquifer Recharge Zone”)
4. National Association of Sewer Service Companies
    a. Pipe Condition Assessment Using CCTV Performance Specification Guideline

866.3 SUBMITTALS: All submittals shall be in accordance with most recent version of SAWS’s General Conditions requirements. Submit the following prior to performing any work.

1. Certifications: Per General Conditions section 5.12.2 all Contractor submittals for all pipe and other products or materials furnished under this specification shall be marked as reviewed and approved by Contractor for compliance with Contract Documents and the referenced standards
2. Contractor is to coordinate the video procedures with the Inspector prior to commencement of any work, including mobilization and preparation of right-of-way effort.
3. The Contractor is to provide the televising and a NASSCO-(PACP) compliant standard video, recorded in MPEG-4 (MP4) format.
4. All inspections shall be conducted by a NASSCO certified CCTV operator and

shall include respective certification number on each video in accordance with NASSCO PACP requirements.

5. Video shall be submitted and uploaded onto SAWS CPMS or SAWS most current program management system. Video must include all the televised segments for the entire project, or for each worksite.
6. Log of the televised system for review shall be uploaded for review and approval by the Engineer.
7. Contractor to provide a post construction video upon request.
8. Contractor is to coordinate the video procedures with the Inspector at completion of project, prior to close out.
9. The Contractor shall provide a line diagram area sketch and written log for each completed segment of videoed sewer main describing the section being televised, flow and camera direction, position of service connections, description and location of failures, pipe condition, weather conditions, and other significant observations.
10. Video shall include an inclinometer, visible on the video being viewed, noting the slope of the main being televised.
11. The Contractor shall provide a graphed report of the inclinometer data gathered for each completed segment of videoed sewer main.

866.4 EXECUTION: Before construction of the sanitary sewer main, the main shall be televised to locate laterals, observe existing conditions and immediately upon cleaning or clearing existing main. After completion of the work specified in the contract documents, and prior to placement of the final course of asphalt or other final surface, the newly constructed or rehabilitated sanitary sewer main shall be televised immediately upon cleaning.

1. Equipment:
   a. The television unit shall have the capability of displaying in color, on the video, pipe inspection observations such as pipe defects, sags, and points of root intrusion, offset joints, service connection locations, and any other relevant physical attributes.
      i. Each video shall be permanently labeled with the following:
      ii. Project name / SAWS Job # / Work Order #;
      iii. Date of television inspection;
      iv. Station to station location and size of sanitary sewer;
      v. Street/easement location;
      vi. Name of Contractor;
      vii. Date video submitted;
      viii. Video number;
      ix. SAWS Inspector Name.
   b. The television inspection equipment shall have an accurate footage counter which displays on the monitor the exact distance of the camera from the center of the starting manhole.
   c. A camera with rotating and panning lens capabilities is required.
   d. The camera height shall be centered in the conduit being televised.
   e. The speed of the camera through the conduit shall not exceed 40 feet per

minute.

f. The produced video shall also have an inclinometer that displays the slope of the sewer main being televised.

g. The Contractor shall be required to have all materials, equipment, and labor force necessary to complete all videotaping on the job site prior to isolating the sewer manhole segment and beginning videotaping operations.

2. Televising shall be observed by the Inspector or Engineer and Contractor, as the camera is run through the system.
3. Any abnormalities such as, but not limited to, misaligned joints, cracked/defected pipe, rolled gaskets, shall be repaired by the Contractor solely at his expense.
4. Sections requiring repair shall be re-televised from manhole to manhole to verify condition of repair.
5. If the Contractor provides a video of such poor quality that it cannot be properly evaluated, the Contractor shall re-televise as necessary and provide a video of good quality at no additional cost to SAWS.
6. If the Contractor cannot provide a video of such good quality that can be reviewed by SAWS, SAWS may elect to televise the line at the Contractor's expense.
7. Television inspection shall be done one section between two manholes at a time.
8. Flow in the section being televised shall be bypassed if the line is in service and the flow exceeds 25% of the internal pipe diameter.
9. When the depth of flow at the upstream manhole of the manhole section being worked is above the maximum allowable for television inspection, the flow can be reduced to allowable levels by performing bypass pumping, as approved by the Inspector.
10. The Contractor shall not be allowed to float the camera.
11. There may be occasions during the televised inspection of a manhole section when the camera will be unable to pass an obstruction.
    a. At that time, and prior to proceeding, the Contractor shall contact the Inspector.
    b. If the length of sewer main cannot be televised because of obstructions, the Contractor shall clean the system as is necessary.
    c. If, in the opinion of the Inspector, the obstruction is attributed to a collapsed main or pipe deflection, televising shall be suspended, payment shall be made based on the actual televised length, and the remaining televising of the sewer line shall be continued upon successful correction of the blockage by the Contractor at his expense.
    d. No additional payment shall be made for additional setups required due to obstructions encountered during televising.
12. No lateral connections shall be made to the sanitary sewer main at the “12 o’clock” position.
13. All lateral connections shall clearly indicate which side of the sanitary sewer main it was installed from.
14. The Contractor is solely responsible for any damage of sewer mains as a direct result of televising operations.
15. Any repair shall also be the responsibility of the Contractor.
16. The method(s) used for securing passage of the camera are at the discretion of the Contractor, and as approved by the Inspector.
17. No sanitary sewer main televising effort shall commence until all pertinent permits

or required approvals have been obtained by SAWS.

18. No separate and/or additional payment will be made for any excavation, man entry, or any other method which may be required to retrieve video equipment that may have been hung up, destroyed, and/or lost during the operation.
19. Bypass Pumping:
    a. The Contractor shall perform bypass pumping operations in accordance with Specification Item No. 864, "Large Diameter Bypass Pumping," or Specification Item No. 865 “Small Diameter Bypass Pumping”.
    b. The Contractor shall furnish all labor, supervision, tools, equipment, appliances, and materials to perform all operations in connection with bypass pumping of sewage flow for the purpose of preventing interference with the televising of the sanitary sewer manholes and mainlines as well as providing reliable sewer service to the occupants of the buildings being served.
    c. The Contractor will be required to provide adequate pumping equipment and force mains in order to maintain reliable sanitary sewer service in all mains involved in the scope of the work.
    d. Under no circumstances shall the flow be interrupted or stopped, such that damage is done to either private or public property, or sewage flows/overflows into a storm sewer or natural waterway.
    e. The Contractor shall provide bypass pumping of sewage around each segment(s) of main that is to be televised and shall be responsible for all required bulkheads, pumps, equipment, piping, and other related appurtenances to accomplish the sequence of pumping.
    f. The Contractor shall be required to have all materials, equipment, and labor necessary to complete the repair or replacement on the jobsite prior to isolating the sewer manhole or line segment and beginning bypass pumping operations.
    g. The Contractor shall locate bypass pumping suction and discharge lines so as to not cause undue interference with the use of streets, private driveways, and alleys to include the possible temporary trenching of force mains at critical intersections.
    h. Traffic management shall be done under the approval of respective SAWS, City, County, or State Traffic, Barricade, and Signalization Departments.
    i. The Contractor shall not initiate any effort to accommodate bypass pumping piping operations until specific written approval is given.
    j. The Contractor shall coordinate with all property owners to ensure that no damage will be caused to their property during any and all sewer rehabilitation work.
    k. The Contractor shall complete the televising as quickly as possible and shall satisfactorily meet all requirements prior to discontinuing bypass pumping operations and returning flow to the sewer manhole or main segment.
    l. The Contractor shall ensure that no damage will be caused to private property as a result of bypass pumping operations. Ingress and egress to adjacent properties shall be maintained at all times.
    m. Ramps, steel plates, or other methods shall be employed by the Contractor to facilitate traffic over surface piping.

n. Pre-televising of sanitary sewer lines will be required prior to rehabilitating lines.

866.5 SETTLEMENT TESTING: Settlement testing shall be performed in accordance with Specification Item No. 849 “Sanitary Sewer Testing.”

866.6 PAYMENT: Payment will be made for the work to be done for pre and post television inspection on the basis of the unit bid price per linear foot of pipe diameters 8" through 15’’, 18" through 24’’, and 27’’ larger shall be considered full compensation for all labor, materials, settlement test, equipment, tools, logging, cleaning, by pass pumping and incidentals necessary to complete the work, as illustrated below:

a. 8" through 15"
b. 18" through 24"
c. 27" and larger

1. No additional compensation shall be provided for all needed repairs, re-cleaning, or re-televising effort.
2. There will be no separate pay item for this work for bypass pumping associated with this work.
3. There will be no separate pay item for ramps, steel plates, or other methods be employed by the Contractor to facilitate traffic over surface piping.

-End of Specification-

ITEM NO. 868

Sanitary Sewer System Cleaning

868.1 DESCRIPTION: This item shall govern cleaning the sanitary sewer system. The Contractor shall furnish all labor, equipment, and materials necessary for cleaning the sanitary sewer system, including the removal of all debris/solids, sand, grease, grit, rock, etc. from the sewer mains, manholes, or structures to facilitate television inspection.

868.2 REFERENCED STANDARDS: Reference standards cited in this Specification Item NO. 868 refer to the current reference standard published at the time of the latest revision date.

1. San Antonio Water System (SAWS):
    a. Specifications for Water and Sanitary Sewer Construction
    b. SAWS Materials Specifications
2. COSA – City of San Antonio:
    a. Utility Excavation Criteria Manual.
    b. City of San Antonio (COSA) Specifications for Construction
3. Texas Commission of Environmental Quality (TCEQ)
    a. Chapter 217 Design Criteria for Domestic Wastewater Systems
    b. Chapter 213 (“Edwards Aquifer Recharge Zone”)
4. National Association of Sewer Service Companies
    a. Sewer Pipe Cleaning Specification Guideline

868.3 SUBMITTALS: Submit equipment manufacturer’s operational manuals and guidelines to the Inspector for review.

1. Submit a list of lawful disposal sites proposed for dumping debris from cleaning operations.
2. Submit and maintain Liquid Waste Manifests conforming to City of San Antonio requirements.
3. Send the SAWS copies of the completed manifests to the Inspector within 24 hours after disposal of waste materials.

868.4 CONSTRUCTION: The Contractor shall be required to have all materials, equipment, and labor necessary to complete the cleaning of the sanitary sewer system on the jobsite prior to isolating it for the cleaning process.

1. The Contractor shall only use the type of cleaning identified below to perform the necessary removal of all material which will not create hazards to health, property, affect downstream treatment plant processes, or damage to the sanitary sewer system.
2. The sanitary sewer mains, manholes, and structures shall be cleaned using mechanical, hydraulically-propelled, and/or high velocity sewer cleaning equipment.
3. The cleaning process shall remove all debris, grease, sand, silts, solids, rags, rock, etc. from each sewer segment, including the manhole(s) or structures.
4. Selection of cleaning equipment and the method for cleaning shall be based on the condition of the sanitary sewer lines at the time work commences and will be subject to SAWS' pre-approval.

5. All cleaning equipment and devices shall be operated by experienced personnel. Satisfactory precautions shall be taken to protect the sanitary sewer lines, manholes, or structures from damage that might be inflicted by the improper use of the cleaning process or equipment.
6. Any damages done to a sewer line manhole, or structure by the Contractor shall be repaired by the Contractor at no additional cost and to the satisfaction of SAWS.
7. Cleaning shall also include the manhole or structure wall washing by a high pressure water jet.
8. Hydraulic-propelled devices which require a head of water to operate must utilize a collapsible dam.
9. The dam must be easily collapsible to prevent damage to the sewer line, property, etc.
10. When using hydraulically-propelled devices, precautions shall be taken to insure that the water pressure created does not cause damage or flood public or private property.
11. The Contractor shall not increase the hydraulic gradient of the sanitary sewers beyond the elevation that could cause overflow of sewage into area waterways or laterals.
12. The flow of wastewater present in the sanitary sewer line shall be utilized to provide necessary fluid for hydraulic cleaning devices whenever possible.
13. Cleaning equipment that uses a high velocity water jet for removing all debris shall be capable of producing a minimum volume of 50 gpm, with a pressure of 1,500 psi, for the sanitary sewer main and 3,500 psi for the (manhole) structure at the pump.
14. Any variations to this pumping rate must be pre-approved by the Inspector.
15. To prevent damage to older sewer lines and property, a pressure less than 1,500 psi can be used.
16. A working pressure gauge shall be used on the discharge of all high pressure water pumps.
17. The Contractor shall use, in addition to conventional nozzles, a nozzle which directs the cleaning force to the bottom of the pipe for sewers 18" and larger in diameter. The Contractor shall operate the equipment so that the pressurized nozzle continues to move at all times.
18. The pressurized nozzle shall be turned off or reduced anytime the hose is on hold or delayed in order to prevent damage to the line.
19. Mechanical cleaning, in addition to normal cleaning when required, shall be with approved equipment and accessories driven by power winching devices.
20. The Contractor shall submit the equipment manufacturer's operational manual and guidelines to the Inspector, which shall be followed strictly unless modified by the Inspector.
21. All equipment and devices shall be operated by experienced operators so that they do not damage the pipe in the process of cleaning. Buckets, scrapers, scooters, porcupines, kites, heavy duty brushes, and other debris-removing equipment/accessories shall be used as appropriate and necessary in the field, in conjunction with the approved power machines.
22. The use of cleaning devices such as rods, metal pigs, porcupines, root saws, snakes,

scooters, sewer balls, kites, and other approved equipment, in conjunction with hand winching device, and/or gas, electric rod propelled devices, shall be considered normal cleaning equipment.

23. In addition to the requirements specified herein, the Contractor shall maintain a clean work area and surrounding premises within the work limits so as to comply with Federal, State, and local environmental and anti-pollution laws, ordinances, codes, and regulations when cleaning and disposing of waste materials, debris, and rubbish.
24. The Contractor shall also keep the work and surrounding premises within work limits free of accumulations of dirt, dust, waste materials, debris, and rubbish.
25. Suitable containers for storage of waste materials, debris, and rubbish shall be provided until time of disposal. It is the sole responsibility of the Contractor to secure a licensed legal dump site for the disposal of this material.
26. Under no circumstances shall sewage or solids removed from the main or manhole be dumped on the ground, streets, ditches, catch basins, storm drains, or sanitary sewers. Cost for this item shall be included in the price bid for sanitary sewer system cleaning.
27. The Contractor may be required to demonstrate the performance capabilities of the cleaning equipment proposed for use on the project. If the results obtained by the proposed sanitary sewer system cleaning equipment are not satisfactory to the Inspector, the Contractor shall use different equipment and/or attachments, as required, to meet the requirements of the contract documents. More than one type of equipment/attachments may be required at any given location within the project scope.
28. When hydraulic or high velocity cleaning equipment is used, a suitable sand trap, weir, dam, or suction shall be constructed in the downstream manhole in such a manner that all the solids and debris are trapped for removal.
29. Whenever hydraulically-propelled cleaning tools which depend upon water pressure to provide their cleaning force, or any tool which retard the flow of water in the sanitary sewer mains are used, precautions shall be taken to insure that the water pressure created does not cause any damage or flooding to public or private property being served by the manhole section involved.
30. Any damage of property, as a result of flooding, shall be the sole liability and responsibility of the Contractor.
31. The flow of wastewater present in the sanitary sewer system shall be utilized to provide necessary fluid for hydraulic cleaning devices whenever possible.
32. When additional quantities of water from fire hydrants are necessary to avoid delay in normal working procedures, the water shall be conserved and not used unnecessarily.
33. No fire hydrant shall be obstructed or used when there is a fire in the area.
34. The Contractor shall be responsible for obtaining the water meter and all related charges for the set-up, including the water usage bills from respective water purveyor agency. All expenses shall be considered incidental to the cleaning of the existing sanitary sewer system.

868.5 MEASUREMENT AND PAYMENT: The Contract or shall be fully responsible and shall be paid for sewer system cleaning as part of Item No. 866, "Sewer Main Television Inspection" for furnishing all labor, hauling, materials, equipment, tools, debris disposal, inspection, and incidentals necessary to complete the work. No separate pay item will be made for sewer system cleaning.

-End of Specification-

SECTION 911
DUCTILE IRON PIPE

PART 1 - GENERAL

1.01 SUMMARY

A. This specification specifies the requirements for exposed ductile-iron pipe and fittings for use in lift stations. This specification covers 3" through 64" ductile-iron pipe with flanged connections, centrifugally cast, for water or other liquids.

1.02 RELATED DOCUMENTS

A. The current editions of the following American Water Works (AWWA) specifications shall apply to the extent applicable in each reference:

1. C104/A21.4: AWWA Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings

2. C110/A21.10: American National Standard for Ductile-Iron and Gray-Iron Fittings for Water

3. C111/A21.11: American National Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings

4. C115/A21.15: AWWA Standard for Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges

5. C150/A21.50: AWWA Standard for Thickness Design of Ductile-Iron Pipe

6. C151/A21.51: AWWA Standard for Ductile-Iron Pipe, Centrifugally Cast

7. C153/A21.53, AWWA Standard for Ductile-Iron Compact Fittings for Water Service

8. C600: AWWA Standards for Ductile-Iron, Centrifugally Cast in Metal Molds or Sand-lined Molds, for Water or Other Liquids.

B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.03 SUBMITTALS

A. Submittals shall comply with the requirements of Section 01300 Submittals of these Contract Documents.

B. The Contractor shall submit for review the following information:

1. The Manufacturer of the pipe shall submit through the Contractor an affidavit that the pipe, fittings and other products or materials furnished for this Work comply with all applicable provisions of these specifications.

C. The Contractor shall submit, upon request, the following:

1. Certified dimensional drawings of all valves, fittings, and appurtenances.

2. Certified dimensional drawings of joints, showing the manufacturer's allowable deflections.

3. The Manufacturer's approved installation instructions for the joints being used.

D. Certifications: The Manufacturer will furnish Owner sworn certificates that pipe and joints have been manufactured, tested, and inspected in accordance with applicable specifications.

E. Independent Test Certificates: At the Owner's option, the Engineer may direct the pipe Manufacturer to furnish test certificates from an independent testing laboratory certifying that pipe conforms to the applicable specifications.

F. Approval of the shop drawings and acceptance of certifications by the Engineer shall not relieve the Contractor of the responsibility to ensure the pipe is installed in strict accordance with the Contract Documents and Manufacturer's recommendations.

1.04 QUALITY ASSURANCE

A. Materials and Workmanship: All ductile iron pipe and fittings shall be from a single Manufacturer. The Contractor shall furnish materials under this Section which are new, unused and as specified, or if not particularized herein, which are the best of their respective kind, free of defects and imperfections, and suitable for the service intended, subject to the approval of the Engineer. The pipe and/or fitting Manufacturer's production facility shall be open for inspection by the Owner or his designated agents with a reasonable advance notice.

B. Inspection of the pipe will be made by the Owner and/or Engineer after delivery. The pipe shall be subject to rejection at any time on account of failure to meet any of the Specification requirements, even though pipes may have been accepted as satisfactory at the place of manufacture. Pipe rejected after delivery shall be marked for identification and shall immediately be removed from the job.

1.05 MANUFACTURER'S QUALIFICATIONS

A. All pipe and fittings shall be manufactured by a single Manufacturer to be approved by Engineer.

1.06 DESIGN REQUIREMENTS

A. Lift station piping shall be ductile iron and shall have flanged connections to allow for removal of pumps and valves without interruption of the lift station operations. Wall penetrations shall be designed to allow for pipe flexure while excluding exfiltration or infiltrations. Pipe suction velocities shall be between 3 and 7 feet per second. Provide flexible coupling on all outlet pipes within 2 feet of station wall.

B. All pipe shall be designed for the following minimum conditions:

1. Working Pressure: Working pressure shall be 150 pounds per square inch (psi).

2. Surge Allowance: Surge allowance shall be 100 psi. For design purposes, surge allowance shall be added to the working pressure.

C. All pipe shall conform to the following pressure classes:

Pipe Size (inch)	**Pressure Class (psi)**
3 through 12	350
16 and 20	250
24	200
30 through 64	150

1.07 DELIVERY, STORAGE AND HANDLING

A. Care shall be taken in loading, transporting and unloading to prevent injury to the pipe or coatings. Under no circumstances shall the pipe be dropped or skidded against each other. Slings, hooks, or pipe tongs shall be padded and used in such a manner as to prevent damage to the exterior surface or internal lining of the pipe.

B. Materials, if stored, shall be kept safe from damage. The interior of all pipe, fittings, and other appurtenances shall be kept free from dirt or foreign matter at all times.

C. Pipe shall not be stacked higher than the limits recommended by its manufacturer. The bottom tier shall be kept off the ground on timbers, rails, or concrete. Pipe in tiers shall be alternated. At least two rows of 4-in by 4-in timbers shall be placed between tiers and chocks affixed to each end in order to prevent movement.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Lift station piping shall be ductile iron, centrifugally cast of 60-42-10 iron, and shall conform to the requirements of the latest revision of AWWA C151 and AWWA C110.

B. Each length of pipe furnished shall bear identification markings in conformance with Sec. 51.10 of AWWA Standard C151.

C. The Manufacturer shall take adequate measures during pipe production to assure compliance with AWWA C151 by performing quality-control tests and maintaining results of those tests as outlined in Sec 51.14 of that Standard.

D. The Contractor shall be fully liable for the cost of replacement or repair of pipe, fitting or special which in the opinion of the Owner or Engineer is damaged. Sections of pipe having been discovered with cuts or gouges in excess of 10% of the pipe wall thickness shall be cut out and removed. The undamaged portion of the pipe shall be rejoined using the heat fusion joining method.

E. Stockpiled pipe shall be stored on level surface on pallets, skids, sand or rock free berms, sandbags, old tires, or other suitable means sot that the pipe will not be damaged. If the pipe must be stacked for storage, such stacking shall be done in accordance with the pipe Manufacturer's recommendations. The pipe shall not be rolled, pushed, or slid into place and shall be secured to prevent rolling. The pipe shall be handled in such a manner that it is not pulled over sharp objects or cut by chokers or lifting equipment.

2.02 JOINTS AND FITTINGS

A. Ductile iron pipe fittings shall have not less than the thickness, class, or pressure rating specified for ductile iron pipe. Fittings shall be furnished with all necessary glands, gaskets, bolts, etc. as may be required to complete the joints.

B. Flanged ductile iron pipe shall have full face type SBR rubber joint gaskets in accordance with AWWA C111, latest revision with the exception that gaskets containing asbestos material or natural rubber will not be permitted.

C. Assembly bolts shall be square headed carbon steel machine bolts with hexagon nuts per ANSI B18.2. Thread shall conform to ANSI B1.1. Bolt length shall be such that after joints are assembled, the bolts shall protrude through the nuts, but not more than ½-in.

D. Fittings for 3" and larger, pipe shall be ductile iron, pressure class 250, complying with the requirements of the latest revision of ANSI/AWWA Standard C110/A21.10, as applicable. Fittings shall be as shown on the Drawings and shall have the same pressure rating as the connecting pipe.

2.03 COATING AND LINING

A. All ductile iron pipe and fittings will require a ceramic-filled amine-cured epoxy and shall be lined internally with Protecto 401 by Indurall. The lining thickness shall be 40 mils minimum. Application shall be performed by an applicator approved by the coating manufacturer, in accordance with manufacturer's instructions and under controlled conditions at the applicator's shop or the pipe manufacturer's plant. Applicator shall submit a certified affidavit of compliance with manufacturer's instructions and requirements specified herein.

B. Exterior coating shall consist of a nominal one-mil thick asphaltic material applied to the outside of the pipe as described in Section 51.8 of AWWA C151.

C. The Contractor shall take every precaution to prevent damage to the lining. If the lining is damaged or found to be faulty at delivery site, the damaged or faulty portions shall be repaired or replaced with lining in accordance with this specification and AWWA C104.

D. Unless otherwise specified, all coatings shall be shop applied with "hold-backs" provided as required at pipe and fitting ends for satisfactory installation for joint connections in the field. Provide all necessary coating materials to perform field coating applications at joints. Unless otherwise noted, field applied coating material shall be compatible with or equal to the shop applied material. Field repair of pipe with damaged coating shall receive prior approval of the Engineer. If, in the opinion of the Engineer that the coating damage is beyond repair, the pipe shall be replaced at the expense of the Contractor. All flange bearing surfaces shall be uncoated.

E. All exposed pipe, valves, and fittings outside the wet well shall receive after installation a 100% solids epoxy coating system with a topcoat system of urethane, suitable for the environment. Prior to application, prepare surfaces in accordance with Manufacturer's instructions and any reference to cleaning in the Manufacturer's instructions shall be understood to refer to applicable SSPC specifications. Thickness, mixing and application shall be in accordance with Manufacturer's instructions. Apply finish coat in accordance with the color coding set forth in Table 2 in the Owner's Lift Station Design & Construction Guidelines. Approved Manufacturers are Tnemec, Carboline, Sherwin-Williams, PPG, and M.A.B. Paints. Exterior coating shall consist of a nominal one-mil thick asphaltic material applied to the outside of the pipe as described in Section 51.8 of AWWA C151.

SAN ANTONIO WATER SYSTEM LIFT STATION COLOR CODES

TYPES OF EQUIPMENT	COLOR
1. Pump Suction Piping	Gray – Pantone Number 431 U
2. Header and Force Main Piping	Gray – Pantone Number 431 U
3. Pump/Motors and Mounts	Gray – Pantone Number 431 U
4. Potable Water Line	Avalon Blue – Pantone Number 558 C
5. Compressed Air Line (where used)	Green – Pantone Number 349
6. Power Conduit	Orange – Pantone Number 166
7. Control/Instrumentation Conduit	Yellow – Pantone Number 109
8. Recycle water pipe	Purple – Pantone Number 521 C

F. All pump discharge pipe and fittings within wet well, except SS 316 and PVC, shall receive after installation, a 100% solids coal tar epoxy coating system. Thickness, mixing and application shall be in accordance with Manufacturer's instructions. Prior to application, prepare surfaces in accordance with Manufacturer's instructions, and any reference to cleaning in the Manufacturer's instructions shall be understood to refer to the applicable SSPC specifications. Approved Manufacturers are Tnemec, Carboline, Sherwin-Williams, PPG, and M.A.B. Paints.

2.04 TESTING AND INSPECTION:

A. Hydrostatic Testing: All pipe shall be factory hydrostatically proof tested after manufacture at a minimum of 500 psi for a period of not less than 10 seconds.

PART 3 - EXECUTION

3.01 GENERAL

A. The pipe shall be installed as shown on the drawings and specified by the Engineer.

B. The Contractor shall furnish all fittings and special pieces required for closures, curves, bends, branches, valves, and connections indicated or shown on the drawings. All connections to the pipe shall be at fittings.

C. Stockpiled pipe shall be stored on level surface on pallets, skids, sand or rock free berms, sandbags, old tires, or other suitable means so that the pipe will not be damaged. If the pipe must be stacked for storage, such stacking shall be done in accordance with the pipe Manufacturer's recommendations. The pipe shall not be rolled, pushed, or slid into place and shall be secured to prevent rolling. The pipe shall be handled in such a manner that it is not pulled over sharp objects or cut by chokers or lifting equipment.

D. All pipe and fittings shall be thoroughly cleaned before laying, shall be kept clean until they are used in the Work, and when installed or laid, shall conform to the lines and grades required.

E. Care shall be taken in loading, transporting, and unloading to prevent injury to the pipe. Pipe or fittings shall not be dropped. All pipe or fittings shall be examined before

leaving and no pieces shall be installed which is found to be defective.

F. If any defective pipe is discovered after it has been installed it shall be removed and replaced with a sound pipe in a satisfactory manner at no expense to the Owner.

3.02 JOINTING

A. All piping and fittings shall be installed true to alignment and rigidly supported. Anchorage shall be provided where required. Any damage to linings shall be repaired to the satisfaction of the Engineer before the pipe is installed. Each length of pipe shall be cleaned out before installation. All of manufacturer's recommendations shall be utilized.

B. The deflection at joints shall not exceed 75 percent of that recommended by the pipe manufacturer. Fittings, in addition to those shown on the Drawings, shall be provided, if required, in areas where conflict exists with the existing facilities.

C. When pipe cutting is acceptable to the Engineer, the cutting shall be done by abrasive saw, leaving a smooth cut at right angles to the axis of the pipe.

D. Flanged joints shall be made using gaskets, bolts, bolt studs with a nut on each end, or studs with nuts where the flange is tapped. The number and size of bolts shall conform to the same ANSI Standard as the flanges.

E. Bolts in flanged joints or mechanical joints shall be tightened alternately and evenly.

3.03 TESTING

A. All piping shall be subject to acceptance tests. Provide all necessary utilities, labor and equipment for flushing and testing and dispose of all waste after the test, including water.

B. All pipe and fittings shall be pressure tested using water to 1.5 times the working pressure for one hour and the pipeline shall show no leakage.

C. The Contractor shall, at his own expense, correct any leakage and repair any damage to the pipe and pipe appurtenances or to any structures resulting from, or caused by tests. All leaks shall be repaired and lines retested.

D. The working pressure for ductile iron pipe pump discharge piping shall be 175 psi.

3.04 CLEANING

A. Clean all of the pipe by flushing with water or other means to remove all dirt, stones, pieces of wood, or other material which may have entered during the construction period. All debris shall be removed from the pipeline. The lowest segment outlet shall be flushed last to assure debris removal.

PART 4 - MEAUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Ductile Iron Pipe will not be measured separately.

4.02 PAYMENT

A. Ductile Iron Pipe will not be paid separately. Costs for ductile iron pipe will be considered subsidiary to the lump sum bid items for each lift station.

END OF SECTION 911

SECTION 912
VALVES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:

1. Gate Valves
2. Check Valves
3. Combination Air Release and Air Vacuum Valves
4. Surge Relief Valves
5. Ball Valves
6. Plug Valves

B. Scope of Work: This section covers all valves, except where specific requirements are given in other sections and in the Owner's Standards.

1.03 DEFINITIONS

A. CWP: Cold working pressure

B. EPDM: Ethylene propylene copolymer rubber

C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber

D. NRS: Nonrising stem

E. OS&Y: Outside screw and yoke

F. RS: Rising stem

G. SWP: Steam working pressure

1.04 SUBMITTALS

A. Complete specifications, data, and detailed drawings covering the items furnished under this specification shall be submitted for approval in accordance with Section 01300 Submittals. Catalog cuts, showing sufficient detail as determined by the Engineer, will be acceptable in lieu of detailed drawings for valves smaller than 4 inches in size and for other miscellaneous small items for which detailed drawings are not readily available.

B. Drawings and data submitted shall include complete connection and schematic wiring diagrams for all electric motor operators, equipment, devices and controls.

1.05 QUALITY ASSURANCE

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.

2. ASME B31.1 for power piping valves.

3. ASME B31.9 for building services piping valves.

C. NSF Compliance: NSF 61 for valve materials for potable-water service.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.

2. Protect threads, flange faces, grooves, and weld ends.

3. Set angle, gate, and globe valves closed to prevent rattling.

4. Set ball and plug valves open to minimize exposure of functional surfaces.

5. Set butterfly valves closed or slightly open.

6. Block check valves in either closed or open position.

B. Use the following precautions during storage:

1. Maintain valve end protection.

2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

1.07 GENERAL REQUIREMENTS

A. Pipe and valve purchase orders shall be coordinate to insure proper installation of the valves and piping in conformance with the specified requirements.

B. All valves shall be provided with manual operators.

1. Wrench nuts shall be provided on all buried valves, on all valves which are to be operated through floor boxes, and where shown on the plans. All wrench nuts shall comply with Section 3.16 of AWWA C500. Not less than two operating keys shall be furnished for operation of the wrench nut operated valves.

C. The direction of rotation of the wheel, wrench nut, or lever to open each valve shall be to the left (counterclockwise). Each valve body or operator shall have cast thereon the word OPEN and an arrow indicating the direction to open.

D. Actual length of valves shall be within 1/16inch (plus or minus) of the specified or theoretical length.

E. Unless otherwise specified or shown on the plans, all 3 inch or larger buried valves shall have mechanical joint ends conforming to ANSI 21.11, all other 3 inch or larger valves shall have flanged end, and all 2 ½ inch or smaller valves shall have threaded ends. Unless otherwise specified flanges shall conform to ANSI Class 125.

F. All valves to be installed shall be rated for a working minimum pressure of 150 psi.

G. All valve flanges shall be furnished to be compatible with AWWA C110 design requirements.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS FOR VALVES

A. Refer to valve schedule articles for applications of valves.

B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

C. Valve Sizes: Same as upstream piping unless otherwise indicated.

D. Valve Bypass and Drain Connections: MSS SP-45.

2.02 GATE VALVES 3 INCH OR LARGER IN SIZE

A. Except as modified or otherwise provided herein, AWWA C515 shall govern the design, component materials, construction, and manufacture of all gate valves 3-inch or larger in size. The Contractor shall furnish resilient wedge gate valves per AWWA C515 standards.

B. Modifications:

1. Mechanical Joint. The gland, gasket, and all bolts for each bell of mechanical joint valves shall be furnished by the valve manufacturer.

2. Stem Seals. Unless otherwise authorized by the Owner, stem seals for nonrising stem valves shall be of the triple O-ring type.

3. Flanges. Flanges shall have ANSI Class 125 diameter and drilling and be compatible with AWWA C110.

4. Threaded Valves. Any Valve used to isolate ARVs, pressure gauges, or pressure transmitters shall be permitted to be threaded

5. Fusion bonded epoxy coating. Valves shall be fusion bonded epoxy coated on the interior as well as the exterior of the valve. The coating is applied after the valve body is shot blasted clean. The coating is applied to all ferrous surfaces so that even the bolt holes and body to-bonnet flange surfaces are epoxy coated.

C. Types:

1. Solid Wedge. All gate valves 6 inches or smaller in size installed in vertical lines shall be of the solid wedge type.

2. Outside Stem. All gate valves installed in structures or above grade shall be of the nonrising stem, outside screw and yoke type.

3. Nonrising Stem. All buried gate valves shall be of the nonrising stem type.

4. Square Bottom: All gate valves 8-inches and larger installed in vertical lines shall be of the double square bottom type. Square bottom valves shall be of such design that full gate support is provided and rubbing contact between the discs and gate seat is prevented, at all positions of the gate except where the gate wedges are in contact when seating the discs.

5. Valves with nonrising stems (NRS) shall have stem seals of the double o-ring or three Chevron ring design.

6. All gate valves shall be rated for a minimum working pressure of 150 psi, except as noted on the Plans. A certificate of compliance for the above shall be furnished by the manufacturer for each valve. All gate valves will be pressure tested in the field along with the associated piping.

7. All gate valves shall be leak tested at the factory per AWWA C515 and a certificate of compliance furnished by the manufacturer for each valve.

8. The interior of all gate valves and the exterior of buried gate valve shall be fusion bonded epoxy coated for wastewater application. The exterior of non-buried gate valves shall be cleaned and primed at the factory.

2.03 GATE VALVES SMALLER THAN 3 INCHES IN SIZE

A. Gate valves smaller than 3 inches in size shall be 316 stainless steel body, rising stem, solid wedge valves capable of being repacked under pressure when the valve is fully open. All gate valves used to convey wastewater shall be flanged.

2.04 METAL SEATED SWING CHECK VALVE

A. Class 150, Iron Swing Check Valves with Metal Seats:

B. Except as modified or otherwise provided herein, AWWA C508 shall govern the design, component materials, construction, and manufacture of all metal seated swing check valves. The Contractor shall furnish either one of Clow Style 106LW, Mueller #2600-6-01, Kennedy IBBM Swing Check Valve, or American "50" Line with weight and lever.

1. Valve bonnets and bodies shall be made of gray iron meeting or exceeding ASTM A126, Grade B.

2. Shall be rated for a minimum 200 psi working pressure.

3. Clapper arm shall be made of ductile iron conforming to ASTM A536 Grade 65-45-12.

4. Valve shall be installed in a vertical line with upward flow and furnished as a lever and weight configuration. Spring lever configurations will not be permitted.

5. The disc shall not contact the body when the valve is in the full open position.

6. Shafts shall be stainless steel with corrosion-resistant bearings at each end. Shaft and bearings shall be completely replaceable, if necessary, with valve remaining in the pipeline.

7. Double O-ring seals fully contained within the shaft bearing shall be provided if valve shaft is extended outside the body.

8. Grease fitting for lubrication between O-rings is required.

9. Check valve seats shall be bronze. The mating seat shall be field removable and replaceable, if necessary, without removing the valve from the pipeline.

10. Fusion bonded epoxy coating. Valves shall be fusion bonded epoxy coated on the interior as well as the exterior of the valve. The coating is applied after the valve body is shot blasted clean. The coating is applied to all ferrous surfaces so that even the bolt holes and body to-bonnet flange surfaces are epoxy coated.

11. The valve cover shall be circular flange to allow installation of flanged emergency bypass pumping assembly.

2.05 WASTEWATER AIR/VACUUM VALVES

A. Combination Wastewater air/vacuum valves shall be fully automatic float operated valves designed to exhaust large quantities of air during the filling of a piping system and close upon liquid entry. The valve shall re-open during draining or if a negative pressure occurs.

B. All valves must be furnished by the same manufacturer.

C. Valves shall be manufactured and tested in accordance with AWWA C512.

D. Valves shall be rated for a minimum working pressure of 150 psi.

E. Valve sizes 3 inches and smaller shall have a full size NPT inlets and outlets equal to the nominal valve size. The valve body shall have a 2-inch NPT cleanout and 1-inch NPT drain connections on the side of the casting.

F. Valve sizes 4 inches and larger shall have bolted flange inlets with NPT outlets. Flanges shall be Type 316 Stainless steel.

G. The valve shall have three additional NPT connections for the backwash accessories.

H. The extended valve body shall provide a flow area equal to the nominal valve size. A bolted cover with Type 316 Stainless steel screws and flat gasket shall be provided to allow for maintenance and repair.

I. The resilient seat shall provide drop tight shut off to the full valve pressure rating. The seat shall be a minimum of 0.5 inches thick on 2 inches and larger valves and secured in such a manner as to prevent distortion.

J. On valve sizes 4 inches and larger, the cover shall be fitted to the valve body by means of a machined register with a guide shaft extending through the float. A resilient bumper shall be provided to cushion the float during sudden opening conditions.

K. The valve body, cover, and baffle shall be constructed of Type 316 Stainless steel.

L. All inner metal parts shall be Type 316 Stainless steel.

M. Resilient seats shall be Buna-N.

N. A flanged outlet connection shall be provided for required vault vent piping.

O. Backwash accessories shall be furnished and consist of an inlet shut-off valve, a blow-off valve, a clean water inlet valve, rubber supply hose, and quick disconnect couplings. Accessory valves shall be quarter-turn, full ported Type 316 Stainless steel ball valves.

P. The exterior of the valve shall be coated with a universal alkyd metal primer that is FDA approved for potable water.

2.06 SURGE RELIEF VALVES (where applicable)

A. Surge relief valves shall be furnished by Apco, GA Industries or approved equal.

B. Main valve body shall be in-line wye pattern of cast iron conforming to ASTM A126 Class B, with integral flanges, faced and drilled per ANSI B16.1 Class 125. The valve body shall be inherently self-cleaning and have a net flow area through the valve no less than the area of its nominal pipe size. The body shall have a removable stainless-steel seat.

C. The valve disc shall be cast iron or steel with a renewable, resilient seat ring of rubber or other suitable material and retained by a bronze or stainless-steel follower ring and stainless steel screws. The valve stem shall be stainless steel bushing retained in the valve cover. The valve stem shall be sealed where it passes through the body by dual seals separated by a lantern ring with external leak detection port.

D. Sizes through 8-inches shall have a dual compression springs; larger valves shall have a single compression spring. Springs shall be encased in steel cylinders; exposed

springs or tension springs are not acceptable. An integral hydraulic system shall permit quick opening and adjustable, slow closing without the need of pre-charged cylinders. The valve shall be fully capable of operating in any position.

E. The valve shall be factory tested and set to open at a pre-determined pressure. Springs shall permit field adjustment from near zero to 10 percent above factory setting.

F. Provide a NEMA 4 limit switch mounted on the valve to indicate when the valve is open or closed.

G. The surge relief valve shall quickly open when the system pressure exceeds its setting, remain open as long as the pressure exceeds this setting, and slowly close drop tight when the pressure subsides below the spring setting.

2.07 BALL VALVES

A. Valves shall be 2-piece full port design constructed of a 316 stainless steel body and end adapter. The Watts Series S-FBV-1 ball valves are suitable for a full range of liquids and gases. The S-FBV-1's full port orifice ensures maximum flow capacity, while reinforced PTFE seats, PTFE stem packing, thrust washer and body seal provide maximum safety and high operating pressure/temperature limits. A 2-piece full port stainless steel ball valve to be installed as indicated on the plans. The valve must have an adjustable stem packing, reinforced PTFE seats, PTFE stem packing, thrust washer and body seal. Pressure rating no less than 1000psi (69 bar) WOG non-shock, 125psi (8.6 bar) WSP. Valve must conform to MSS-SP-110. Valve shall be a Watts Series S-FBV-1 or approved equal.

2.08 PLUG VALVES

A. All plug valves shall be of the nonlubricated, eccentric type with bodies and plugs of semi-steel construction. Valves shall be rated for a minimum working pressure of 150 psig. The area at the valve port shall be at least 80 percent of the full pipe area. All valves shall open by turning counterclockwise. Plug valves specified herein shall be as manufactured by Val-Matic Valve, Clow, or approved equal.

B. Valves shall have balanced plugs with a resilient facing of neoprene solidly bonded thereto to assure bubble-tight shutoff low torque requirements.

C. Seats shall have a welded-in overlay of 90 percent pure nickel on all surfaces contacting the plug face.

D. Valves shall be furnished with bolted bonnets and self-adjusting chevron-type packing. Packing shall be replaceable without disassembling the valve or removing the bonnet from the valve.

E. Corrosion-resistant, permanently lubricated bearings shall be provided at both ends of the valve shafts.

F. All valves shall be supplied with mechanical joint ends conforming to ANSI B16.1, Class 125, unless otherwise noted herein. Valves in vaults shall be flanged.

G. All exterior hardware on valves shall be of Type 304 stainless steel.

2.09 EXTENSIONS STEMS AND STEM GUIDES

A. Extension stems and stem guides shall be furnished and installed on all buried valves and other valves where shown, where specified, and where required. Extension stems shall be fabricated from solid steel shafting not smaller in diameter than the stem of the valve or from galvanized steel pipe having an internal diameter not smaller than the diameter of the valve stem.

B. Stem couplings shall be both threaded and keyed to the coupled stems and shall be of approved design and construction. Pipe couplings will not be acceptable. Bronze bushed stem guides of cast iron construction and adjustable in two directions shall be furnished and rigidly installed where and as needed for adequate support of extension stems. Where extension stems exceed 12 feet in length, the top stem guide shall be designed for thrust to carry the weight of the extension stem and the extension stem provided with a suitable collar to bear against the steam thrust guide and thus support the stem. All rising extension stems shall be provided with bronze or stainless steel sleeves, securely attached to the stem in each case, of such length and location that the sleeve will be in contact with and extend entirely through each stem guide throughout the full vertical travel of the stem.

C. Extension stems for buried valves shall extend to within 6 inches of the surface of the ground. Each extension stem shall be connected to the valve operator with a suitable universal joint type coupling. All connections shall be pinned. Each extension stem shall be provided with spacers which will center the stem in a valve box having an inside diameter of 5 ¼ inches and shall be equipped with a standard AWWA wrench nut as described in AWWA C500.

2.10 VALVE BOXES

A. All buried valves shall be provided with valve boxes. Valve boxes shall be of cast iron of the extension sleeve type, suitable for the depth of cover over the pipeline as required by the plans or otherwise specified. Valve boxes shall be not less than 5 inches in diameter, shall have a minimum thickness at any point of 3/16 inch and shall be provided with suitable cast iron bases and covers. Covers shall have cast thereon an appropriate name designating the service for which the valve is used.

B. All parts of valve boxes, bases, and covers shall be coated by dipping in hot bituminous varnish.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.02 VALVE INSTALLATION

A. Install valve in accordance with manufacturer's written instructions and approved submittals.

B. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

C. Locate valves for easy access and provide separate support where necessary.

D. Install valves in horizontal piping with stem at or above center of pipe.

E. Install valves in position to allow full stem movement.

F. Install check valves for proper direction of flow and as follows:

G. Swing Check Valves: In horizontal position with hinge pin level.

H. Install valves in horizontal position to allow vertical stems in all wastewater applications.

3.03 SETTING OUTSIDE VALVES

A. Each valve which is installed in direct contact with earth backfill shall be provided with a valve box of such type and design that surface loads, impact or shock will not be transmitted through the box to the valve.

B. Valve and valve boxes shall be set plumb. Each valve box shall be placed directly over the valve it serves, with the top of the box brought flush with the finished grade. After being placed in proper position, earth shall be filled in around each valve box and thoroughly tamped for a distance on each side of the box of 4 feet at the top of the pipe and 2 feet measured at the top of the trench.

C. Each valve shall be inspected before installation to ensure that all foreign substances have been removed from within the valve body and shall be opened and closed to see that all parts are in first-class working condition. Geared valves shall be inspected to see that the gears are properly lubricated.

3.04 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.05 MANUFACTURER FIELD SERVICE

A. Manufacturer's authorized representative shall be present at the jobsite for assistance during equipment start-up and to train owner personnel in operation, maintenance and troubleshooting of the equipment provided.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT AND PAYMENT

A. The work performed, materials furnished and all labor, tools, equipment, excavation, furnishing, hauling and placing valves and barrel extensions including anchorage and all incidental and subsidiary materials and work; preparing, shaping, dewatering, shoring of trenches, bedding, placing and compacting backfill materials and for all other incidentals necessary to complete the installation, as indicated in the Drawings, complete in place will not be measured or paid for directly, but shall be considered subsidiary to the various bid items of the contract.

END OF SECTION 912

SECTION 913
HIGH DENSITY POLYETHYLENE (HDPE) PIPE AND FITTINGS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all materials, labor, tools, and appliances and shall properly install, connect in place, and test and place in service at the locations shown on the Drawings, HDPE pipe and fittings of the sizes indicated and to the elevations or depths indicated for the proper completion of the work.

B. Wherever the Work disturbs existing conditions or Work already completed, the Contractor shall restore the same to its original condition in every detail. All such replacement and repair shall meet with the approval of the Engineer.

C. HDPE Pipe and fittings are not necessarily completely indicated or detailed on the Drawings. The Drawings indicate pipe and fittings in a general configuration. It is the Contractor's responsibility to furnish all materials, pipe and fittings required.

D. The Contractor shall provide a complete installation, whether or not indicated on the Drawings or specified herein. The Contractor shall be responsible for all details, devices, accessories, and special construction necessary to properly furnish, install, adjust, test, and place in continuous satisfactory service, and complete the Work in an acceptable manner.

E. Full responsibility for fabricating and installing the HDPE pipe and fittings, for selecting materials of construction not otherwise specified, and for demonstrating compliance with specified performance requirements shall rest with the Contractor. The Engineer's approval of 1) the manufacture and installation of the pipe and fittings; and 2) the use of materials included in this specification shall not relieve the Contractor and manufacturer of full responsibility for meeting all performance requirements and guarantees.

1.02 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

Without limiting the generality of other requirements of these specifications, all Work specified herein shall conform to or exceed the applicable requirements of the referenced portions of the following documents to the extent that the requirements therein are not in conflict with the provisions of this Section.

Reference specifications include:

1. ASTM D1248 - Specification for Polyethylene Plastics Molding and Extrusion Materials.

2. ASTM D2657 - Standard Practice for Heat-Joining Polyolefin Pipe and Fittings.

3. ASTM D3350 – Specification for Polyethylene Plastic Pipe and Fitting Materials.

4. ASTM F477 – Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

5. ASTM F714 – Specification for Polyethylene Plastic (PE) Pipe (SDR-PR) Based on Outside Diameter.

6. ASTM D3216 – Flanged and Mechanical Joint Adapters.

Nominal Physical Properties for PE3408

Property	**ASTM Test Method**	**Nominal Value**
Cell Classification	D3350	345464C
Density, Natural	D1505	0.946 gm/cc
Density	D1505	0.955 gm/cc
Melt Index (190°C, 2.16 kg)	D1238	0.07 gm/10 min.
Flow Rate (190°C, 2.16 kg)	D1238	8.5gm/10 min.
Flexural Modulus	D790	136,000 psi
Elastic Modulus: short-term	D638	125,000 psi
Elastic Modulus: long-term	D638	30,000 psi
Tensile Strength @ Yield	D638	3,500 psi
ESCR	D1693	>10,000 hrs. failure
Slow Crack Growth, PENT	F1473	>100 hrs.
HDB @73.4°F	D2837	1600 psi
HDB @140°F	D2837	800 psi
UV Stabilizer (Carbon)	D1603	2.5%
Brittleness Temperature	D746	<-180°F
Melting Point	D789	261°F
Vicat Softening Temperature	D1525	255°F
Hardness	D2240	64

Izod Impact Strength (Notched)	D256	7 ft-lb_f/in.
Thermal Expansion Coefficient	D696	1.0 x 10^{-4} in/in/°F
Poisson's Ratio	-----	0.42
Manning Roughness	-----	0.01
Volume Resistivity	D991	2.6 x 10^{16} Ω-cm
Average Molecular Weight	GPC	330,000

Test procedures are ASTM unless otherwise specified PPI=Plastics Piping Institute, and GPC=Gel Permeation Chromatography.

B. The material shall be listed by the Plastics Pipe Institute (PPI), a division of the Society of Plastics Industry in Report PPI TR-4. The PPI listing shall be in the name of the pipe manufacturer and testing and validation samples of the pipe manufacturer's production pipe shall be based on ASTM D2837 and PPI TR-3.

C. Materials used for the manufacture of the pipe and fittings shall be High Density Extra High Molecular Weight (EHMW), PE4710 Polyethylene and shall comply with the requirements of ASTM D3350 for Type III, Class C, Category 5, Grade P34 material, and have a cell classification of 345464C per ASTM D3350. Pipe shall be manufactured in accordance with ASTM F714. Manufacturer shall be in good standing with the Plastics Pipe Institute.

D. The polyethylene pipe manufacturer shall provide certification that stress regression testing has been performed on the specified product. The regression testing shall have been performed in accordance with ASTM D2837 and the manufacturer shall provide a product supplying a minimum Hydrostatic Design Basis (HDB) of 1600 psi as determined by ASTM D2837.

1.03 SUBMITTALS

A. Submittals shall comply with the requirements of Section 01300 Submittals of these Contract Documents.

B. The Contractor shall submit for review the following information:

1. The Manufacturer of the pipe shall submit through the Contractor an affidavit that the pipe, fittings and other products or materials furnished for this Work comply with all applicable provisions of these specifications.

C. Certifications: The Contractor shall furnish a certified affidavit of compliance for all pipe and other products or materials furnished under this Section of the Specifications, and certified copies of the following supplemental data for all pipe, fittings, and specials:

1. Certifications listed in Section 1.0.

2. All quality control check sheets used during the inspection and testing of pipe and fittings produced for this Work.

D. HDPE Pipe and Fittings lay schedule to indicate compliance with Drawing configuration.

E. Certification of at least five installations of HDPE Pipe of 24-inch and diameter or larger in the last five years.

F. Approval of the shop drawings and acceptance of certifications by the Engineer shall not relieve the Contractor of the responsibility to ensure the pipe is installed in strict accordance with the Contract Documents and Manufacturer's recommendations.

1.04 QUALITY ASSURANCE

A. Materials and Workmanship: The Contractor shall furnish materials under this Section which are new, unused, and as specified, or if not particularized herein, which are the best of their respective kind, free of defects and imperfections, and suitable for the service intended, subject to the approval of the Engineer. The pipe and/or fitting manufacturer's production facility shall be open for inspection by the Owner or his designated agents with a reasonable advance notice.

1.05 MANUFACTURER'S QUALIFICATIONS

A. All HDPE pipe and HDPE fittings shall be manufactured by a single qualified Manufacturer. The Manufacturer shall have at least five installations of HDPE Pipe of 24-inch and diameter or larger in the last five years.

PART 2 - PRODUCTS

2.01 HDPE PIPE, FITTINGS, AND ADAPTORS

A. Pipe shall be manufactured from materials meeting the requirements of Section 1.0

B. Pipe used shall be pressure rated using the certified HDB from the Manufacturer. Pipe shall have a pressure rating in accordance with the following formula:

$$P = (2 \times HDB/DR-1) \times F$$

Where DR = Dimension Ration = D/t

And P = internal pressure, psi

HDB = long term hydrostatic strength, psi (1600 psi)

D = outside diameter, inches

T = minimum wall thickness, inches

F = design safety factor (0.5 for water @ 73.4°F)

C. Pipe supplied under this specification shall have a nominal DIPS (Ductile Iron Pipe Size) outside diameter and Dimension Ration (DR) and pressure rating of the pipe at 73°F shall match the following at a minimum:

D. The pipe shall carry the same pressure rating and the fittings. At the point of fusion, the outside diameter and minimum wall thickness of the fitting shall match the outside diameter and minimum wall thickness specifications of ASTM F714 for the same size pipe to which it is joined.

E. All fittings shall be ductile iron. This requires an HDPE adaptor to be fused to the HDPE end and include a mechanical joint solid sleeve and megalug restraint on ductile iron end. All fittings shall meet the required minimum system pressure rating of 160 psi. Extrusion welded pipe mitered fittings and HDPE fittings shall not be allowed.

F. The ductile iron fittings must meet the Owner's standards for ductile iron fittings and be manufactured in accordance with ANSI/AWWA C110/A21.10.

G. Flanged and Mechanical Joint Adapters: Flanged and mechanical joint adapters shall be manufactured per AWWA C906-99 standards and be fully restrained to the pressure rating of the pipe with a 2:1 safety factor. They are to be installed per the manufacturer's recommendations and be centered and aligned to the mating component before assembly and tightening evenly. Bolted threads must be lubricated, and flat washers used under nut. Flange adaptors shall be epoxy coated with bolt circle and holes to ANSI/AWWA C110.A21.10 standards, including screws with a Rockwell hardness of C40-45 converted from Brindle. All MJ adaptors shall come with extended T-bolts, glands, gaskets, and stiffeners.

H. All connections to valves will require ductile iron mechanical joint restrained adaptors for connection valve and fittings. For the HDPE connection to the ductile iron lift station piping, a thrust collar is required in addition to the adaptor, sleeve, and restrained fittings.

I. Mechanical Restraint: Mechanical restraint for HDPE may be provided by mechanical means separate from the mechanical joint gasket sealing gland. The restrainer shall provide wide, supportive contact around the full circumference of the pipe and be equal to the listed widths. Means of restraint shall be machined serrations on the inside surface of the restrainer equal to or greater than the listed serrations per inch and width. Loading of the restrainer shall be a ductile iron follower that provides even the circumferential loading over the entire restrainer. Design shall be such that the restraint shall be increased with increases in line pressure.

Serrated restrainer shall be ductile iron ASTM A536-80 with a ductile iron follower; bolts and nuts shall be corrosive resistant, high strength alloy steel.

The restrainer shall have a pressure rating of, or equal to that of the pipe on which it is used. Restrainers shall be JCM Industries, Sur-Grip or approved equal.

Pipe stiffeners shall be used in conjunction with restrainers. The pipe stiffeners shall be designed to support the interior wall of the HDPE. The stiffeners shall support the pipe's end and control the "necking down" reaction to the pressure applied during normal installation. The pipe stiffeners shall be formed of 316 stainless steel to the HDPE manufacturers published average inside diameter of the specific size and DR of the HDPE. Stiffeners shall be JCM Industries or pre-approved equal.

2.02 GENERAL

A. The Contractor shall furnish all fittings and special pieces required for closures, curves, bends, branches, air release valves, isolation valves, flush valves, and connections indicated or shown on the Drawings. All connections to the pipe shall be at fittings.

B. Marking: Each length of pipe and each fitting shall be plainly marked as required by ASTM D-3350. All pipe shall be marked and include a single colored stripe (which provides an easy, obvious quick means to identify the pipe DR [dimension ration] on a multiple DR project. Each permanent, co-extruded color designates a different DR – which determines pressure rating), after factory testing, to indicate type or class of pipe. Any pipe without marking, as specified herein, shall not be delivered to the project site.

C. Packaging: The manufacturer shall package the pipe in a manner designed to deliver the pipe to the project neatly, intact and without physical damage. The transportation carriers shall use appropriate methods and intermittent checks to ensure the pipe is properly supported, stacked, and restrained during transportation such that the pipe is not nicked, gouged, or physically damaged.

D. Handling: The pipe and fittings shall be handled by the use of belt slings, padded cradles, nylon slings or other devices designed and constructed to prevent damage to the pipe, coating, or lining. The use of chains, cables, hooks, or other equipment which might injure the pipe will not be permitted. Fusion segments of the pipe shall be handled so as to avoid damage to the pipe. Spreader bars are recommended when lifting long fused sections.

E. Damaged Materials: The Contractor shall be fully liable for the cost of replacement or repair of pipe, fitting, or special which in the opinion of the Owner or Engineer is damaged. Sections of pipe having been discovered with cuts or gouges in excess of 10% of the pipe wall thickness shall be cut out and removed. The undamaged portion of the pipe shall be rejoined using the heat fusion joining method.

F. Storage: Stockpiled pipe shall be stored on level surface on pallets, skids, sand or rock free berms, sandbags, old tires, or other suitable means sot that the pipe will not be damaged. If the pipe must be stacked for storage, such stacking shall be done in accordance with the pipe manufacturer's recommendations. The pipe shall not be rolled, pushed, or slid into place and shall be secured to prevent rolling. The pipe shall be handled in such a manner that it is not pulled over sharp objects or cut by chokers

or lifting equipment.

PART 3 - EXECUTION

3.01 HANDLING PIPE AND FITTINGS

A. Care shall be taken in loading, transporting, and unloading to prevent injury to the pipe. Pipe or fittings shall not be dropped. All pipe or fittings shall be examined before lying and no pieces shall be installed which is found to be defective.

B. If any defective pipe is discovered after it has been installed it shall be removed and replaced with a sound pipe in a satisfactory manner at no expense to the Owner.

C. All pipe and fittings shall be thoroughly cleaned before laying, shall be kept clean until they are used in the Work, and when installed or laid, shall conform to the lines and grades required.

3.02 LAYING EXTERIOR PIPE AND FITTINGS TRENCH CONSTRUCTION METHODS

A. Haunching and Initial Backfill: Pipe and fittings shall be installed in accordance with Class I, II, or III materials of ASTM D2321 Section 5, ASTM D2774, and the manufacturer's requirements except as otherwise provided herein. Class IV and V materials are not recommended for embedment. A firm even bearing throughout the length of the pipe shall be constructed by tamping selected material at the sides of the pipe up to the springline. Blocking will not be permitted.

B. All pipe shall be sound and clean before laying. When laying is not in progress, the open ends of the pipe shall be closed by watertight plug or approved means. Alignment shall be preserved in laying. The deflection at joints or radius of curvature shall not exceed half of the Manufacturer's published allowances. Fittings, in addition to those shown on the Drawings, shall be provided, if required, in crossing utilities which may be encountered upon opening the trench.

C. In the pipe-laying phase, some accommodations can be made to allow for thermal expansion/contraction. Placement of the pipe in the trench will normally provide from acceptable levels of "snaking". Pipe should not be pulled to straighten. Leave the side-to-side path and cut to length for the tie-in. The final tie-in should be performed after an overnight stay in the trench to allow the pipe to cool down to near normal soil conditions.

D. Minimum bearing areas for concrete and pipe interfaces shall be as shown on the Drawings and Details. Joints shall be protected by felt roofing paper prior to placing concrete. Concrete shall be placed against undisturbed material. Wooden side forms shall be provided for thrust blocks.

E. Connections made to valves, rigid pipes or manholes should be supported by thrust blocking or solidified, well tamped bedding below the joint. A concrete pad should be

installed under a heavy member to resist settlement and preclude the HDPE pipe supporting the component.

F. In disturbing the pipe in the field, each pipe shall be placed as near as possible to the point where it is to be fused and laid, and the pipe securely wedged in place to prevent its movement until required. A sling shall be used for rolling or lifting pipe. No iron chains shall be used. Pipe which has been improperly distributed and which must be moved longitudinally along the trench shall be moved by such means as recommended by the Manufacturer and as approved by the Engineer.

If in the process of manufacture, transportation, or handling, any pipe or special received any damage, such pipe or specials shall be replaced at the Contractor's expense.

Pipe which is placed in storage shall be so arranged as not to cause inconvenience to traffic and must be protected sufficiently to prevent injury to the pipe. The Contractor shall have sole responsibility for the protection of the pipe and shall replace all pipe damaged as a result of his failure to adequately protect all pipe placed in storage.

Before placement of pipe in the trench, each pipe or fitting shall be thoroughly cleaned of any foreign substance, which may have collected thereon and shall be kept clean at all times thereafter. The openings of all pipes and fittings in the trench shall be closed during any interruption of the work. As pipe laying progress, the Contractor shall keep the pipe interior free of all debris. The Contractor shall completely clean the interior of the pipe of all sand, dirt, or any other debris following completion of the pipe laying.

No pipe shall be laid until the trench has been properly excavated, as specified, shown or as directed to provide a firm but slightly yielding trough for embedding the pipe. Bedding material shall be as specified, and all such must be free of cemented hard lumps or foreign material.

Pipes shall be thoroughly cleaned before they are laid and kept clean until completed. Before lowering into the trench, each pipe and fitting shall be checked for soundness. Pipe shall be carefully handled and lowered in the trench.

All trenches shall be kept free of water when pipe laying is in process.

Proper implements, tools, and facilities satisfactory to the Engineer, shall be provided and used by the Contractor for the safe and convenient prosecution of the Work. All pipe and fittings shall be carefully lowered into the trench by means of a backhoe or crane using proper slings, and other suitable tools or equipment, in such a manner as to prevent damage to the pipe. Metal slings, cables or chains shall not be placed around the pipe to move or lower it in the trench. Under no circumstances shall pipe or accessories be dropped or dumped into the trench. Any defective piece shall be removed, and a new piece shall be furnished and installed by the Contractor in replacement thereof at no additional cost.

Wherever necessary to deflect pipe from a straight line, either in vertical or horizontal

plane to avoid obstructions, or for other reasons, the degree of deflection, or radius of curvature shall not exceed half of the manufacturer's published allowances and must be approved by the Engineer. The Contractor shall anticipate the need for deflected joints.

Provide inductive tracer detection tape directly above the centerline of all non-metallic pipes. Tracer tape shall be placed in accordance with the manufacturer's recommendations. The detector tape must be laid in the same trench as a force main pipe. The detector tape must be located above and parallel to the force main. The detector tape must bear the label "PRESSURIZED WASTEWATER" continuously repeated in at least 1.5 inch letters.

G. Field joining of pipe and fittings shall be in accomplished using the butt heat fusion method in strict accordance with the Manufacturer's instructions. All butt fusions of the pipe shall result in a joint that is as strong as the pipe. Training the Manufacturer's fusion joining procedures shall be provided by the Manufacturer to the Contractor. See Section 3 for Manufacturer's Field Service Requirements.

H. Butt Fusion Method: Sections of polyethylene pipe should be joined into continuous lengths on the jobsite above ground. The butt fusion equipment used in the joining procedures should be capable of meeting all conditions recommended by the pipe manufacturer, including, but not limited to, temperature requirements of 400°F, alignment, and an interfacial fusion pressure of 75 psi. The butt fusion joining will produce joint weld strength equal to or greater than the tensile strength of the pipe itself. All field welds shall be made with fusion equipment equipped with a McElroy Data Logger. Temperature, fusion pressure, and a graphic representation of the fusion cycle shall be a part of the quality control records.

3.03 LAYING EXTERIOR PIPE AND FITTINGS TRENCHLESS CONSTRUCTION METHODS

A. Follow all manufacturer recommendations for allowable pulling lengths based on short-term tensile strength. Use of pull forces greater than calculated may result in pipe damage.

3.04 PIPE INSPECTION

Each pipe shall be inspected during construction and shall be true to both line and grade; shall show no leaks, and the hydraulics of the pipe shall be in no way impaired. The pipe shall be free from defects; and shall contain no deposits of sand, dirt or other materials which will in any way reduce the full cross-sectional area. All finished work shall be neat in appearance and of first-class workmanship, and all details shall conform to contract, detail, shop or working Drawings. Proper bulkheads, plugs, or stoppers must be in place where required.

If, as the result of any inspection before final completion of the Work, it is found that any section of the pipe has unduly settled, that joints have opened up or gaskets are displaced, or when pipes are found cracked, broken or misshaped, or if any other

defects are found in the pipes or in any of their appurtenances which might impair the stability of the satisfactory performance of the pipe, or which show non-conformance with the Drawings or Specifications, and the Contractor shall cause such order defective or inferior work to be removed and replaced by proper material and workmanship without extra compensation for the labor, equipment and materials required.

3.05 MANUFACTURER FIELD SERVICE

Manufacturer's field representative shall certify that the installations and fusion welding of pipe joints observed were satisfactorily completed and all pipe installation crews were familiar with the proper methods and procedures for the pipeline installations. The manufacturer shall also be available for technical field support throughout the remainder of the project.

3.06 FIELD TRAINING REQUIREMENTS

Contractor is required to provide a minimum of a four (4) hour training session to two (2) Owner operators during the pipe joining and pipe laying process. The Contractor must coordinate this training with the Owner 72 hours in advance and provide the field training prior to completion of the project.

3.07 WARRANTY

A minimum 2-year warranty from date of final acceptance is required.

3.08 MEASUREMENT

HDPE pipe will be measured by per lump sum for the Wastewater Line Segments A1 and A3.

Where a line ties into an existing system, the length of the new line will be measured from the visible end of the existing system at the completed joint. Unless otherwise indicated, the length of the line will be measured along pipe horizontal centerline stationing through fittings, valves, manholes, and other appurtenances.

Fittings will not be measured separately. These will be subsidiary to the Line A1 and A2 item.

Excavation and backfill, when included as pipe installation will not be measured as such but shall be included in the lump sum bid for constructing pipe and measured as a pipe complete in place including excavation and backfill.

All casing pipe, air release valve and associated manholes/vaults, fittings, asphalt repair, bore pits, and all items necessary to complete the construction of the Line Segments A1 and A2 complete and in place will not be measured as such but shall be included in the lump sum price.

3.09 PAYMENT

Payment for pipe, measures as prescribed above, will be made at the unit price bid per LF for the various sizes of pipe, of the materials and type indicated. Payment for pipe, measures as prescribed above, will be made at the unit price bid per LF complete-in-place as designed and represented in the Drawings and other Contract Documents. Subsidiary items to the bid price per LF of pipe shall include the following:

1. Clearing
2. Constructing any necessary embankment
3. Excavation, disposal of surplus or unusable excavated material
4. Furnishing, hauling, and placing pipe
5. Fittings
6. Field constructed joints, collars, temporary plugs, caps, or bulkheads
7. All necessary lugs, rods, or braces
8. Pipe coatings and protection
9. Connections to existing systems or structures, concrete blocking and thrust blocks and restrained joints
10. Preparing, shaping, pumping for dewatering, and shoring of trenches
11. Bedding materials
12. Backfill materials
13. Hauling, placing, and preparing bedding materials
14. Particle migration measures
15. Hauling, moving, placing, and compacting backfill materials
16. Temporary and permanent pavement repairs and maintenance
17. Temporary and permanent removal and replacement of pavement, curb, drainage structures, driveways, sidewalks, and any other improvements damaged or removed during construction
18. Cleanup
19. Vertical stack on deep services

20. Air Release Valves and associated vaults and manholes as shown on Drawings

21. Bore Pits as shown on Drawings

22. All Construction methods including open cut and trenchless as shown on Drawings

23. All asphalt and trench repair

24. Casing Pipe

25. All other incidentals necessary to complete the pipe installation as indicated

No separate payment will be made for thrust restraint measures.

Payment, when included as a Contract pay item, will be made under

Pay Item No. 1: Inclusive of furnishing all tools, labor, materials, equipment, and miscellaneous items necessary for the complete construction and related demolition as shown on the Drawings and specified in the Contract Documents, complete and in-place for the lump sum price.

END OF SECTION 913

SECTION **914**
MISCELLANEOUS METALS

PART 1: GENERAL

1.1 SCOPE OF WORK

A. Furnish all labor, materials, equipment, and incidentals required to complete and install fabricated metal items. Furnish all supplementary items necessary for their proper installation.

B. Check Drawings carefully and furnish all anchors, sleeves, bolts, brackets, clips, inserts, angles, loose lintels, tubing, bar stock, plates, and other miscellaneous metal not distinctly specified under other sections but necessary to complete the Work.

1.2 REFERENCE STANDARDS

A. Aluminum Association Inc. (AA)

1. ASD-1 - Aluminum Standards and Data
2. Specifications for Aluminum Structures

B. American Institute of Steel Construction (AISC)

1. Manual of Steel Construction - Allowable Stress Design, Ninth Edition

C. American Society for Testing and Materials (ASTM)

1. ASTM A36 - Standard Specification for Carbon Structural Steel
2. ASTM A48 - Standard Specification for Gray Iron Castings
3. ASTM A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
4. ASTM A108 - Standard Specification for Steel Bars, Carbon, Cold-Finished, Standard Quality
5. ASTM A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
6. ASTM A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

7. ASTM A167 - Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
8. ASTM A193 - Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service
9. ASTM A276 - Standard Specification for Stainless Steel and Heat-Resisting Steel Bars and Shapes
10. ASTM A283 - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
11. ASTM A307 - Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength
12. ASTM A325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
13. ASTM A366 - Standard Specification for Steel, Sheet, Carbon, Cold-Rolled, Commercial Quality
14. ASTM A500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
15. ASTM A501 - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
16. ASTM A563 - Standard Specification for Carbon and Alloy Steel Nuts
17. ASTM B695 - Standard Specification for Coating of Zinc Mechanically Deposited on Iron and Steel
18. ASTM F436 - Standard Specification for Hardened Steel Washers
19. ASTM F594 - Standard Specification for Stainless Steel Nuts

D. American Iron & Steel Institute (AISI)

E. American National Standards Institute (ANSI)

1. ANSI B18.22.1 - Plain Washers

F. American Welding Society (AWS)

1. AWS D1.1 - Structural Welding Code Steel
2. AWS D1.2 - Structural Welding Code Aluminum
3. AWS A2.4 - Standard Symbols for Welding, Brazing and Nondestructive Examination
4. AWS A5.1 - Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding

G. Steel Structures Painting Council (SSPC)

1. SSPC SP-1 - Surface Preparation Specification No. 1 Solvent Cleaning
2. SSPC SP-2 - Surface Preparation Specification No. 2 Hand Tool Cleaning

3. SSPC SP-3 - Surface Preparation Specification No. 3 Power Tool Cleaning

4. SSPC SP-6 - Surface Preparation Specification No. 6 Commercial Blast Cleaning

5. SSPC SP-10 - Surface Preparation Specification No. 10 Near-White Blast Cleaning

H. Where reference is made to one of the preceding standards, the revision in effect at the time of bid opening shall apply unless specifically noted otherwise.

1.3 SUBMITTALS

A. Prior to fabrication, submit in accordance with Section 0 1300 shop drawings, erection or setting drawings, product data, etc., showing methods of assembly, anchorage, and connection to other members. Indicate welded connections in accordance with AWS A2.4. Shop drawings will be required for all items included under this Section.

1. Shop drawings for miscellaneous metal fabrication shall, with each fabrication, clearly indicate the Contract Drawing and Detail Number(s) for which that fabrication is provided.

B. Submit samples as requested by the Engineer during the course of construction.

1.4 COORDINATION

A. Coordinate completely the work of this Section with the work of other sections. Verify at the site both the dimensions and work of other trades adjoining items of work in this Section before fabrication and installation of the items specified.

B. Furnish to the pertinent trades all items included under this Section that are to be built into the work of other sections.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver items to be incorporated into the work of other trades in sufficient time to be checked prior to installation.

B. Deliver anchorage devices with setting drawings, templates, and instructions for installation.

C. Store delivered items off the ground and protected from dirt and weather.

D. Protect items to be incorporated into the Work against scratches, splashes, mortar, paint, or other damage during transportation, storage, installation, and until adjacent work by other trades in complete.

E. Repair items which have become damaged or corroded to the satisfaction of the Engineer prior to incorporating them into the work.

PART 2 - PRODUCTS

2.1 STEEL FABRICATIONS

A. Materials

1. Structural steel shapes, plates, bars, and rods: ASTM A36.

2. Steel plates - bent or cold-formed: ASTM A283, Grade C.

3. Steel sheets: ASTM A366.
4. Welded and seamless steel pipe: ASTM A501 or ASTM A53, Type E or S, Grade B Schedule 40. Use standard malleable iron fittings, galvanized for exterior work.
5. Welded and seamless rectangular steel tubing: ASTM A500, Grade B.
6. Carbon steel bolts and studs: ASTM A307, Grade A hot dip galvanized where noted.
7. High strength bolts, nuts, and washers for structural steel: ASTM A325 mechanically galvanized to ASTM B695, Class 50, Type II where noted.
    a) Elevated temperature exposures: ASTM A325-Type I
    b) General application: ASTM A325-Type I or II
8. Headed Anchor Studs: Nelson Type H4L or S3L by Nelson Stud Welding Company, or equal
9. Welding Materials: AWS A5.1
10. Galvanizing
    a) General: ASTM A123
    b) Hardware: ASTM A153
    c) Assembled steel products: ASTM A123
11. Shop and Touch-up Primer: SSPC - Paint 15 Type I red oxide

B. Fabrication

1. See general fabrication requirements in Paragraph 2.07.
2. Fabricate miscellaneous steel in accordance with the Drawings. Fabrications include beams, angles, support brackets, splice plates, anchor bolts (except for equipment furnished in Division 11), and any other miscellaneous steel called for on the Drawings and not otherwise specified.
3. Thoroughly clean steel fabrications of all loose mill scale, rust, grease or oil, moisture, dirt, or other foreign matter and finish.
    a) Remove scale, rust, and other deleterious materials before shop coat of paint is applied.
    b) Clean off heavy rust and loose mill scale in accordance with SSPC SP-6 unless otherwise indicated.
    c) Remove oil, grease, and similar contaminants in accordance with SSPC SP-1.

C. Finishes

1. Items in areas which are not exposed to weather or moisture, shall have exposed surfaces painted with a shop coat of primer compatible with the finish coatings specified in Division 9, after fabrication but before shipping. Apply two shop coats of primer to surfaces that will be inaccessible after erection.

a) Remove scale, rust, and other deleterious material before shop coat of paint is applied. Clean off heavy rust and loose mill scale in accordance with SSPC-2, SSPC-3 or SSPC-6. Remove oil, grease, and similar contaminants in accordance with SSPC SP-1.

b) Immediately after surface preparation, brush or spray on metal primer paint, applied in accordance with manufacturer's instructions and at rate to provide a uniform dry film thickness of 3.0 mils per coat applied. Use painting methods which will result in full coverage of joints, corner, edges, and all exposed surfaces.

c) As soon as possible after erection, touch up any scraped, abraded, or unpainted surfaces using primer as specified for shop coats.

2. Items exposed to weather, submerged in water or subject to splashing, or located in corrosive environments shall be hot dip galvanized after fabrication unless otherwise noted on the Drawings or specified.

a) Following all manufacturing operations, items to be galvanized shall be thoroughly cleaned, pickled, fluxed, and completely immersed in a bath of molten zinc. The resulting coating shall be adherent and shall be the normal coating to be obtained by immersing the items in a bath of molten zinc and allowing them to remain in the batch until their temperature becomes the same as the bath. Coating shall be not less than 2 ounces per square foot of surface.

b) Where field welding of galvanized material is necessary, welds shall be wire brushed clean and immediately regalvanized in the field using "Galvalloy" galvanizing stick compound or coating with ZRC zinc coating by the Sealube Company.

2.2 STAINLESS STEEL FABRICATIONS

A. Materials

1. Plates and sheets

a) Exterior, submerged, or industrial use: ASTM A167, Type 316

b) Interior and architectural use: ASTM A167, Type 304

2. Structural shapes

a) Exterior, submerged, or industrial use: ASTM A276, Type 316

b) Interior and architectural use: ASTM A276, Type 304

3. Bolts, nuts, and washers: ASTM A276, Type 316

B. Fabrication

1. See general fabrication requirements in Paragraph 2.07.

2.3 CAST IRON FABRICATIONS

A. Materials

1. Gray iron castings: ASTM A48, Class 30.

B. Fabrication

1. See general fabrication requirements in Paragraph 2.07.

2. Provide frames, covers, and grates for manholes, catch basins, and inlets fabricated from good quality, strong, tough, even grained cast iron. Castings shall be as manufactured by the Neenah Foundry; Mechanics Iron Foundry; or equal. Sizes shall be as shown on the Drawings or specified.

3. Provide solid manhole and holdhole covers and frames for electrical and telephone underground systems. Covers shall have letters "HIGH VOLTAGE," "LOW VOLTAGE," "SIGNAL," "TELEPHONE," as applicable, embossed on top.

2.4 ALUMINUM FABRICATIONS

A. Aluminum Framing and Fabrications

1. Materials

a) Aluminum structural shapes and plates: Alloy 6061-T6

b) Extruded aluminum pipe: Alloy 6063-T6

c) Fasteners, stainless steel: ASTM A276, Type 316

2. Fabrication

a) See general fabrication requirements in Paragraph 2.07.

b) Fabricate miscellaneous aluminum shapes and plates as shown. Furnish welded and mitered angle frames and other fabrications complete with welded anchors attached. Furnish all miscellaneous aluminum shown but not otherwise detailed. Structural shapes and extruded items shall comply with the dimensions on the Drawings within the tolerances published by the Aluminum Association.

c) Weld aluminum work on the unexposed side when possible in order to prevent pitting or discoloration of exposed aluminum surfaces.

3. Finishes

a) All exposed aluminum surfaces shall have fabricator's standard mill finish unless otherwise specified.

B. Aluminum Nosings for Concrete Stairs

1. Nosings shall be Wooster Products, Inc. - Type 116, 3-inch wide nosing with 1-inch nose depth, "Alumogrit" surface, or equal.

2. Provide concealed stainless-steel integral anchors extending at least 1¼-inches below the tread and spaced out more than 12-inches on center. Drilled anchors are not acceptable. Furnish treads with heavy duty protective tape cover.

2.5 ANCHORS, BOLTS, AND FASTENING DEVICES

A. Furnish anchors, bolts, fasteners, etc., as necessary for installation of the work of this Section or for securing the work of other sections to in-place construction.

B. For structural purposes, unless otherwise noted, drilled concrete anchors shall be adhesive capsule type or expansion type anchor bolts.

1. Adhesive capsule anchors shall be a two-part stud and capsule chemical resin anchoring system. Capsules shall be self-contained, exactly proportioned, sealed glass units containing premeasured amounts of resin, aggregates, and hardener. Stud assemblies shall be as indicated on the Drawings and shall include all-thread anchor rod with nut and washer. Provide manufacturer's recommended drive units and adaptors for installing capsules and studs. Install anchors in full compliance with the manufacturer's recommendations.

a. Threaded anchor rod assemblies shown on the Drawings shall be manufactured from the following materials:

1) Standard:
Rod: ASTM A307, Grade A Nut:
ASTM A563, Grade A
Washer: ANSI B18.22.1, Type A Plain

2) High Strength:
Rod: ASTM A193, Grade B7
Nut: ASTM A563, Grade DH
Washer: ASTM F436

3) Stainless Steel:
Rod: ASTM F594 (AISI Type 304) Nut:
ASTM F594
Washer: ANSI B18.22.1, Type A, Plain

b. Acceptable manufacturers: "HVA Adhesive Anchor" by Hilti; "Parabond Capsule Anchor" by Molly; or equal

2. Expansion Anchors shall be drop-in wedge type anchors of the sizes noted on the Drawings complete with nuts and washers. Unless otherwise noted, provide zinc plated carbon steel anchors. Stainless steel anchors, where required shall be all AISI Type 316 construction. When the length or embedment of the bolt is not noted on the Drawings, provide length sufficient to place the wedge and expansion sleeve portion of the bolt at least one inch behind the reinforcing steel within the concrete. Expansion anchors shall be "Kwik Bolt" by Hilti; "Parabolt" by Molly; or equal.

3. Threaded rods set in epoxy paste shall be materials as indicated on the Drawings and as specified in the preceding paragraphs for adhesive capsule anchors.

C. Headed anchor studs shall be flux ended, welded to plates or other embeds as shown on the Drawings. Studs shall be made from cold drawn steel Grades C-1010 through C-1020 per ASTM A108 and shall be welded per the manufacturer's recommendations. Headed anchor studs shall be Type H4L or S3L by Nelson Stud Welding Company, Loraine, OH; or equal.

2.6 SPECIAL PREFABRICATED ACCESS HATCHES AND ACCESSORIES

A. Refer to Item No. 11000 Non-Clog Submersible Sewage Pumps for information on the access hatches and accessories.

2.7 FABRICATION - GENERAL

A. Form all miscellaneous metal work true to detail, with clean, straight, sharply defined profiles, and smooth surfaces of uniform color and texture. Provide fabrications free from defects impairing strength or durability. Drill or punch holes and smooth edges. Ease exposed edges to a small, uniform radius. Fabricate supplementary pieces necessary to complete each item though such pieces are not definitely shown or specified.

B. Supply components required for anchorage of fabrications. Connections and accessories shall be of sufficient strength to safely withstand stresses and strains to which they will be subjected. Steel accessories and connections to steel or cast iron shall be steel, unless otherwise specified. Threaded connections shall be made so that the threads are concealed by fitting.

C. Welded joints shall be rigid and continuously welded or spot welded as specified or shown. Dress the face of welds flush and smooth. Continuously weld and grind smooth welds that will be exposed. Exposed joints shall be close fitting and jointed where least conspicuous. Conceal fastenings where practical. Punch or drill for temporary field connections and for attachment of the work of other trades.

D. Welding of parts shall be in compliance with the latest edition of the AWS structural welding code for steel (D1.1) or aluminum (D1.2) as appropriate, and shall only be done where shown, specified, or permitted by the Engineer. Welding shall be performed only by welders certified to perform the required welding in compliance with the requirements of the AWS Code. Component parts of built-up members to be welded shall be adequately supported and clamped or held by other adequate means to hold the parts in proper relation for welding.

E. Castings shall be of good quality, strong, tough, even-grained, smooth, free from scale, lumps, blisters, sand holes, and defects of any kind which render them unfit for the service for which they are intended. Thoroughly clean castings. Castings may be subjected to a hammer inspection in the field by the Engineer. All finished surfaces shown on the Drawings and/or specified shall be machined to a true plan surface allowing pieces to seat at all points without rocking. Make allowances in the patterns so that thicknesses specified or shown will not be reduced in obtaining finished surfaces. Castings will not be acceptable if the actual weight is less than 95 percent of the theoretical weight computed from the dimensions shown. Provide facilities for weighing castings in the presence of the Engineer and show true weights, certified by the supplier.

F. Shop painting will not be required for galvanized metal, stainless steel, aluminum, copper, brass, and bronze unless specifically specified.

PART 3 - EXECUTION

3.1 INSTALLATION - GENERAL

A. Items to be attached to concrete or masonry after such work is completed shall be installed in compliance with the details shown. Furnish to appropriate trades all anchors, sockets, or fastenings required for securing work to other construction.

B. Set metal work level, true to line and plumb as indicated.

C. Weld field connections and grind smooth where practicable. Clean and strip primed, steel items to bare metal where site welding is required. Conceal fastenings where practicable.

D. Secure metal to wood with lag screws, of adequate size, with appropriate washers.

E. Secure metal to masonry with embedded anchors, setting compound, lead caulking and sleeves, or cement-sand grouting. Fastening to wood plugs in masonry will not be permitted.

F. Touch-up abrasions to finish or primer coatings immediately after erection and prior to both final coating and final acceptance.

G. Break contact between dissimilar metals as shown on the Drawings or as specified in Paragraph 3.01.

H. Field-apply coatings for installation of metal fabrications according to the following schedule. (For embedded items, coat the embed.)

1. All steel surfaces in contact with exposed concrete or masonry shall receive a protective coating of an approved heavy bitumastic troweling mastic applied in compliance with the manufacturer's instructions prior to installation.

2. Where aluminum contacts a dissimilar metal, apply a heavy brush coat of zinc-chromate primer followed by two coats of aluminum metal and masonry paint to the dissimilar metal.

3. Where aluminum contacts masonry or concrete, apply a heavy coat of zinc chromate primer to the surface of the aluminum.

4. Where aluminum contacts wood, apply two coats of aluminum metal and masonry paint to the wood.

3.2 INSTALLATION - STAIR NOSINGS

A. Extend nosings to within 4-inches of ends of treads. Set top flush with tread and edge flush with riser. Set nosing anchors into concrete as concrete is poured. Do not remove protective tape until completion of Project.

3.3 INSTALLATION - HATCHES AND LADDER EXTENSIONS

A. Access hatches and telescoping ladder extensions shall be installed in compliance with manufacturer's instructions.

3.4 SCHEDULE OF FABRICATED METAL ITEMS

A. Steel Lintels. Galvanized or stainless steel of size and shape as indicated with minimum of 4-inch bearing at jambs unless otherwise shown.

B. Shelf Angles/Veneer Relief Angles. Galvanized or stainless steel of size and shape as indicated. Provide minimum 4-inch bearing at jambs unless otherwise shown.

C. Steel Supports and Frames for Louvers. Galvanized structural steel of size and shape indicated or as required for wind loads.

D. Roof Curb Framing. Galvanized structural steel sections as indicated.

E. Ceiling Mounted Equipment Supports. Galvanized structural steel as indicated.

F. Steel Pipe Guard Post (Bollards). Galvanized Schedule 40 steel pipe as indicated, fill with concrete to formed crowned cap.

G. Break Metal Closure Angles and Plates. Galvanized. Size, gauge, and anchorage as indicated, fit tight against surfaces.

H. Wall Sleeves. Galvanized Schedule 40 steel or cast iron pipe with end joints as shown on the Drawings. Provide center anchor around circumference as shown.

I. Bolts, Anchors, Brackets, Clips, and Inserts. Type and size required to rigidly secure members for which they are to be used.

J. Miscellaneous Angles, Plates, Gratings, Tubing, Bar Stock, Break Metal, etc. As required for the proper installation of various items throughout the building if not otherwise furnished.

END OF SECTION 914

SECTION 915
SURFACE PREPARATION AND SHOP PRIME PAINTING

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment, and incidentals required for the surface preparation and application of shop primers on ferrous metals, excluding stainless steels, as specified herein.

1.02 RELATED WORK

A. Finish painting is included in Section 09902.

1.03 SUBMITTALS

A. Submit to the Engineer, as provided in Section 01300 for shop drawings, manufacturer's specifications and data on the proposed primers and detailed surface preparation, application procedures and dry mil thicknesses.

B. Submit representative physical samples of the proposed primers, if required by the Engineer.

1.04 REFERENCE STANDARDS

A. Steel Structures Painting Council (SSPC)

1. SSPC-SP-6: Surface Preparation Specification No. 6 Commercial Blast Cleaning.

2. SSPC-SP-10: Surface Preparation Specification No. 10 Near White Blast Cleaning.

B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Submerged Surfaces - shop primer for ferrous metals which will be submerged or which are subject to splash action or which are specified to be considered submerged service shall be sprayed with one coat (dry film thickness 2.5 to 3.5 mils) of Tnemec Series 1 Omnithane by Tnemec Company, Inc. or Sherwin Williams Macropoxy 646 by Sherwin- Williams Company.

B. Non-Submerged Surfaces - spray apply one coat (dry film thickness 2.5 to 3.5 mils) of Tnemec Series 1 Omnithane Primer by Tnemec Company, Inc. or Sherwin Williams Macropoxy 646 by Sherwin-Williams Company.

C. Non-Primed Surfaces - gears, bearings surfaces and other similar surfaces obviously not to be painted shall be given a heavy shop coat of grease or other suitable rust-resistant coating. This coating shall be maintained as necessary to prevent corrosion during all periods of storage and erection and shall be satisfactory to the Engineer up to the time of the final acceptance test.

D. Compatibility of Coating Systems - shop priming shall be done with primers that are guaranteed by the manufacturer to be compatible with their corresponding primers and finish coats as specified in Section 09902 for use in the field and which are recommended for use together.

PART 3 - EXECUTION

3.01 APPLICATION

A. Surface Preparation and Priming

1. Non-submerged components scheduled for priming, as defined above, shall be blast cleaned in accordance with SSPC-SP-6, immediately prior to priming. Submerged components scheduled for priming, as defined above, shall be blast cleaned in accordance with SSPC-SP-10, immediately prior to priming.

2. Surfaces shall be dry and free of dust, oil, grease and other foreign material before priming.

3. Shop prime in accordance with approved manufacturer's recommendations.

B. Non-Primed Surfaces

1. Apply approved coating per manufacturer's recommendations.

3.02 FABRICATED ITEMS

A. All items to be shop primed shall be blast cleaned as specified for applicable service prior to priming. If, in the opinion of the Engineer, any prime coating has been improperly applied or a material contrary to these Specifications has been used, that coating shall be removed by abrasive blasting to white metal and reprimed in accordance with these Specifications.

B. All shop prime coats shall be of the correct materials and applied in accordance with these Specifications. Remove any prime coats not in accordance with these Specifications by blast cleaning and applying the specified prime coat at no additional cost to the Owner.

C. Shop primed surfaces shall be cleaned thoroughly and damaged or bare spots prepared as approved and retouched with the specified primer before the application of successive paint coats in the field.

D. Properly protect the shop prime and finish coats against damage from weather or any other cause.

E. A shop finish coat shall be equal in appearance and protection quality to a field applied finish coat. If, in the opinion of the Engineer, a shop finish coat does not give the appearance and protection quality of other work of similar nature, prepare the surfaces and apply the coat (or coats) of paint as directed by the Engineer to accomplish the desired appearance and protection quality. Submit to the Engineer substantial evidence that the standard finish is compatible with the specified finish coat.

F. Wherever fabricated equipment is required to be blast cleaned, protect all motors, drives, bearings, gears, etc, from the entry of grit. Any equipment found to contain grit shall be promptly and thoroughly cleaned.

END OF SECTION 915

SECTION 916
PAINTING

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The work of this section consists of furnishing all materials, labor, equipment, and incidentals required and performing all the painting necessary to complete this Contract in its entirety, including surface preparation.

B. It is the intent of these Specifications to paint all interior concrete where scheduled, exposed miscellaneous metal, pipe, fittings, supports, valves, equipment, and all other work obviously required to be painted unless otherwise specified. Minor items omitted in the schedule of work shall be included in the work of this Section where they come within the general intent of the specifications as stated herein.

C. In addition to the new structures, all existing structures (piping, fittings, valves, equipment, etc.) modified in this project are to be prepared for painting and painted. This includes all items in these existing areas both exterior, interior and submerged. The paint systems to be used on all existing surfaces are as scheduled for the new structures. All pipes are to be painted to conform to this section. Colors are to be consistent throughout the new and existing structures. Surface preparation shall conform to Section 09901.

D. The following surfaces or items are not required to be painted:

1. Portions of metal, other than aluminum, embedded in concrete. This does not apply to the back face of items mounted to concrete or masonry surfaces which shall be painted before erection. Aluminum to be embedded in or in contact with concrete or masonry shall be coated to prevent electrolysis.
2. Stainless steel.
3. Fencing.
4. Concealed surfaces of pipe or crawl spaces.
5. Acoustical ceilings.
6. Tile.
7. Exterior concrete, unless otherwise specified, and heavy duty concrete topping.
8. Finish hardware, except door closers that are not finished.
9. Manhole frames and covers.
10. Fiberglass other than piping.
11. Packing glands and other adjustable parts, and nameplates and dataplates of mechanical equipment.

1.02 RELATED WORK

A. Surface Preparation and Shop Prime Painting is included in Section 09901.

B. Color for Header and Force Main Piping shall be Grey Pantone #431U.

C. Color for Pump Motors and Motor Mounts shall be Grey Pantone #431U.

D. Color for Potable Water Line shall be Avalon Blue – Pantone Number 558.

E. Color for Power Conduits shall be Orange – Pantone Number 166.

F. Color for Control/Instrumentation Conduits shall be Yellow – Pantone Number 109.

1.03 REFERENCES

A. American Association of State Highway and Transportation Officials (AASHTO)

B. American Society for Testing and Materials (ASTM)

1. ASTM C150 - Specification for Portland Cement
2. ASTM D4258 - Practice for Surface Cleaning Concrete for Coating

C. National Science Foundation (NSF)

1. Standard 61

D. Occupational Safety and Health Act (OSHA)

1. Air Pollution Control Rules
2. Color Coding

E. Steel Structures Painting Council (SSPC)

1. SSPC-SP-1 - Surface Preparation Specification - Solvent Cleaning
2. SSPC-SP-2 - Surface Preparation Specification - Hand Tool Cleaning
3. SSPC-SP-3 - Surface Preparation Specification - Power Tool Cleaning
4. SSPC-SP-6 - Commercial Blast Cleaning
5. SSPC-SP-10 - Near White Metal Blast Cleaning

1.04 SUBMITTALS

A. Submit to the Engineer for review in accordance with Section 01300 shop drawings, working drawings, and product data including manufacturer's specifications and data on the proposed paint systems and detailed surface preparation, application procedures and dry film thickness. Certify that the systems submitted meet all applicable volatile organic carbon regulations. Equivalent systems are to be submitted at no additional costs to meet any new regulations.

B. Submit to the Engineer for review in accordance with Section 01300 color cards, including standard and special colors, for initial color selections.

C. Schedule of Painting Operations: Submit to the Engineer for review a complete Schedule of Painting Operations within 90 days after the Notice to Proceed. This Schedule is imperative so that the various fabricators may be notified of the proper shop prime coat to apply. Properly notify and coordinate the fabricators' surface preparation and painting operations with these Specifications. This Schedule shall include for each surface to be painted, the brand name, the percent volume of solids, the coverage and the number of coats the Contractor proposes to use in order to achieve the specified dry film thickness,

and color charts. When the Schedule has been approved, apply all material in strict accordance with the approved Schedule and the manufacturer's instructions. Wet and dry paint film gauges shall be made available to the Engineer to verify the proper application while work is in progress.

1.05 SPARE MATERIAL

A. Furnish one unopened gallon can of each type and each color of paint used.

1.06 PRE-PAINTING CONFERENCE

A. Well in advance of commencement of painting operations, but after major equipment has been delivered, a pre-painting conference shall be held. All parties with an interest in the painting work shall attend, including the Contractor, the Manufacturer, the Owner, the Engineer, and the painting subcontractor. The Contractor shall contact each party and arrange the meeting.

B. The conference shall include an inspection of the areas to be painted by all parties and a discussion of the conformance of each area with the specifications. Important issues such as environmental conditions, climate control systems, original primer, dry film thickness, and monitoring the number of coats that have been field applied shall be discussed and problems shall be resolved.

C. A written record of the meeting shall be submitted to the Engineer.

PART 2 - PRODUCTS

2.01 MATERIALS

A. All painting materials shall be fully equal to those manufactured by the Tnemec Company Inc. or Sherwin-Williams Company. The painting specification has been prepared on the basis of Tnemec, Sherwin-Williams, M.A.B. Paints, and PPG products and recommendations for applications. No brand other than those named will be considered for approval unless the brand and type of paint proposed for each item in the following schedule together with sufficient data substantiated by certified tests conducted at no expense to the Owner, to demonstrate its equality to the paint(s) named, is submitted in writing to the Engineer for approval within 30 days after the signing of the Notice to Proceed. The type and number of tests performed and information necessary for approval shall be subject to the Engineer's approval. Color availability to match those colors specified will also be considered as an important property for equality.

B. All painting materials shall be delivered to the mixing room in unbroken containers, bearing the manufacturer's brand, date of manufacture and name. They shall be used without adulteration and mixed, thinned, and applied in strict accordance with manufacturer's directions for the applicable materials and surface and with the Engineer's approval before using.

C. Shop priming shall be done with primers that are guaranteed by the manufacturer to be compatible with the finish paints to be used. Refer to Section 09901 for special primers.

D. No paint containing lead will be allowed. Oil shall be pure boiled linseed oil.

E. Work areas will be designated by the Engineer for storage and mixing of all painting materials. Materials shall be in full compliance with the requirements of pertinent codes

and fire regulations. Proper containers outside of the buildings shall be provided and used for painting wastes, and no plumbing fixture shall be used for this purpose.

F. All recommendations of the paint manufacturer in regard to the health and safety of workmen shall be followed.

2.02 PAINTING SYSTEMS

A. All colors will be in accordance with those listed in Section 1.02. Colors charts shall be submitted by the Contractor.

B. The following surfaces shall have the types of paint scheduled below applied at the dry film thickness (DFT) in mils per coat noted. Some colors will require an additional coat from what is listed to get the proper color coverage.

1. Ferrous metals submerged or subject to splashing:

   a) Tnemec
      2 Coats: N69-Color Hi-Build Epoxoline II (6-8 mils DFT per coat)
   b) Sherwin-Williams
      2 Coats: Macropoxy 646 FC, B58 Series (4-6 mils DFT per Coat)

2. Exterior nonsubmerged ferrous metals:

   a) Tnemec
      1 Coat: N69-Color Hi-Build Epoxoline II (4-6 mils DFT)
      1 Coat: 73-Color Endura-Sheild (3-5 mils DFT)
   b) Sherwin-Williams
      1 Coat: Macopoxy 646 FC, B58 Series (4-6 mils DFT)
      1 Coat: Hi-Solids Polyurethane, B65-300 Series (2.5 mils DFT)

3. Interior nonsubmerged ferrous metals:

   a) Tnemec
      2 Coats: Series N 69-Color Hi-Build Epoxoline II (4-6 mils DFT per coat)
   b) Sherwin-Williams
      2 Coats: Macropoxy 646 FC, B58 Series (4-6 mils DFT per coat)

4. Exterior galvanized, and non-ferrous metal:

   a) Tnemec
      1 Coat: Series N 69-Color Hi-Build Epoxoline II (3-5 mils DFT)
      1 Coat: 740-Color Endura-Shield (3-5 mils DFT)
   b) Sherwin-Williams
      1 Coat: Macropoxy 646 FC, B58 Series (4-6 mils DFT)
      1 Coat: Hi-Solids Polyurethane, B65 – 300 Series (2.5 mils DFT)

5. Interior galvanized, and non-ferrous metals:

   a) Tnemec
      2 Coats: 69-Color Hi-Build Epoxoline II (2-3 mils DFT per coat)
   b) Sherwin Williams
      2 Coats: Macropoxy 646 FC, B58 Series (4-6 mils DFT per coat)

6. Galvanized and non-ferrous metal submerged or subject to splashing:

   a) Tnemec
      1 Coat: N69-1211 Epoxoline II (3-5 mils DFT)
      1 Coat: Series N 69-Color Hi-Build Epoxoline II (4-6 mils DFT)
   b) Sherwin-Williams
      2 Coats: Macropoxy 646 FC, B58 Series (4-6 mils DFT per coat)
   c) PPG PITT-GUARD® Direct-to-Rust Epoxy Mastic Coating 97-145 series

7. Aluminum in contact with dissimilar materials:

   a) Tnemec
      2 Coats: 69-Color Hi-Build Epoxoline (3 mils DFT per coat)
   b) Sherwin-Williams
      2 Coats: Macropoxy 646 FC, B58 Series (4 - 6 mils DFT per coat)

C. Any surfaces not specifically named in the Schedule and not specifically excepted shall be prepared, primed and painted in the manner and with materials consistent with these Specifications. The Engineer shall select which of the manufacturer's products, whether the type is indicated herein or not, shall be used for such unnamed surfaces. No extra payment shall be made for this painting.

2.03 COLOR CODING FOR PIPES AND EQUIPMENT

A. When color coding is specified, it shall consist of color code painting and identification of all exposed conduits, trough items, and pipelines for the transport of gases, liquid, and semi-liquids including all accessories such as valves, insulated pipe coverings, fittings, junction boxes, bus bars, connectors, and all operating accessories which are integral to be whole functional mechanical pipe and electrical conduit system. Colors shall be as noted in Section 1.02.

B. All hangers and pipe support floor stands shall be painted the same color and with the same paint as the pipe it supports. The system shall be painted up to but not including the flanges attached to the mechanical equipment nor the flexible conduit connected to electrical motors. When more than one pipe system is supported on the same bracket, the bracket shall be painted the same color as the adjacent wall or ceiling. Colors shall be as noted in Section 1.02.

C. All systems which are an integral part of the equipment, that is originating from the equipment and returning to the same piece of equipment, shall be painted between and up to but not including, the fixed flanges or connections on the equipment.

D. The color code establishes, defines, and assigns a definite color for each category of pipe. Pipelines which are not listed shall be assigned a color by the Engineer and shall be treated as an integral part of the Contract.

E. Banding for pipes shall be as specified in the Paint and Color Coding Schedule. Bands shall be 2-inch wide and located on each end of the pipe title, at 2-ft from the title bands, and at wall penetrations.

2.04 LETTERING OF TITLES

A. Each pipe system shall be labeled with the name of the materials in each pipeline and alongside this an arrow indicating the direction of flow of liquids. Titles shall be as so described in attached schedule. Titles shall not be located more than 20-linear-ft apart and shall also appear directly adjacent to each side of any wall the pipeline breaches, adjacent to each side of the valve regulator, flowcheck, strainer cleanout, and all pieces of equipment.

B. Titles shall identify the contents by complete name. Identification title locations shall be determined by the Engineer but in general they shall be placed where the view is unobstructed and on the two lower quarters of pipe or covering where they are overhead. Title should be clearly visible from operating positions especially those adjacent to control valves.

C. Titles on equipment shall be applied at eye level on machines where possible or at the upper most broad vertical surface of low equipment. Where more than one piece of the equipment item to be titled exists, the items shall be numbered consecutively as indicated on the mechanical drawings or as directed by the Engineer; for example Pump No. 1, Pump No. 2, etc. Titles shall be composed and justified on the left hand side as follows:

1. Pump No. 1
2. Pump No. 2

D. Application of titles.

1. The color of the titles shall be black or white, as approved, to best contrast with the color of the pipes and equipment and shall be stencil applied.
2. Stencil text is to be in ALL CAPS worded exactly as shown in the Schedule. Titles are to be printed in a single line.
3. Letter sizes

Outside Diameter of Pipe or Covering (inches)	Size of Legend Letters (inches)
¾ to 1 ¼	½
1 ½ to 2	¾
2 ½ to 6	1 ¼
8 to 10	2 ½
More than 10	3 ½

Equipment titles are to be 2-in high.

4. Arrow sizes. Where "a" is equal to ¾ of outside diameter of pipe or covering, the arrow shaft shall be 2 "a" long by 3/8 "a" wide. The arrow head shall be an equilateral triangle with sides equal to "a". Maximum "a" dimension shall be 6-in.
5. When using direction arrows, point arrowhead away from pipe markers and in direction of flow. If flow can be in both directions, use a double-headed directional flow.

2.05 METAL TAGS

A. For pipelines smaller than ¾-in in diameter, securely fasten metal tags, 2½-in × ½-in, of Birmingham or Stubs 17 gauge brass with lettering etched and filled with enamel. Tags shall be approved by the Engineer.

2.06 FABRICATED EQUIPMENT

A. Unless otherwise indicated all fabricated equipment shall be shop primed and shop or field finished.

B. All items to be shop primed shall be thoroughly cleaned of all loose material prior to priming. If, in the opinion of the Engineer, any prime coating shall have been improperly applied or if material contrary to these Specifications shall have been used, that coating shall be removed by sandblasting to white metal and reprimed in accordance with these Specifications.

C. All shop prime coats shall be of the correct materials and applied in accordance with these Specifications. Remove any prime coats not in accordance with these Specifications by sandblasting and apply the specified prime coat at no additional cost to the Owner.

D. Shop primed surfaces shall be cleaned thoroughly and damaged or bare spots retouched with the specified primer before the application of successive paint coats in the field.

E. Be responsible for and take whatever steps are necessary to properly protect the shop prime and finish coats against damage from weather or any other cause.

F. A shop finish coat shall be equal in appearance and protection quality to a field applied finish coat. If, in the opinion of the Engineer, a shop finish coat does not give the appearance and protection quality of other work of similar nature, prepare the surfaces and apply the coat or coats of paint as directed by the

Engineer to accomplish the desired appearance and protection quality. Submit to the Engineer substantial evidence that the standard finish is compatible with the specified finish coat.

G. Wherever fabricated equipment is required to be sandblasted, protect all motors, drives, bearings, gears, etc., from the entry of grit. Any equipment found to contain grit shall be promptly and thoroughly cleaned.

PART 3 - EXECUTION

3.01 PREPARATION OF SURFACES

A. All surfaces to be painted shall be prepared as specified herein or in Section 09901 and shall be dry and clean before painting. Special care shall be given to thoroughly clean interior concrete and concrete block surfaces of all marks before application of finish.

B. All metal welds, blisters, etc., shall be ground and sanded smooth in accordance with SSPC-SP-10. All pits and dents shall be filled and all imperfections shall be corrected so as to provide a smooth surface for painting. All rust, loose scale, oil, grease, and dirt shall be removed by use of approved solvents, wire brushing, or sanding.

C. Report unsatisfactory surfaces to the Engineer. Concrete shall be free of dust, oil, curing compounds, and other foreign matter, conforming to ASTM D4258.

D. All submerged concrete shall be brush off blast cleaned. Open all bug holes and air entrained holes with minimum aggregate exposure. Provide a uniform surface profile similar to #100 grit sandpaper.

E. Concrete block surface shall be smooth and cleaned of all dust, efflorescence, chalk, loose mortar, dirt, grease, oil, tar, and other foreign matter, conforming to ASTM D4258.

F. All plastic pipe surfaces shall be lightly sanded before painting.

G. Wood surfaces shall be dry. Sand to obtain a smooth surface. All encrustations shall be removed.

H. Exposed Pipe: Bituminous coated pipe shall not be used in exposed locations unless approved by the Owner or Engineer. Pipe which shall be exposed after project completion shall be primed in accordance with the requirements herein. Any bituminous coated pipe which is inadvertently installed in exposed locations shall be sandblasted clean before priming and painting. After installation all exterior, exposed flanged joints shall have the gap between adjoining flanges sealed with a single component polysulfide sealant to prevent rust stains.

I. Primed or Previously Painted Surfaces and Nonferrous Surfaces: All coated surfaces shall be cleaned prior to application of successive coats. All nonferrous metals not to be coated shall be cleaned. This cleaning shall be done in accordance with SSPC-SP-1, Solvent Cleaning.

J. Shop-Finished Surfaces: All shop-coated surfaces shall be protected from damage and corrosion before and after installation by treating damaged areas immediately upon detection. Abraded or corroded spots on shop-coated surfaces shall be "Hand Cleaned" and then touched up with the same materials as the shop coat. All shop coated surfaces which are faded, discolored, or which require more than minor touch-up in the opinion of the Engineer shall receive new surface preparation before being repainted. Cut edges of galvanized sheets and exposed threads and cut ends of galvanized piping, electrical conduit, and metal pipe sleeves, that are not to be finished painted, shall be "Solvent Cleaned" and primed with zinc dust-zinc oxide metal primer.

K. Galvanized and Zinc-Copper Alloy Surfaces: These surfaces to be painted shall be "Solvent Cleaned" and treated as hereinafter specified. Such surfaces not to be painted shall be "Solvent Cleaned."

L. Aluminum embedded or in contact with concrete must be painted according to the schedule for aluminum in contact with dissimilar materials.

3.02 WORKMANSHIP

A. General:

1. Primer (spot) and paint used for a particular surface shall, in general, be as scheduled for that type of new surface. Confirm with the paint manufacturer that the paint proposed for a particular repaint condition will be compatible with the existing

painted surface. Sample repainted areas on the actual site will be required to insure this compatibility. Finished repainted areas shall be covered by the same guarantee specified for remainder of work.

2. At the request of the Engineer, samples of the finished work prepared in strict accordance with these Specifications shall be furnished and all painting shall be equal in quality to the approved samples. Finished areas shall be adequate for the purpose of determining the quality of workmanship. Experimentation with color tints shall be furnished to the satisfaction of the Engineer where standard chart colors are not satisfactory.

3. Protection of furniture and other movable objects, equipment, fittings and accessories shall be provided throughout the painting operations. Canopies of lighting fixtures shall be loosened and removed from contact with surface, covered and protected and reset upon completion. Remove all electric plates, surface hardware, etc., before painting, protect and replace when completed. Mask all machinery name plates and all machined parts not receiving a paint finish. Dripped or spattered paint shall be promptly removed. Lay drop cloths in all areas where painting is being done to adequately protect flooring and other work from all damage during the operation and until the finished job is accepted.

4. On metal surfaces apply each coat of paint at the rate specified by the manufacturer to achieve the minimum dry mil thickness required. If material has thickened or must be diluted for application by spray gun, the coating shall be built up to the same film thickness achieved with undiluted material. One gallon of paint as originally furnished by the manufacturer shall not cover a greater area when applied by spray gun than when applied unthinned by brush. Deficiencies in film thickness shall be corrected by the application of an additional coat(s). On masonry, application rates will vary according to surface texture, however, in no case shall the manufacturer's stated coverage rate be exceeded. On porous surfaces, it shall be the painter's responsibility to achieve a protective and decorative finish either by decreasing the coverage rate or by applying additional coats of paint.

5. Paints shall be mixed in proper containers of adequate capacity. All paints shall be thoroughly stirred before use and shall be kept stirred while using. No unauthorized thinners or other materials shall be added to any paint.

6. Only skilled painters shall be used on the work and specialists shall be employed where required.

B. Field Priming:

1. Steel members, metal castings, mechanical and electrical equipment, and other metals that are shop primed before delivery at the site will not require a prime coat on the job. All piping and other bare metals to be painted shall receive one coat of primer before exposure to the weather, and this prime coat shall be the first coat as specified in the painting schedule.

2. Equipment which is customarily shipped with a baked-on enamel finish or with a standard factory finish shall not normally be field painted unless the prefinished equipment is specifically color selected and unless the finish has not been damaged

in transit or during installation. Surfaces that have been shop painted and have been damaged, or where the shop coats or coats of paint have deteriorated, shall be properly cleaned and retouched before any successive painting is done on them in the field. All such field painting shall match as nearly as possible the original finish.

C. Field Painting:

1. All painting at the site shall be designated as Field Painting.
2. All paint shall be at room temperature before applying, and no painting shall be done when the temperature is below 50°F, in dust-laden air, when rain or snow is falling, or until all traces of moisture have completely disappeared from the surface to be painted.
3. Successive coats of paint shall be tinted so as to make each coat easily distinguishable from each other with the final undercoat tinted to the approximate shade of the finished coat.
4. Finish surfaces shall not show brush marks or other irregularities. Undercoats shall be thoroughly and uniformly sanded with No. 00 sandpaper or equal to remove defects and provide a smooth even surface. Top and bottom edges of doors shall be painted and all exterior trim shall be back- primed before installation.
5. Painting shall be continuous and shall be accomplished in an orderly manner so as to facilitate inspection. All exterior concrete and masonry paint shall be performed at one continuous manner structure by structure. Materials subject to weathering shall be prime coated as quickly as possible. Surfaces of exposed members that will be inaccessible after erection shall be cleaned and painted before erection.
6. All materials shall be brush painted unless spray painting is specifically approved by the Engineer. The Contractor shall be responsible for all damage caused by overspray or drifting.
7. All surfaces to be painted as well as the atmosphere in which painting is to be done shall be kept warm and dry by heating and ventilation, if necessary, until each coat of paint has hardened. Any defective paint shall be scraped off and repainted in accordance with the Engineer's directions.
8. Before final acceptance of the work, all damaged surfaces of paint shall be cleaned and repainted as directed by the Engineer.
9. Any pipe scheduled to be painted and having received a coating of a tar or asphalt-compound shall be painted with two coats of Kop-Coat's Inertol Tar Stop, ICI Paints' Tarset Standard 7000 or equal before successive coats are applied per the schedule. Tnemec recommends using 69 Hi- Build Epoxoline II over tar, but a test patch must be run initially to test the paint's compatibility with the tar.

3.03 CLEANUP

A. The premises shall at all times be kept free from accumulation of waste material and rubbish caused by employees or work. At the completion of the painting remove all tools, scaffolding, surplus materials, and all rubbish from and about the buildings, and leave work "broom clean" unless more exactly specified.

B. Upon completion, remove all paint where it has been spilled, splashed, or splattered on all surfaces, including floors, fixtures, equipment, furniture, etc., leaving the work ready for inspection.

3.04 PAINT

A. General Notes and Guidelines:

1. Pipe lines, equipment, or other items which are not listed here shall be assigned a color by the Engineer and shall be treated as an integral part of the Contract.
2. When color coding is specified or directed by the Engineer, it shall consist of color code painting and identification of all exposed conduits, through lines and pipelines for the transport of gases, liquids, or semi-liquids including all accessories such as valves, insulated pipe coverings, fittings, junction boxes, bus bars, connectors, and any operating accessories which are integral to a whole functional mechanical pipe and electrical conduit systems.
3. All moving parts, drive assemblies, and covers for moving parts which are potential hazards shall be Safety Orange.
4. All safety equipment shall be painted in accordance with OSHA standards.
5. All inline equipment and appurtenances not assigned another color shall be painted the same base color as the piping. The pipe system shall be painted with the pipe color up to but not including the flanges attached to pumps and mechanical equipment assigned another color. Tanks shall be painted the color of the piping system that they serve unless the tank is fiberglass and levels are monitored through the tank.
6. All conduit shall be painted to match its background surface.
7. Building surface colors shall be painted as scheduled in the Finish Schedule or as selected by the Engineer.
8. Control panels shall be factory finished.

END OF SECTION 916

SECTION 917
STRUCTURAL LINING CORROSION PROTECTION FOR UNDERGROUND CONCRETE STRUCTURES

PART 1 - GENERAL

1.01 GENERAL

A. This specification defines the method and material for the installation of new and the rehabilitation of sanitary sewer structures (manholes, wet wells, lift/pump stations, large diameter concrete pipe, etc.) utilizing a spray applied calcium aluminate cementitious structural rehabilitation system. The purpose of this project is to obtain a dense and durable concrete lining that is resistant to biosulfuric acid attack and meets the strength requirements described elsewhere in this specification. The work covered in this specification consists of furnishing all labor, equipment, materials, and supervision necessary to accomplish the rehabilitation as specified. When complete the rehabilitated structure shall:

1. Provide for a uniformly smooth surface of specified thickness.

2. Minimize, if not eliminate sources of inflow/infiltration (I/I).

3. Provide a service life that is supported by documented test analysis.

1.02 CONTRACTOR'S SEQUENCE OF OPERATION

A. The Contractor's sequence of operation relative to structural rehabilitation shall include, but not be limited to the following:

1. Eliminate all sources of groundwater infiltration and voids in walls.

2. Rehabilitate all interior surfaces including walls, ceilings, and floors in accordance with specification and nature of the sub-surfaces.

3. Provision to "cure" the installed lining material.

4. Provision to "test" lining and structural rehabilitation materials.

1.03 SUBMITTALS

A. The Contractor shall furnish detailed and complete data pertaining to the surfaces of the structure to be rehabilitated, the rehabilitation product, surface preparation and installation to the Engineer for approval. The submission of this data shall be made in a timely manner to prevent project delay. At the request of the Engineer, the Contractor shall test for adverse chemical conditions that may hinder overall product performance.

B. Prior to initiating the work, the Contractor shall submit specific technical data with complete physical properties of the structure to be rehabilitated and the proposed

product for the rehabilitation of the structure, as well as a specific plan for sub-surface preparation.

C. A work plan

D. A safety plan. It is the Contractor's responsibility to comply with OSHA standards and all regulations pertaining to the work including confined space entry.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Lining material furnished under this specification shall be a prepackaged mortar mix, including all cement, aggregates, and any required additives. It is the intent of this specification that the Contractor only be required to add the proper amount of potable water so as to produce concrete suitable for spray application. Do not add Portland cement, other aggregates, or any admixtures whatsoever to lining material. Typical package weights shall not be less than 50 lbs and shall be identical for all material furnished on this project.

B. The chemical composition of the cement portion as well as the aggregates of the mortar mix shall be as follows:

Al_2O_3	CaO	$FeO + Fe_2O_3$	SiO_2
39-44%	35-39%	9-14%	5-7%

C. The properties of the mortar mix are typically as follows:

Compressive Strength (ASTM C109)	> 5,500 psi	24 hours
Flexural Strength (ASTM C293)	> 1,200 psi	24 hours
Splitting Tensile Strength (ASTM C496)	> 800 psi	24 hours
Slant Shear test (ASTM C882)	> 1,200 psi	24 hours
Shrinkage at 28 days (ASTM C596)	< 0.08% cured @ 90% relative humidity	
Freeze/Thaw after 300 Cycles (ASTM C666)	No visible damage after 300 cycles	

D. The mortar mix shall be "SewperCoat 2000HS Regular", as manufactured by Kerneos Inc. – Chesapeake, Virginia or approved equal.

E. Mortar mix must have at least seven (10) years of successful performance in similar applications and be supplied by an ISO 9001 certified manufacturer. Manufacturer's ISO 9001 certificate shall be submitted to Engineer and Owner.

F. In addition, the mortar mix shall be designed to withstand long-term exposure to a bacterially corrosive hydrogen sulfide environment that may be expected to produce a pH of 1 on normal Portland cement based concrete or typical brick and mortar surfaces.

G. Water used in mixing shall be fresh, clean, potable water, free from injurious amounts of oil, acid, alkali, vegetable, sewage and/or organic matter. Water shall be considered

as weighing 8.32 pounds per gallon.

H. Mortar mix shall be stored with adequate provisions for the prevention of absorption of moisture. It shall be stored in a manner that will permit easy access for inspection and identification of each shipment.

PART 3 - EXECUTION

3.01 SAMPLING AND TESTING

A. A recognized independent testing laboratory shall test mortar materials used on the project. The Manufacturer, instead of an independent laboratory, may test project sample specimens, provided the Owner, Engineer, and Manufacturer are in agreement of this testing method prior to project commencement. Specific materials recommended by the Engineer shall then be tested.

B. The cost of sampling and testing of the mortar mix during placement and the surface to which it is applied shall be borne by the Contractor. Other testing required showing conformance with these specifications shall be the responsibility of the Contractor. Certified test reports and certificates, when so directed, shall be submitted in duplicate to the Engineer and to such other agencies or persons the Engineer may designate.

C. Any materials failing to meet the requirements of these specifications shall not be incorporated into the work plan.

3.02 QUALIFICATION OF WORK CREW

A. The lining material Manufacturer shall maintain a listing of competent Contractors that have demonstrated requisite skill and training to be qualified applicators of their materials.

B. Prior to project commencement, the Contractor must satisfy the Engineer that all Contractor's work crew personnel have performed satisfactory work in similar capacities elsewhere for a sufficient period of time to be fully qualified to properly perform the work in accordance with the requirements of the related specifications.

C. Foreman shall have at least 4 years experience with similar work and project conditions.

D. Nozzlemen shall be qualified by having had similar work experience.

E. Work Crew responsibilities prior to application of lining material shall include the following:

1. Surface preparation as discussed in section 4.1.

2. Ensure the operating air pressure is uniform and provides adequate nozzle velocity for proper compaction.

3. Continuously regulate the water content so that the applied materials consistently achieve proper compaction with a low percentage of rebound and no visible "sag".

4. Ensure that the installation equipment nozzle is held at the proper distance away from and as nearly perpendicular to the prepared sub-surface as the working conditions will permit to secure maximum material compaction with minimum rebound and no visible "sag".

5. Follow a sequence routine that will fill corners with adequately compacted material applied at a maximum practicable layer thickness.

6. Determine necessary operating procedures for placement in confined spaces, extended distances or around unusual obstructions where placement velocities and mix consistency may need to be adjusted.

7. Direct the crew as to when to start and stop the flow of materials during installation and to immediately stop all work when material is not arriving uniformly at the nozzle.

8. Ensure that slough pockets are removed and prepared for installation of replacement material.

9. Bring the installed materials to established finished elevations in a neat and timely manner and within established tolerances.

F. Applicator's job foreman shall operate the mixing/placing equipment and direct the work of mixing crew personnel. Applicator's work crew shall also maintain proper line pressures throughout the mixing/placing equipment to ensure the necessary consistent nozzle velocity. Applicator's work crew shall further see that all material fed to the nozzle is uniformly fed through this equipment.

3.03 EQUIPMENT

A. Equipment shall be of spray type and approved by the material manufacturer. Alternate equipment may be utilized provided it meets the performance requirements of the specification. All equipment must be kept in operating condition and good repair.

PART 4 - CONSTRUCTION METHODS

4.01 SURFACE PREPARATION

A. Ensure all sub-surfaces are clean and free of laitance, loose material, residue and all existing coating and lining materials. See Section 4.4 for Inflow and Infiltration Prevention. For detailed explanation of the required surface preparation see ACI RAP-3 "Spall Repair by Low Pressure Spraying" page 2. ACI 546R "Concrete Repair Guide", Chapter 2 also provides a good reference for important considerations for

repairing concrete surfaces using mortar.

B. Sub-surfaces shall be thoroughly saturated with water prior to the application of the lining materials. In no instance shall shotcrete be applied in an area where running water exists. It is the intent of this specification that the existing surface be saturated and free of any running water just prior to installation – or SSD, "saturated surface dry condition." To achieve this condition, it may be necessary to presoak the sub-surface for a period of at least 24 hours.

4.02 OPERATIONS

A. The Contractor shall provide all equipment necessary to individually gauge, control, and monitor the actual amounts of all component materials necessary to complete the lining installation. The type of equipment and methods used to gauge, control, and monitor component materials shall be subject to approval by the Engineer and Manufacturer.

B. All lining materials shall be thoroughly mixed by mechanical means to ensure all agglomerated particles are reduced to original size or removed prior to placement into the application equipment (i.e. the hopper). Each batch of material should be entirely discharged before recharging with fresh material. Mixing equipment shall be cleaned at regular intervals to remove all adherent materials.

C. The addition of water to the mix shall be in strict accordance with the Manufacturer's recommendations.

D. Re-mixing or tempering shall not be permitted. Rebound materials shall not be reused.

4.03 PROTECTION OF ADJACENT SURFACES

A. During progress of the work, adjacent areas or grounds which may be permanently discolored, stained or otherwise damaged by dust and rebound material, shall be adequately protected and, if contacted, shall be cleaned by early scraping, brushing or washing as the surroundings permit.

4.04 INFLOW AND INFILTRATION PREVENTION

A. If inflow or infiltration is observed within the structure after surface preparation is complete, a rapid setting crystalline enhanced hydraulic cement product specifically formulated for infiltration control shall be used to stop minor infiltration flows in accordance with the manufacturer's recommendations. The material shall meet the following strength requirements:

Compressive Strength (ASTM C597B)	600 psi 1,000 psi	(24 hours) (7 days)
Bond Strength (ASTM C321)	30 psi 80 psi	(1 hour) (1 day)

B. The material shall be Preco Plug, Octocrete, Burke Plug or ENGINEER approved equal. Where infiltration flows are more severe, pressure grouting may be required. The material for pressure grouting shall be Avanti A-220, DeNeef or Engineer approved equal installed in accordance with the manufacturer's written instructions.

C. All materials, labor, equipment, and incidentals required to correct inflow and infiltration conditions will be considered incidental to rehabilitation.

4.05 APPLICATION OF MATERIALS

A. Lining material shall not be applied to a frozen surface or to a surface that may freeze within 24 hours of application. Frozen conditions shall be defined as ambient temperatures of 32 degrees Fahrenheit or below.

B. Sequence of application may be from bottom to top or vice versa if rebound is properly removed.

C. Application shall be from an angle as nearly perpendicular to the surface as practicable, with the nozzle held at least 1 foot from the working sub-surface (except in confined control). If the flow of material at the nozzle is not uniform and slugs, sand spots, or wet sloughs result, the nozzleman shall direct the nozzle away from the work until the faulty conditions are corrected. Such defects shall be replaced as the work progresses.

D. Application shall be suspended if:

1. Air velocity separates the cement from the aggregate at the nozzle.

2. Ambient temperature approaches freezing and the newly placed SewperCoat cannot be protected and insulated.

E. The time interval between successive layers of material application must be sufficient to allow “tackiness” to develop but not final set. If final set does occur, this surface shall be prepared in accordance with Sections 4.1.1 of this document.

F. Construction joints within a manhole shall be avoided. In the event a construction joint is necessary and approved by the Engineer, it shall be sloped off to a thin, clean, regular edge, at a 45-degree angle. Prior to placement of the adjoining materials, the sloped portion and adjacent applied material shall be thoroughly cleaned as necessary, then moistened and scoured with an air jet.

G. Nozzleman shall bring the material to an even plane and to well-formed corners.

H. After the body coat has been placed, the surface shall be trued with a thin-edge screed to remove high areas and expose low areas. Low areas shall be properly filled with additional material to insure a true, flat surface in accordance with Section 4.5.5 of this document.

I. For manhole applications, the minimum thickness of SewperCoat shall be a ½-inch

cover over all surfaces. For other larger structures (lift stations, wet wells, treatment plant structures, etc.), the minimum thickness of SewperCoat shall be a 1-inch cover over all surfaces.

4.06 CURING

A. If the material has been applied and furnished in accordance to the specifications, and it has been determined that the environment is not moist enough for natural curing, the Contractor will be required to apply a curing compound to all coated surfaces. Curing compound shall meet the requirements of ASTM C309 and have the approval of the lining material Manufacturer and the Engineer prior to use.

B. Moist curing may also be used in lieu of curing compound. If moist curing is selected, it should be implemented just after the notice of uniform heat generation of the installed lining. Moist curing can consist of the use of soaker hoses, water sprinklers, or vapor/misting machines. Regardless of delivery method, moist curing should continue for a minimum of 18 hours.

4.07 TESTING

A. The Contractor shall notify Inspector and Engineer 48 hours prior to beginning of wet well and manhole testing. The Contractor shall perform the testing for all sanitary sewer wet wells and manholes in accordance with the following:

1. All wet wells and manholes must pass a leakage test.

2. The Contractor shall test each wet well (after rehabilitation) for leakage, separate and independent of all other sanitary sewer piping, by means of a hydrostatic test.

3. Hydrostatic testing shall be conducted by utilizing approved plugs to seal all influent and effluent pipes in the wet well and filling the wet well to the top of the wall with water.

    a. Additional water may be added over a 24-hour period to compensate for absorption and evaporation losses.

    b. At the conclusion of the 24-hour saturation period, the wet well shall be filled to the top and observed.

    c. Any measurable loss within a 30 minute period shall be considered an unsuccessful test and thus require the Contractor to assess the needed repairs, perform such repairs (subject to the approval of the Engineer), and notify the Inspector when the retest will be performed.

    d. All effort, materials, or other costs shall be solely at the Contractor's expense.

4. The Contractor shall test each manhole (after rehabilitation) for leakage, separate and independent of all other sanitary sewer piping, by means of a vacuum test.

5. Vacuum Testing: Manholes shall be tested after rehabilitation with all connections (existing and/or proposed) in place.

    a. Drop-connections and gas sealing connections shall be installed prior to testing.

    b. The lines entering the manhole shall be temporarily plugged with the plugs braced to prevent them from being drawn into the manhole.

    c. The plugs shall be installed in the lines beyond drop connections, gas sealing connections, etc.

    d. Prior to performing the test, the Contractor shall plug all lift holes and exterior joints with a non-shrink grout and plug all pipes entering the manhole.

    e. No grout shall be placed in horizontal joints prior to testing.

    f. Contractor shall use a minimum 60 inch-lb. torque wrench to tighten the external clamps that secure the test cover to the top of the manhole.

    g. The test head shall be inflated in accordance with the manufacturer's recommendations.

    h. A vacuum of 10 inches of mercury shall be drawn, and the vacuum pump will be turned off.

    i. With the valve closed, the level vacuum shall be read after the required test time.

    j. If the drop in the level is less than 1 inch of mercury (final vacuum greater than 9 inches of mercury), the manhole will have passed the vacuum test.

    k. The required test time is 2 minutes

6. Acceptance: Any wet well or manhole which fails the initial test must be repaired with a non-shrink grout or other suitable material based on the material of which the structure is constructed.

7. The wet well or manhole shall be retested as described above until a successful test is attained.

8. After a successful test, the temporary plugs will be removed.

9. To ensure that the plugs have been removed, Contractor shall only do so in the presence of the Inspector.

    a. Repairs to Existing Wet Wells and Manholes: Any existing wet well or manhole which fails to pass the hydrostatic or vacuum test shall be closely examined by the Inspector and the Contractor to determine the location of repair on the structure.

        1) The Contractor shall repair the manhole as directed. Removal and replacement of existing or new wet wells and manholes will not be permitted.

        2) The wet well or manhole shall then be retested and coated with a sewer coating approved by the Owner as stated above.

10. Holiday Testing: Inspect each sanitary sewer wet well and manhole using high voltage holiday detection equipment.

    a. All detected holidays shall be marked and repaired by abrading the coating surface with grit disk paper, or other hand tooling method.

    b. After abrading and cleaning, additional protective coating material shall be applied to the repair area.

    c. All touch-up repair procedures shall follow the protective coating manufacturer's recommendations.

11. If a wet well or manhole fails to pass the hydrostatic or vacuum test, it shall be repaired in accordance with the manufacturer's recommendations and re-tested.

12. It shall not be accepted until it passes the appropriate testing.

13. All repairs and re-testing shall be at no additional cost to the Owner.

PART 5 - MEASUREMENT AND PAYMENT

5.01 MEASUREMENT AND PAYMENT

A. The work performed, materials furnished and all labor, tools, equipment and incidentals necessary to complete the work under this item will not be measured or paid for directly but shall be considered subsidiary to the various bid items of the contract.

END OF SECTION 917

ITEM NO. 1110
Progress Schedule

1110.1 DESCRIPTION: This item shall govern the Contractor's responsibility to provide monthly construction schedules as specified herein for the work under this Contract. These schedules shall be developed as time-scaled network diagrams. Schedules include bar graphs, phasing plans, network diagrams, and narrative reports.

1110.2 REFERENCE STANDARDS: Reference standards cited in this Specification Item No. 1110 refer to the current reference standard published at the time of the latest revision date.

1. San Antonio Water System (SAWS):
   a. Specifications for Water and Sanitary Sewer Construction
   b. SAWS Materials Specifications
2. City Of San Antonio (COSA) Standard Specifications for Construction

1110.3 SUBMITTALS:

1. Contractor's Submittals:

   a. Within 10 days after receipt of Authorization to Proceed, Contractor shall submit in CPMS for review and approval, a detailed construction schedule, reflecting sequence of operations, milestones and commencing and completion dates of each item of work.
   b. Other work may be added to the progress schedule as requested or approved by the Engineer.
   c. At a minimum, the chart shall be maintained current by coloring or cross-hatching a length of bar to indicate the weekly progress towards completion.
   d. Three copies of the progress schedule shall be submitted each month with the monthly "scratch copy," until completion of the project. If updated progress schedules are not provided, monthly payments will be withheld.
   e. Updated copies of the progress schedule shall be available at the established progress meetings for review.
   Contractor shall submit a projection of estimated monthly payments through the life of the Contract. Initial projections shall be correlated with and provided at the same time as the Schedule of Values (if required). Projections shall be updated when requested by the Inspector.

2. Engineer's Review:

   a. If revision of either form or content is necessary, Contractor shall revise and resubmit the progress schedule within five calendar days.
   b. The progress schedule shall be used by the Contractor for planning, organizing, directing, and executing all completion of work and for reporting progress of all remaining work.

3. Revisions and Updates:

   a. After the Engineer's review of the progress schedule, if the Contractor desires to make changes in his method of executing the work, he shall notify the SAWS in writing, stating the reasons for the changes. If SAWS considers these changes to be of a major nature, the Contractor may be required to revise and resubmit all the affected portions of the progress schedule.

   b. Updated progress schedules shall show all changes in activities and milestones including future changes that can be reasonably anticipated by the Contractor.

   c. At the established progress meetings, the most recently updated progress schedule will be reviewed by the Contractor and Engineer. The schedule and work will be reviewed:
      1) To identify those activities started and completed during the previous period;
      2) For a review of remaining durations for selected activities not yet started;
      3) For the addition of change orders and proposed sequencing changes to the network diagram;
      4) For the interfacing of the work under this Contract with the work of other Contractors' or the connection to in-place work.

   d. Following review of the progress schedule at the established meetings, the Contractor shall revise and resubmit the schedule, if any of the following conditions have developed:
      1) When a delay in completion of any work item or sequence of work items results in an indicated extension of the project completion;
      2) When delays in submittals or deliveries or work stoppages are encountered which make re-planning or rescheduling of the work necessary;
      3) When the schedule does not reasonably represent the actual prosecution and progress of the project.

   e. The revised schedule shall be submitted to in CPMS within five calendar days and shall be accompanied by a written narrative report. The narrative report shall include a description of problem areas, current and anticipated delay factors and their estimated impact on performance of other activities and completion dates, and an explanation of corrective action taken or proposed.

   f. All updated or revised schedules submitted after the original schedule shall be in the same detail as the original submittal.

4. Monthly Report: Contractor shall submit a copy of the current adjusted construction Progress Schedule showing the progress to the Work to date and a narrative report with every monthly "scratch copy." Failure to submit the progress schedule shall be considered cause for withholding

any progress payments otherwise due under the Contract. See Section 7.2 of the GENERAL CONDITIONS for more information. The report shall list any construction activities that are behind schedule and discuss measures being taken to bring these activities back on schedule.

1110.4 EXECUTION:

1. Network Diagram:

   a. The network diagram shall show the order and interdependence of activities and sequence in which work is to be accomplished as planned by the Contractor. The diagram shall show how the start of a given activity is dependent upon completion of preceding activities and how its completion restricts the start of following activities.

   b. The diagram shall be constructed in such a manner that sub-networks (relating to particular phases or portions of work) can be readily extracted or revised as required by the Owner. Sub-networks shall include, but are not limited to, the following portions of work:
      1) Shop drawings, received from Contractor, submitted to the Inspector, reviewed, and returned to the Contractor;
      2) Material and equipment order, manufacturer, delivery, installation, and check-out;
      3) Connection to the work of other Contractors' and to in- place work;
      4) Work requiring coordination with the work of other contractors;
      5) Performance tests and supervisory service activities;
      6) Piping activities;
      7) Construction of various facilities;
      8) Concrete placement sequence;
      9) Backfilling, grading, seeding, paving, etc;
      10) Plumbing activities;
         (1) Subcontractor's items of work;
         (2) Final cleaning.

   c. The network diagram shall show the following information related to activities:
      (1) Activity number or label;
      (2) Brief description of activity;
      (3) Estimated duration, in working days, of each activity.

   d. In addition to showing all construction and coordination activities, the diagram shall show following events and milestones:
      (1) Notice to Proceed;
      (2) Connections to the work of other contractors and to in- place work;
      (3) Ready for operation and Contract completion dates;
      (4) Shutdowns;
      (5) Intermediate milestones.

   e. Detail of information shall be such that duration times of activities will

generally range from 1 to 30 days with not over 2% of activities exceeding these limits. Activities which comprise separate portions of work shall be identified separately by coding.

f. Network diagram shall be drawn on 22 inch by 34 inch size sheets with flow of activities generally from left to right. Printing shall be suitable for half size (11" x 17").

g. The network diagram shall be time-scaled.

2. Mathematical Analysis:

a. Contractor shall provide Owner with the following:

1) The calendar used for the computation of dates specified showing the calendar dates of each working day. The calendar shall incorporate the Contractor's assumptions of working days with due consideration being given to legal statutory holidays, Saturdays and Sundays, and weather shutdowns;

2) A listing of each submittal and update of Contractor's detailed construction schedule;

3) List of representative symbols and codes used in preparation of the network diagram.

b. Analysis shall include:

1) Calendar date and lists of activities in order of earliest start date;

2) Separate lists of activities within a given sub-network grouped together and listed in order of their earliest start dates.

3. Narrative Report:

a. The narrative report shall include:

b. Contractor's transmittal letter;

c. Schedule narrative concerning completion and progress of all work according to the activity in the Contractor's construction schedule;

d. Description of any problem areas;

e. Current and anticipated delays, cause, corrective action to be taken, and impact of the delay on other activities, on milestones, and on completion dates;

f. Status of pending items such as permits, Contract modifications, and time extensions;

g. Progress relative to schedule and other project or scheduling concerns;

h. A discussion of coordination efforts and problems.

4. Log of Shop Drawing Submittals:

a. The log of shop drawing submittals shall consist of a complete listing of all shop drawings required by the Specifications with anticipated submission dates. Scheduled submission dates shall be consistent with the construction schedule.

b. The Contractor shall update the log monthly indicating submittal status. Status shall include all dates submitted and whether the submittal was acceptable or if re-submittal is necessary. Anticipated re-submittal dates shall be indicated.

1110.5 DELAYS AND RECOVERY:

1. If it is determined by the Owner that the Contractor is not maintaining anticipated progress, then the Owner may withhold approval of the monthly progress payment as outlined in Section 7.2 of the GENERAL CONDITIONS.
2. Wherever it becomes apparent from the current monthly progress evaluation and updated schedule data that any milestone interface completion dates and/or Contract completion dates will not be met, the Contractor shall take some or all of the following actions:

   a. Increase construction manpower in such quantities and crafts as shall eliminate the backlog of work;
   b. Increase the number of working hours per shift, shifts per day, work days per work week, or the amount of construction equipment, or any combination of the foregoing sufficient to eliminate the backlog of work;
   c. Reschedule work items to achieve concurrency of accomplishment.

3. Under no circumstances will the addition of equipment or construction forces, increasing the working hours, or any other method, manner, or procedure to return to the current Contractor's construction schedule be considered jurisdiction for Contract modification, increased cost, or treated as an acceleration.

1110.6 MEASUREMENT: There will be no measurement for payment of the Progress Schedule, as specified herein.

1110.7 PAYMENT: No direct payment shall be made of any incidental costs associated with preparing and submitting the Progress Schedule, as specified herein.

- End of Specification-

ITEM NO. 1112

Project Record Documents

1112.1 DESCRIPTION: Contractor shall maintain and provide the Inspector with project record documents as specified below. Daily logging and transmittal of record drawing information by accurately identifying all completed work is considered incidental and not eligible for additional payment.

1. Maintenance of Documents:
   a. Maintain in Contractor's field office, in a clean, dry, legible condition, a complete set of the following: Contract Documents, including all addenda, approved Shop Drawings, Samples, Photographs, Change Orders, other Modifications of Contract, Test Records, Survey Data, and all other documents pertinent to Contractor's Work.
   b. Provide files and racks for proper storage and easy access.
   c. Make documents available at all times for inspection by Inspector and/or Engineer.
   d. Record documents shall not be used for any other purpose and shall not be removed from the office without Inspector's approval.
2. Recording:
   a. Label each document "PROJECT RECORD," in 2 inch high printed letters.
   b. Keep record documents current and updated daily.
   c. Do not permanently conceal any work until required information has been recorded.
   d. Contract Documents: Legibly mark to record actual construction including:
   e. The depths of various elements of manhole foundation in relation to datum. This shall include the inclusion of surveyed inlet/outlet elevations for each structure installed;
   f. Specifications and Addenda - Legibly mark up each Section to record:
      1) Manufacturer, trade name, catalog number, and supplier of each product and item of equipment actually installed;
      2) Changes made by Change Orders or Field Change Directives;
      3) Other dimensions and details not in original contract documents.
   g. Shop Drawings - Maintain as record documents and legibly annotate drawings to record changes made after review.
   h. Record Documents are subject to submittal, review, and acceptance by the Inspector on a monthly basis and failure to accurately keep these documents current will result in the Inspector withholding the Contractor's monthly payment.
3. Record Drawings:
   a. Record drawings shall reflect completion of the installation of all equipment, piping, and other work by the Contractor. The drawings shall

show the Work in plan and sections as required for clarity with reference dimensions and elevations for complete record drawings. The monthly record drawings shall be furnished to the Inspector at the time that the "scratch copy" stage of the pay estimate effort is conducted. If the Contractor does not furnish an accurate and approved progress record drawing, the monthly pay estimate will not be processed and payment will be withheld.

4. The Contract Drawings may be used as a starting point in developing these drawings. Subcontractor and manufacturer drawings may be included in this drawing package. The drawing package must be fully integrated and include the necessary cross references between drawings. The drawing package shall include interconnection and termination details to equipment furnished under this Contract Submittal:
   a. At each monthly "scratch copy" meeting of the pay estimate, the Contractor shall deliver a complete set of reviewable and approvable monthly redline drawings and an updated schedule to the Engineer and Inspector via CPMS. Once items to be paid are agreed upon between the Contractor, Inspector, and Engineer all parties will sign the scratch copy as record of approval before the scratch copy is uploaded to CPMS. If the Contractor does not provide these documents the meeting will be reschedule when the Contractor is ready to comply.
   b. Accompany the submittal with a transmittal letter in a duplicate containing the following:
      1.) Date
      2.) Project title and job number
      3) Contractor's name and address
      4) Title and number of each record document
      5) Certificate that each document submitted is complete and accurate
      6) Signature of Contractor Engineer, and Inspector

1112.2 MEASUREMENT: There will be no measurement for payment of the Project Record Drawings, as specified herein.

1112.3 PAYMENT: No direct payment shall be made of any incidental costs associated with preparing and submitting the Project Record Drawings, as specified herein.

- End of Specification-

San Antonio Water System Standard Specification

ITEM NO. 1114

Pre- Construction Video

1114.1 DESCRIPTION: The Contractor shall furnish all labor, materials, equipment, and incidentals to provide the televising in SAWS and recorded in MPEG-1 format. All inspections shall be in accordance with SAWS requirements, shall be submitted and uploaded onto SAWS Contracting and Project Management System (CPMS) or SAWS most current program management system. All digital video files shall be color, closed-circuit TV in MPEG-1 format. The Contractor shall provide all inspection data and upload to CPMS.

1114.2 REFERENCED STANDARDS: Reference standards cited in this Specification Item No. 1114 refer to the current reference standard published at the time of the latest revision date:

1. San Antonio Water System (SAWS):
    a. Specifications for Water and Sanitary Sewer Construction
    b. SAWS Materials Specifications
2. COSA – City of San Antonio:
    a. Utility Excavation Criteria Manual.
    b. City of San Antonio (COSA) Specifications for Construction
3. Texas Commission of Environmental Quality (TCEQ)
    a. Chapter 217 Design Criteria for Domestic Wastewater Systems
    b. Chapter 213 (“Edwards Aquifer Recharge Zone”)

1114.3 SUBMITTALS: All submittals shall be in accordance with most recent version of SAWS’s General Conditions requirements. Submit the following prior to performing any work.

a. Certifications: Per General Conditions section 5.12.2 all Contractor submittals for all pipe and other products or materials furnished under this specification shall be marked as reviewed and approved by Contractor for compliance with Contract Documents and the referenced standards

b. Contractor is to coordinate the pre-video procedures with the Inspector prior to commencement of any work, including mobilization and preparation of right-of-way effort.

c. The Contractor shall provide a diagram and identify the limits of the project area and video the condition of all existing surface features within the project limits including adjoining ROW features such as curbing, sidewalk, fencing, mailboxes, driveways, and trees and shrubs/grass.

d. Contractor shall provide a copy of the pre-construction video prior to commencement of the project by identifying the condition of all existing surface features within the project limits, including adjoining right-of-way features such as curbing, sidewalk, fencing, mailboxes, driveways, and trees/shrubs/grass

e. Video shall be submitted and uploaded onto SAWS CPMS or SAWS most current program management system

f. Video shall be uploaded for review and approval by the Inspector.

1114.4 EQUIPMENT:

1. Equipment:
   a. The television unit shall have capability of displaying in color, on the video, surface feature locations, and any other relevant physical attributes.
      i. Each video shall be permanently labeled with the following:
      ii. Project name / SAWS Job # / Work Order #;
      iii. Date of television inspection;
      iv. Street/easement location;
      v. Name of Contractor;
      vi. Date video submitted;
      vii. Video number;
      viii. SAWS Inspector Name.

   The Contractor shall be required to have all materials, equipment, and labor force necessary to complete all videotaping on the job site prior to beginning videotaping operations.
2. If the Contractor provides a video of such poor quality that it cannot be properly evaluated, the Contractor shall re-televise as necessary and provide a video of good quality at no additional cost to SAWS.
3. If the Contractor cannot provide a video of such good quality that can be reviewed by SAWS, SAWS may elect to televise the site at the Contractor's expense.
4. Television inspection shall be done one area at a time.

1114.5 MATERIALS: All videos shall be a SAWS compliant video, recorded in MPEG-1 format and uploaded onto SAWS Contracting and Project Management System (CPMS) or SAWS most current program management system. The video shall include good sound quality; identification of area being videoed, to include cross streets references, addresses, time and date. Each video shall be marked with the name and contract number, name of Contractor, and a description and location of view being recorded.

1114.6 EXECUTION: Prior to beginning the project, the Contractor shall submit one copy of the completed video for the entire project prior to submission of request for mobilization for review and approval. Failure to submit video will result in denial of any request for payment under the Mobilization line item or Preparation of Right-of-Way.

a. If requested by SAWS Inspector, post construction video shall be submitted prior to project closeout concurrent with project redlines.

b. Failure to submit video will result in denial of request for payment.

1114.7 MEASUREMENT: There will be no measurement for payment of the Pre-

Construction Video, as specified herein.

1114.8 PAYMENT: No direct payment shall be made of any incidental costs associated with preparing and submitting the Pre-Construction Video, as specified herein.

-End of Specification -

SECTION 01300
SUBMITTALS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. The Contractor prepares submittals. Drawings and general provisions of Contract, including General Conditions and Division 1 requirements should be used as the related documents for this requirement. All submittals are to be handled via Owner's Contract and Project Management System (CPMS).

1.2 SUMMARY

A. This Section includes administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other submittals required for performance of the Work.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 SUBMITTAL PROCEDURES

A. Contractor shall be responsible for the following:

1. Coordination: Coordinate preparation and processing of submittals with performance of construction activities. Transmit each submittal sufficiently in advance of performance of related construction activities to avoid delay.

a. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.

b. All submittals shall be uploaded into CPMS. File sizes shall not exceed 400 MB. Submittals delivered by any other method, such as flash drives, will not be accepted.

c. Coordinate transmittal of different types of submittals for related elements of the Work so processing will not be delayed by the need to review submittals or resubmittals concurrently.

i. The Engineer reserves the right to withhold action on a submittal requiring coordination with other submittals until all related submittals are received.

d. Processing: To avoid the need to delay installation as a result of the time required to process submittals, allow sufficient time for submittal review, including time for resubmittals. Time for review shall commence on

i. Allow fifteen (15) calendar days for initial review. Allow additional time if the Engineer must delay processing to permit coordination with subsequent submittals.

ii. If an intermediate submittal is necessary, process the same as the initial submittal.

iii. Allow fifteen (15) calendar days for processing each resubmittal.

iv. No extension of Contract Time will be authorized because of failure to transmit submittals to the Engineer sufficiently in advance of the Work to permit processing, including resubmittals.

2. Submittal Preparation: Place a permanent label or title block on each submittal for identification.

a. Indicate the name of the entity that prepared each submittal on the label or title block.

b. Provide a space approximately 4 inches by 5 inches (100 by 125 mm) on the label or beside the title block on Shop Drawings to record the Contractor's review and approval markings and the action taken.

c. Include the following information on the label for processing and recording action taken.

i. Project name.

ii. Date.

iii. Name and address of the Contractor

iv. Name and address of the Contractor.

v. Name and address of the subcontractor.

vi. Name and address of the supplier.

vii. Name of the manufacturer.

viii. Number and title of appropriate Specification Section.

ix. Drawing number and detail references, as appropriate.

x. Location(s) where product is to be installed, as appropriate.

xi. Other necessary identification.

3. Contractor shall highlight, encircle, or otherwise specifically identify deviations from the Contract Documents on submittals. Requests for deviation shall be by

4. Unless additional copies are required for final submittal, and unless the Engineer observes noncompliance with provisions in the Contract Documents, initial submittal may serve as final submittal.

5. Submittal Transmittal: Package each submittal appropriately and individually for transmittal and handling. Transmit each submittal using a transmittal form approved by the Owner. The Engineer will not review or accept submittals received from sources other than the Contractor.

    a. Submittal number shall be by means of a specification number, a chronological order, and a letter suffices to indicate number of times submitted.

        i. Submittal number shall use Specification Section number followed by a hyponym and then a sequential number (e.g., 06100-01). Resubmittals shall include an alphabetic suffix after another hyponym (e.g., 0610-01-A).

        ii. Operational and Maintenance Manuals submitted shall be identified with the same number as its corresponding equipment submittal. (e.g., 11300-DRAFT), indicates preliminary O&M Manual for equipment submitted under 11300).

6. Make resubmittals in same form and number of copies as initial submittal.

    a. Note date and content of previous submittal.

    b. Note date and content of revision in label or title block and clearly indicate extent of revision.

    c. Resubmit submittals until they

    d. Cost for additional review time for third and any subsequent submittals will be billed to Owner by Engineer for the actual hours required for review of a submittal by Engineer. Contractor shall pay cost for the third and subsequent submittal review to Owner at the completion of the Project as reimbursement.

3.2 SHOP DRAWINGS

A. Submit newly prepared information drawn accurately to scale. Highlight, encircle, or otherwise indicate deviations from the Contract Documents. Do not reproduce Contract Documents or copy standard information as the basis of Shop Drawings. Standard information prepared without specific reference to the Project is not a Shop Drawing.

B. Shop Drawings include fabrication and installation Drawings, setting diagrams, schedules, patterns, templates, and similar Drawings. Include the following information:

1. Dimensions.

2. Identification of products and materials included by sheet and detail number.

3. Roughing-in and setting diagrams.

4. Wiring diagrams showing field-installed wiring and manufacturing wiring (must differentiate between the two), including power, signal, and control wiring.

5. Shopwork manufacturing instructions.

6. Templates and patterns.

7. Schedules.

8. Compliance with specified standards.

9. Notation of coordination requirements.

10. Notation of dimensions established by field measurement.

11. Relationship to adjoining construction clearly indicated.

12. Seal and signature of Professional Engineer, if specified.

13. Electrical requirements.

14. Limits of or range of operation.

15. Performance curves.

16. Sheet Size: Except for templates, patterns, and similar full-size Drawings, submit Shop Drawings on sheets at least 8-1/2 inches by 11 inches but no larger than 24 inches by 36 inches.

17. Do not use Shop Drawings without an appropriate stamp indicating action taken.

3.3 PRODUCT DATA

A. Collect Product Data into a single submittal for each element of construction or system and type of product or equipment. If information must be specially prepared for submittal because standard printed data is not suitable for use, submit as Shop Drawings instead of Product Data.

1. Mark each copy to show applicable choices and options. When pre-printed catalog information is submitted, clearly identify item to be submitted with arrow or other mark. Catalog information not marked clearly shall be returned. Include the following information:

a. Manufacturer's written recommendations.

b. Manufacturer’s product specifications.

c. Manufacturer’s installation instructions.

d. Manufacturer’s catalog cuts.

e. Compliance with trade association standards.

f. Compliance with recognized testing agency standards.

g. Application of testing agency labels and seals.

h. Notation of dimensions verified by field measurement.

i. Notation of coordination requirements.

3.4 SAMPLES

A. Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other elements and for a comparison of these characteristics between submittal and actual component as delivered and installed. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.

B. Attach label on unexposed side of Samples that includes the following:

1. Generic description of Sample.

2. Product name and name of manufacturer.

3. Sample source.

4. Number and title of appropriate Specification Section.

C. Maintain sets of approved Samples at Project site, available for quality control

comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.

D. Submit manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available.

1. Submit one full set(s) of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. Engineer will return submittal with options selected.

E. Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.

1. Submit two sets of Samples. Engineer will retain one Sample sets; remainder will be returned.

F. Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design.

3.5 TECHNICAL SUBMITTALS REQUIRED

A. The Contractor shall provide technical submittals according to the submittal requirements listed in the Technical Specifications.

3.6 ENGINEER'S ACTION

A. Except for submittals, for the record, or for information where action and return is not required, the Engineer will review each submittal, mark to indicate action taken, and return within the time frame specified in Paragraph 3.01.A.1.d. The Engineer will not review submittals that do not bear the Contractor's approval stamp and will return without action.

B. Action Stamp: Once reviewed, the Engineer will stamp each submittal with a uniform, action stamp. The Engineer will mark the stamp appropriately to indicate the action taken, as follows:

1. The Work covered by the submittal may proceed provided it complies with requirements of the Contract Documents. Final payment depends on that compliance.

2. "Exceptions Noted": The Work covered by the submittal may proceed provided

it complies with minor notations or corrections on the submittal and requirements of the Contract Documents. Final payment depends on that compliance.

3. Do not proceed with Work covered by the submittal, including purchasing, fabrication, delivery, or other activity. Revise the submittal according to the notations and resubmit without delay. Repeat, if necessary, to obtain different action mark.

   a. Do not use, or allow others to use, submittals marked "Revise and Resubmit" at the Project Site or elsewhere where Work is in progress.

4. "Rejected": The Work, Material, or Equipment is not acceptable. Do not use or allow others to use submittals marked "Rejected at the Project Site or elsewhere where Work is in progress.

C. When the drawings and data are returned, the corrections shall be made as noted thereon and as instructed by Engineer, corrected copies resubmitted. Contractor shall upload to CPMS response acknowledging noted items in "Reviewed with Comments".

D. Unsolicited Submittals: The Engineer will return unsolicited submittals to the sender without action.

E. If more than one resubmission is required because of failure of Contractor to provide all previously requested corrected data or additional information, Contractor shall reimburse Owner for the charges of Engineer for review and processing of the additional resubmissions upon project completion. This does not include initial submittal data such as shop tests and field tests which are submitted after initial submittal.

3.7 CONSTRUCTION DIARIES

A. The Contractor shall prepare a daily construction diary recording at a minimum the following information concerning events at the site and submit duplicate copies to the Engineer at weekly intervals. The copies are to be signed by the project Superintendent.

1. Work performed.

2. Approximate count of Contractor's personnel, by classification, on the site.

3. List by classification of all Subcontractors, personnel, and any professionals on the site that day.

4. List of all equipment on the site by make and model.

5. High and low temperatures together with general weather conditions.

6. Start time and finish time of day's work.

7. Accidents and / or unusual events.

8. Meetings and significant decisions made.

9. Stoppages, delays, shortages and / or losses.

10. Meter readings and / or similar recordings.

11. Emergencies procedures that may have been needed.

12. Orders and requests of governing authorities.

13. Change Orders received and implemented.

14. Services connected and / or disconnected.

15. Installed equipment and / or system tests and / or startups and results.

16. Partial completions and / or occupancies.

17. Date of substantial completion certified.

PART 4 - MEASURMENT AND PAYMENT

4.01 MEASUREMENT AND PAYMENT

A. The work performed, materials furnished and all labor, tools, equipment and incidentals necessary to complete the work under this item will not be measured or paid for directly but shall be considered subsidiary to the various bid items of the contract.

END OF SECTION 01300

SECTION 11000
NON-CLOG SUBMERSIBLE SEWAGE PUMPS

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Contractor shall furnish all labor, materials, equipment, accessories and incidentals required to provide non-clog submersible centrifugal sewage pumps with base discharge connection assemblies as specified herein and shown on the plans. Contractor shall provide services of manufacturer's representative for a complete installation, start-up supervision and Operation and Maintenance instruction and manuals.

1.2 GENERAL DESCRIPTION

A. The total of tgqdd (2) pumps shall be designed for handling a raw unscreened wastewater. The equipment shall be designed such that the pump unit can be automatically and firmly connected to the discharge piping when lowered into place on a mating discharge connection permanently installed in the wet pit. The pumps should be easily removable from the lift station, without the need for personnel to enter the wet pit, for inspection or maintenance. All equipment, material, parts, and accessories to be provided as part of this specification shall be new and free from any defects. Contractor shall be responsible for inspecting all equipment's prior to installation and shall be responsible for replacement at no additional cost to the owner.

1.3 QUALITY ASSURANCE

A. The pumps shall be furnished by a manufacturer engaged in the production of the specific type of pump for a minimum of 15 years. The manufacturer shall have furnished similar pumps for a least 5 other installations in Texas performing similar duty. Each installation shall have performed satisfactorily for at least 5 years and are still in operation.

B. All manufacturer parts and components shall be engineered for long, continuous and uninterrupted service. Provisions shall be made for easy lubrication, adjustment, or replacement of all parts.

C. Where like items are incorporated into equipment systems (i.e. motors, push buttons, etc.) such items must be identical to achieve standardization for appearance, operation, maintenance, spare parts, and service. Corresponding parts of multiple units shall be interchangeable.

D. All stages of the manufacturing process shall be carefully inspected at the factory by factory inspectors who shall use whatever means necessary to assure the proper fit of all field connections and compliance with all material and fabrication requirements of the specifications.

E. The pump, pump monitoring, and level control panel shall be factory wired and assembled. Assembly and wiring shall be to the point where the only field interconnections to numbered terminal blocks are required.

F. It is absolutely imperative that parts and service shall be available within 50 miles of the lift station and project site for immediate repairs should service become necessary. Unless it can be demonstrated that parts are available at a service center through the same financially sound firm on a continuing basis.

1.4 SUBMITTALS

A. General

1. All equipment and materials shall be new and shall be specifically designed or selected for the function and service specified. No equipment for materials may be used in the project that has not been approved by the OWNER and ENGINEER. Submittals shall be complete and shall contain data to confirm compliance or exception to all sections of these specifications. Any exception must be clearly indicated. Absence of data will be considered as noncompliance and basis for disapproval. Approval for incorporation

into the project will be made only after the review of shop drawings, specifications and data. Before manufacture, the CONTRACTOR shall furnish for OWNER and ENGINEER's review and approval as the data as required hereinafter.

B. Contractor shall submit dimensional drawings for pumps and accessories.

C. Contractor shall submit documentation of warranty, including specific items covered and time periods.

D. Contractor shall submit test results for submersible pumps as described in Section 12 of this specification.

E. Contractor shall submit typical installation guides for the pumps and accessories.

F. Contractor shall submit location and description of service centers and spare parts stock.

G. Pump Curves

1. In addition to published catalog curves, the pump manufacturer shall furnish certified pump curves showing the results of testing pumping units of identical design, size, horsepower and power supply as those to be furnished. Pump curves shall include flow, hydraulic HP, input KW and wire to water efficiency plotted against T.D.H. Curves shall be drawn to a large scale. Additional data on the curve shall include the model, serial number, impeller size, motor rated HP, power supply voltage and frequency, customer for whom the tests were conducted, date and place of testing and name of the individual supervising testing. All data must be indicated in U.S. units (gallons, feet, etc.).

1.5 PERFORMANCE (OPERATING CONDITIONS AND DUTY POINTS) REFER TO APPENDIX A

1.6 WARRANTY

A. General

1. Pump manufacturer will pay cost of parts and labor during the warranty period, provided that the pump, with cable attached, is returned prepaid to an authorized repair facility for repairs. Coverage of parts and labor will be provided for periods indicated below.
2. This warranty shall not apply to any product or part of product which has been subjected to misuse, misapplication, accident, alteration, neglect, or physical damage and monitoring equipment has been bypassed or removed.
3. Warranty does not cover costs for standard and/or scheduled maintenance or parts that, by virtue of their operation require replacement through normal wear, unless a defect in material or workmanship can be determined by manufacturer.
4. Warranty period shall be as follows and from the date of completed pumps testing, operation and start-up and approval and acceptance and beneficial use by the OWNER:
   a. 0 – 24 months warranty is 100%.
   b. 24 – 39 months warranty is 50%
   c. 40 – 60 months warranty is 25%

PART 2 - PRODUCTS

2.1 PUMPS

A. Manufacturers

1. Pumps shall be the product of Xylem, Inc. – Flygt, or approved equal by the OWNER and ENGINEER.

B. Design

1. General
   a. Major pump components shall be of gray cast iron, ASTM A-48 Class 35B, with smooth surfaces devoid of blowholes and other irregularities.

b. Exposed nuts and bolts shall be AISI type 316 stainless steel or brass construction.
c. All surfaces, other than stainless steel, shall be protected by a factory applied spray coating of acrylic dispersion zinc phosphate primer with a polyester resin paint finish on the exterior of the pump.
d. Critical mating surfaces where watertight sealing is required shall be machined and fitted with Nitrile or Viton rubber O-rings. Sealing will be the result of controlled compression of rubber O-rings in two planes and O-ring contact of four sides without the requirement of a specific torque limit.
e. No secondary sealing compounds, rectangular gaskets, elliptical O-rings, grease or other devices shall be used.

2. Impeller
   a. The impeller shall be of 450 Brinell hardness hi-chrome, ASTM A-532, Class III, Type A1 or better, dynamically balanced, semi-open, multi vane, backswept, non-clog design.
   b. The impeller vane leading edges shall be mechanically self-cleaned upon each rotation as they pass across a machined spiral groove located on the stationary insert ring maintaining an unobstructed leading edge.
   c. The impeller shall be induction hardened to Rc 45, screw shaped leading edges and shall be capable of handling solids, fibrous materials, heavy sludge and other matter found in wastewater.
   d. Impellers shall be locked to the shaft and shall be coated with alkyd resin primer.
   e. The impeller to volute clearance shall be readily adjustable by the means of a single trim screw.
3. Volute
   a. Pump volutes shall be single piece gray cast iron, ASTM A-48, Class 35B, non-concentric design with smooth passages large enough to pass any solids that may enter the impeller.
   b. Minimum inlet and discharge size shall be as indicated herein.
4. Insert Ring
   a. A replaceable insert ring shall be of 450 Brinell hardness hi-chrome, ASTM A-532, Class III, Type A1 or better, having an integral machined spiral shaped groove shall be installed in the pump volute.
   b. The clearance between the insert ring and the impeller shall be adjustable to provide effective sealing between the multi-vane semi-open impeller and the volute housing.
5. Motor
   a. The pump motor shall be a NEMA B design, induction type with a squirrel cage rotor, shell type design, housed in an air filled, watertight chamber.
   b. The motor shall be invertor duty rated in accordance with NEMA MG1, Part 31.
   c. The submersible motor shall be FM or UL Listed for Class I, Division 1, Groups C and D explosion-proof hazardous locations.
   d. The stator windings shall be insulated with moisture-resistant Class H insulation for 180 degrees C.
   e. The stator shall be insulated by the trickle impregnation method using Class H monomer-free polyester resin resulting in a winding fill factor of at least 95%.
   f. The motor shall be designed for continuous duty while handling pumped media of up to 104 degrees F.
   g. The stator shall be heat-shrink fitted into the cast iron stator housing. The use of fastening devices used to hold or locate the stator and that penetrate the stator housing are not acceptable.
   h. The motor service factor shall be 1.15. The motor shall have a voltage tolerance of +/- 10%.
   i. The motor shall be designed for continuous duty capable of fifteen (15) evenly spaced starts per hour.
   j. The motor shall be designed for a continuous operation in up to a 40-degree C ambient and shall have a NEMA Class B maximum operating temperature rise of 80 degrees C.

k. Motor horsepower shall be sufficient so that the pump is non-overloading throughout its entire performance curve, from shut-off to run-out.
l. Motor shaft shall be one-piece, extending through the pump and motor. Extension couplings shall not be acceptable. Shaft shall be constructed of 431 stainless steel. Shaft sleeves shall not be acceptable.

6. Cable Entry Seal
   a. The power cable entry seal design shall preclude specific torque requirements to ensure a watertight seal and shall allow simple field changing of power without affecting pump or motor warranty.
   b. The cable entry shall consist of a single cylindrical elastomer grommet, flanked by washers, all having a close tolerance fit against the cable outside diameter and the entry inside diameter and compressed by the body containing a strain relief function, separate from the function of sealing the cable.
   c. The power cable shall be sized according to the NEC and ICEA standards and shall be of sufficient length to reach the junction box without the need of any splices.
   d. The outer jacket of the cable shall be oil resistant chlorinated polyethylene rubber.
   e. The motor and cable shall be capable of continuous submergence underwater without loss of watertight integrity to a depth of 65 feet or greater.
   f. A separate junction chamber shall be provided inside the pump for connection of power cables to stator leads. The chamber shall be sealed by a nonmetallic terminal board bolted to a machined surfaced and utilizing an O-ring to obtain a watertight seal.
7. Cooling System
   a. The motor of the pump shall be provided with cooling jacket and cooled by the pumped liquid
   b. The impeller back vanes shall pump the cooling liquid with a velocity of at least 0,5m/s to avoid sedimentation of small particles in the cooling system
   c. Two cooling liquid supply pipes, one discharging low and one discharging high within the jacket, shall supply the cooling liquid to the jacket.
   d. An air evacuation tube shall be provided to facilitate air removal from within the jacket. Two cooling liquid return ports shall be provided.
   e. The internals to the cooling system shall be non-clogging by virtue of their dimensions. The cooling jacket shall be equipped with two flanged and bolted inspection ports of not less than 4"Ø located 180° apart.
8. Mechanical Seal
   a. Pumps shall be provided with a mechanical seal system consisting of two totally independent seal assemblies operating in a lubrication chamber between the pump volute and motor chamber for seal lubrication and cooling.
   b. The lower seal shall act as the primary unit to prevent entry of pumped liquid to the oil chamber shall contain one stationary and one positively driven rotating, corrosion resistant tungsten-carbide ring.
   c. The upper seal shall act as a secondary unit to prevent pumped liquid or oil from entering the stator housing shall contain one stationary and one positively driven rotating, corrosion resistant tungsten-carbide ring.
   d. The seal springs shall be isolated from the pumped media to prevent materials from packing around them, limiting their performance
   e. Mounting of the lower seal on the impeller hub is not acceptable
   f. The seal system shall allow continuous pump operation with the motor exterior totally dry.
   g. Each seal interface shall be held in contact by its own spring system. The seals shall require neither maintenance nor adjustment nor depend on direction of rotation for sealing
9. Bearings
   a. The motor bearings shall be sealed and permanently grease lubricated with a B- 10 design life of 100,000 hours at any point along the usable pump curve at maximum speed.
   b. The upper bearing shall be two row angular contact ball bearing.
   c. The lower bearing shall be a two-row angular contact ball bearing to handle the

thrust and radial forces.

10. Pump protection devices

    a. The pump manufacturer shall provide a pump monitoring unit which shall be mounted in the control panel or mounted on a dead front panel or swing outdoor and shall be wired to activate an alarm.

11. Accessories
    a. The pump manufacturer shall furnish all station hardware and accessories for use with the pumps furnished or for any future requirements or revisions as may be indicated in the Plans or other sections of the Contract Specifications.
    b. All items inside the wet well shall be 316 stainless steel or aluminum as indicate below.
    c. To ensure compatibility, all access covers in structures containing submersible pumps shall be provided by the supplier of the submersible pumps. Refer to specification for access cover requirements.

12. Testing
    a. Testing shall be required and include the following:

        1) The pump shall be visually inspected to confirm that it is built in accordance with the specification as to HP, speed, voltage, phase and hertz.
        2) The motor and seal housing chambers shall be meggered for infinity to test for moisture content and/or insulation defects.
        3) Pump shall be allowed to run dry to check for proper rotation.
        4) Discharge piping shall be attached, the pump submerged in water and amp readings shall be taken in each leg to check for an unbalanced stator winding. If there is a significant difference in readings, the stator windings shall be checked with a bridge to determine if an unbalanced resistance exists. If so, the stator shall be replaced.

    b. Factory tests are required for all pumps. Results of the performance tests shall be certified and signed and sealed by a Licensed Professional Engineer in the State of Texas and submitted for approval before final shipment.

2.2 MECHANICAL ACCESSORIES:

A. General:
    1. The Pump Manufacturer shall furnish and be responsible for coordinating proper fit and suitability of all station hardware and accessories for the use with the pumps furnished or for any future requirements or revisions as may be indicated on the Drawings or other sections of the Contract Specifications. All items furnished shall be guaranteed, to the OWNER, suitable for the intended use and shall be warranted against defective workmanship, materials and excessive corrosion for a period of five years after startup, approval and acceptance and beneficial use by the OWNER.

B. Access Covers:
    a. To ensure compatibility the supplier of the submersible pumps shall supply all access covers in structures containing submersible pumps.
    b. Quantity and sizes are stated on the plans.
    c. Material shall be 6061-T6 aluminum for bars, angles and extrusions. 1/4” diamond plate shall be 5086 aluminum.
    d. Unit to be Pedestrian Rated, for a minimum live load of 300-lbs./sq. ft. Deflection shall not exceed 1/150th of the span.
    e. Hinges shall be of heavy-duty design. Material shall be grade 316 stainless steel.
    f. All access covers shall have a "Safe-Hatch" is designed to combine covering of the opening, fall through protection per OSHA standard 1910.23 and controlled confine space entry per OSHA standard 1910.146.
    g. The grating shall be designed to withstand a minimum live load of 300 pounds per square foot. Deflection shall not exceed 1/150th of the span.
    h. Doors cannot be closed unless the fall through protection has been put back in place

i. Grate openings shall be 4” x 6”, which will allow for visual inspections, and a gloved hand to make limited maintenance and float adjustment while safety grate is left in place.
j. Quality materials provide superior corrosion resistance (designed to withstand the harsh sewer environment)
k. Open grates create a physical barrier around the pit, protecting passing pedestrians
l. Grates shall be “Safety Orange” in color for a visual awareness of the hazard.

C. Guide Rail and Upper Guide Rail Brackets:
a. Dual rail and upper guide rail brackets shall be provided by the pump supplier for each pump. The dual rails and upper guide rail bracket shall be constructed of 316 stainless steel. The dual guide rail design keeps the pump in proper alignment with the stationary discharge piping. The rail shall be constructed of 316 stainless steel of minimum of 3” diameter, and positioned on each side of the pump so that no weight of the pump bears on the rails at any time.
b. Dual rail intermediate guide rail brackets shall be provided by the pump supplier for guide rails which exceed 20 feet in length. Intermediate guide rail brackets shall be located at each 20’ increment of guide rail or at midpoint of guide rail span. The intermediate guide rail bracket shall be constructed of 316 stainless steel.

D. Power Cable Supports:
a. A 316 Stainless steel cable grip shall be provided for each pump power and pilot cable. The grip shall have a loop on one end, which will hang from a hook provided on the upper guide bar bracket.
b. Mounting bracket support rack with hooks constructed of 316 stainless steel shall be provided for supporting the pump power cables, lifting cable/chain assembly and level controls. A mounting support rack with hooks shall be provided for each pump.

E. Pump Lifting Assembly:
a. A 316 Stainless steel wire or cable, of diameter matching weight of lifting chain required, connected to a short length (approximately ten links long) of high tensile strength proof-tested 316 stainless steel chain of required capacity, connected to the lifting eye or lifting bail of the submersible pump. Total length of assembly shall reach the top of the station plus ten feet.
b. A forged “grip-eye” of wrought alloy steel, shall be provided to connect to the end of the lifting cable or chain of the pump lifting device. Two “grip eye” shall be provided for the lift station.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation of the pumps shall be in strict accordance with the manufacturer’s instructions and recommendations.

B. The locations of the discharge piping are shown on the construction drawings and shall be verified by the contractor and pumps manufacture.

C. The location of the pumps, access covers, and discharge connection are approximate. The precise placement and alignment of anchor bolts, discharge assembly, guide rails, upper guide rail bracket, access cover and associated connections shall be in accordance with the supplemental construction details provided by the pump manufacturer. The contractor and manufacturer shall verify and check alignment during start up field testing. Improper alignment shall be corrected by the CONTACTOR prior to continuation of testing.

3.2 STARTUP AND FIELD TESTING

A. After the pumps have been completely installed and wired, the CONTACTOR shall remove the pumps to the wet well top deck and an authorized representative of the pump manufacturer shall inspect each pump for proper installation.

1. Megger stator and power cable
2. Measure and record stator and power cable resistance
3. Check for proper rotation
4. Check power supply voltage
5. Measure Motor no load current
6. Check level control operation and sequence
7. Review recommended operation and maintenance procedure
8. Review warranty with OWNER's personnel

After initial inspection, the CONTACTOR shall lower the pumps into place in the wet well and provide water for an initial startup operation check. The manufacturer's service representative shall supervise lowering and connection of the pumps to the discharge connection confirming proper guide rail and discharge connection alignment. The service representation shall then perform an initial operation check of each pump including:

1. Motor current in each phase
2. Supply voltage with one, two and three pumps running
3. Vibration
4. Discharge connection seating

B. On completion of initial inspection and operational checks, the pump manufacturer shall furnish the OWNER and ENGINEER with a written report of the findings and data determined with regard to the pumps, motors, accessories, level control and electrical protection devices. The final report shall be signed by a manufactures authorized field representative. A copy of the report shall be included in the operation and maintenance manuals.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT AND PAYMENT

A. No separate measurement or payment will be made for submersible pumps and related accessories. The equipment, material, labor, testing, etc. required by this section shall be considered subsidiary to the individual bid items provided on the Bid Proposal.

END OF SECTION

SECTION 11015
COMMON REQUIREMENTS FOR EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, Specification Sections, apply to this Section.

1.2 SUMMARY

A. In addition to the specific requirements of the individual equipment specification sections, the CONTRACTOR shall be responsible for ensuring all mechanical equipment comply with the requirements of this Section.

B. CONTRACTOR shall furnish and install all tools, equipment, materials, and supplies and shall perform all labor necessary for the installation, testing, and placing into operation of all equipment, complete and operable, in accordance with the requirements of the Contract Documents.

C. Related Sections:
1. Section 912 “Valves” for basic valve requirements associated with equipment systems, along with the individual valve sections.

1.3 REFERENCES

A. Reference Specifications, Standards, Codes, and Regulations:
1. Various Project sections contain references to specifications, standards, codes, regulations, and other documentation and shall be considered a part of those sections as specified and modified.
2. Where a referenced document contains references to other standards, those documents are included as references under this Section as if referenced directly.
3. In the event of conflict between the requirements of the Project specification sections and those of the listed documents, the requirements of the Project specification section shall prevail.
4. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Opening of Bid. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued.

B. Commercial Standards: All equipment, products, and their installation shall be in accordance with the following standards, as applicable, and as specified in each Section of these specifications.
1. American Society for Testing and Materials (ASTM).
2. American Public Health Association (APHA).
3. American National Standards Institute (ANSI).
4. American Society of Mechanical Engineers (ASME).
5. American Water Works Association (AWWA).
6. American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE).
7. American Welding Society (AWS).
8. National Fire Protection Association (NFPA).
9. Federal Specifications (FS).
10. National Electrical Manufacturers Association (NEMA).
11. Rubber Manufacturers of America (RMA).
12. Manufacturer's published recommendations and specifications.
13. General Industry Safety Orders (OSHA).

C. The following standards are referred to in the various Project specification sections:
   1. American National standards Institute (ANSI):
      a. B1.1 Unified Screw Threads.
      b. B1.20.1 Pipe Threads, General Purpose (Inch)
      c. B16.1 Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250, and 800.
      d. B31.3 Process Piping Code.
      e. B46.1 Surface Texture.
      f. S12.6 Method for the Measurement of the Real-Ear Attenuation of Hearing Protections.
   2. American Water Works Association (AWWA):
      a. D100 Welded Steel Tanks for Water Storage.
      b. C206 Field Welding of Steel Water Pipe.
   3. ASTM International, Inc. (ASTM):
      a. A 48 Specification for Gray Iron Castings.
      b. A 108 Specification for Steel Bars, Carbon, Cold-Finished, Standard Quality.
   4. National Electrical Manufacturer's Association (NEMA): MG-1, Motors and Generators.
   5. National Fire Protection Association (NFPA): NFPA 70, National Electric Code.
   6. National Sanitation Foundation (NSF): NSF 61, Drinking Water Components – Health Effects.

1.4 SUBMITTALS

A. The information requested in the various Project specification sections shall be prepared and submitted in accordance with Section 01300 "Submittal" and in accordance with the requirements described in the following paragraphs.

B. Equipment and Related Lists: Lists are included for the convenience of the ENGINEER and CONTRACTOR and are not complete listings of all equipment, devices and material to be provided under this Contract. The CONTRACTOR agrees to prepare his own material and equipment takeoff lists as necessary to meet the requirements of the Project.

C. Product Data: Provide construction details, material descriptions, dimensions of individual components and profiles, finishes for rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

D. Shop Drawings: Provide plans, elevations, sections, details, and attachments to other work.
   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Layout, sizes, types and materials for anchor bolts to be furnished.
   3. Location of all necessary supporting instrumentation furnished, including associated mounting brackets and hardware.
   4. Wiring Diagrams: For power, signal, and control wiring diagrams, including terminals and numbers.
   5. Complete motor nameplate data, as defined by NEMA, motor manufacturer, and include any motor specifications.
   6. Equipment weights and lifting points.

E. Manufacturer Installation Instructions: Instructions for field procedures for erection, adjustments, inspection, and testing shall be provided prior to installation of the equipment.

F. Torsional Analysis:
   1. CONTRACTOR shall submit to the ENGINEER a torsional and lateral vibration analysis of the following equipment. The analysis shall be performed by a specialist experienced in this type of work.
      a. All engine drives.
      b. All blowers and compressors with drives of 100 horsepower and over.
      c. All vertical pumps with universal joints and extended shafts.
      d. All other equipment where specified.

2. The torsional natural frequency of the drive train must be avoided by +25 percent by any exciting frequency of the equipment, throughout the entire operating range.

G. Guarantees and Warranties: After completion, the CONTRACTOR shall furnish to the OWNER the manufacturer's written guarantees, that the equipment will operate within the specified design and performance parameters and meet these specifications. CONTRACTOR shall also furnish the manufacturer's warranties as published in its literature and as specified.

H. Coordination Drawings: Provide for screening system components, such as screen, conveyor, compactor washer, utilities, instrumentation, electrical wiring and devices, grating openings, handrail modifications, and all other details, drawn to scale, on which all components of the system are shown and coordinated with each other.

I. Information Submittals:
1. Manufacturer’s Certification of Compliance.
2. Special shipping, storage and protection, and handling instructions.
3. Manufacturer’s installation instructions.
4. Manufacturer’s Certificate of Proper Installation.
5. Qualifications of manufacturer and manufacturer’s representative.
6. Location of nearest stocking distributor of spare parts.
7. Suggested spare parts list to maintain the equipment in service for a period of one year. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current pricing information.
8. Welding certificates.
9. Factory Test Reports: Based on evaluation of comprehensive tests performed by manufacturer.
10. Field quality-control reports.
11. Warranty: Sample of special warranty.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Unless otherwise specified in the individual specification sections;
1. All equipment shall be the product of a manufacturer which has been in the design, fabrication, assembly, testing, start-up and service of full scale pumping units with at least fifteen (15) North American installations of the type, model, and size specified for a period of not less than five (5) years prior to the bid date of this Contract.
2. A list of similar installations shall be furnished with the shop drawing submittal, including names and telephone numbers of contacts.
3. Certified to ISO 9001 by an accredited certification agency.

B. Installer Qualifications: Unless otherwise specified in the individual specification sections; CONTRACTOR shall provide a manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

C. Source Limitations: Equipment of each type specified as specified in the individual specification sections shall be supplied by a single manufacturer. This does not require that all equipment be manufactured by a single manufacturer, but does require that the manufacturer of the system shall be responsible for the complete system.

D. Welding Qualifications: Qualify procedures and personnel according to one of the following American Welding Society (AWS) codes as applicable.
1. D1.1/D1.1M, "Structural Welding Code – Steel.”
2. D1.2/D1.2M, "Structural Welding Code – Aluminum.”
3. D1.3, "Structural Welding Code - Sheet Steel.”
4. D1.4, "Structural Welding Code - Reinforcing Steel.”
5. D1.6, "Structural Welding Code--Stainless Steel.”

E. Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

F. Stainless Steel Construction:

1. Structural stainless steel components shall conform to AISC “Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings.”
2. Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code – Steel” and AWS D1.6, "Structural Welding Code--Stainless Steel."
3. Fabricate parts and assemblies from sheets and plates of Type 304 stainless steel with 2D finish conforming to AISI 304 and ASTM A666, unless otherwise noted.
4. Fabricate rolled or extruded shapes to conform to ASTM A276.
5. Fabricate tubular products and fittings to conform to ASTM A269, A351 and A403.
6. Factory welding to be by the arc, inert gas, MIG, or TOG method. Add filler wire to all welds to provide for a cross section and weld metal equal to or greater than the parent metal. Fully penetrate butt welds to the interior surface and provide gas shielding to interior and exterior of the joint.
7. Field welding of stainless steel will not be permitted.
8. Bolts, nuts, and washers shall be Type 316 stainless steel in accordance with ASTM A193.

G. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

H. ASME Compliance: Fabricate and label equipment component to comply with ASME Boiler and Pressure Vessel Code.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver, handle and store equipment components in accordance with shop drawings, manufacturer’s written instructions.

B. Special requirements for the storage and handling of equipment will be provided in the specified equipment section.

1.7 PROJECT CONDITIONS

A. Structural Performance: All equipment, supports, anchors and fasteners shall be of adequate size and strength to withstand loads associated with starting, turbulence, debris, thrusts from liquid movement, thermal expansion and contraction and other loads encountered under operating conditions.

B. Operation: Equipment shall be designed and capable of either continuous or intermittent operation.

C. System Arrangement:
1. The equipment, sizes, materials, and arrangements described in the individual specification sections are typically based on recommendations by equipment manufacturers and shall be considered minimum limits of acceptability. The equipment MANUFACTURER shall be responsible for design, arrangement, and performance of all equipment supplied under this section.
2. Modifications to structural design due to a manufacturer’s varying space requirements, foundation requirements, floor slope requirements, dimension changes, or other requirements to fit manufacturer specific requirements shall be coordinated by CONTRACTOR and included in the Bid.
3. The CONTRACTOR shall be responsible for any modifications to the piping, electrical, structural, and mechanical layouts to accommodate, as well reimbursement to OWNER for additional charges by ENGINEER for additional work required for accomplishing the changes.

D. Environmental Conditions:
1. All equipment, including controls and drives specified herein, shall be specifically designed for the service and the environment to be encountered.
2. Designed and capable of operation at ambient temperatures of 0^{o}F to 110^{o}F.
3. Furnish heat tracing and insulation as required, if required for exterior installation. Insulation alone shall not be sufficient to fulfill freeze protection provisions of this section.

E. NSF Certified: All surfaces and materials in contact with water or in contact with a chemical being added to water that is being treated for potable water use and conveyance, shall comply with the requirements of the Safe Drinking Water Act and shall conform to NSF-61. Product shall bear the mark or seal of an accredited testing laboratory.

F. Field Measurements, Existing Facilities Installation: Verify actual dimensions of openings, adjacent facilities and equipment, utilities and related items by field measurements before fabrication as applicable.

PART 2 - PRODUCT

2.1 GENERAL REQUIREMENTS

A. The CONTRACTOR shall furnish and install only such equipment as the designated single manufacturer certifies is suitable for use with its equipment and the service conditions.

B. All manufactured items provided under this Section shall be new, of current manufacture, and shall be the products of reputable manufacturers specializing in the manufacture of such products; such manufacturers shall have had previous experience in such manufacture and shall, upon request of the ENGINEER, furnish the names of not less than five (5) successful installations of its equipment of comparable nature to that offered under this Contract.

C. All combinations of manufactured equipment which are provided under these specifications shall be entirely compatible, and the CONTRACTOR and the designated single manufacturer shall be responsible for the compatible and successful operation of the various components of the units conforming to specified requirements.

D. Where two or more equipment of the same type and/or size are required, such units shall all be produced by the same manufacturer.

E. Tolerance: Tolerances and clearances shall be as shown on the shop drawings and shall be closely adhered to. Machine work shall in all cases be of high-grade workmanship and finish, with due consideration to the special nature or function of the parts. Members without milled ends and which are to be framed to other steel parts of the structure may have a variation in the detailed length of not greater than 1/16-inch for members 30 feet or less in length, and not greater than 1/8-inch for members over 30 feet in length.

F. Machine Finish: The type of finish shall be the most suitable for the application and shall be shown in micro-inches in accordance with ANSI B46.1. The following minimum finishes shall be used:
   1. Surface roughness not greater than 63 micro-inches shall be required for all surfaces in sliding contact.
   2. Surface roughness not greater than 250 micro-inches shall be required for surfaces in contact where a tight joint is not required.
   3. Rough finish not greater than 500 micro-inches shall be required for other machined surfaces.
   4. Contact surfaces of shafts and stems which pass through stuffing boxes and contact surfaces of bearings shall be finished to not greater than 32 micro-inches.

G. Noise Level:
   1. When the equipment is in operation, no single piece of equipment shall exceed the OSHA noise level requirements for a one hour exposure, and the regulatory agency having jurisdiction where the Project is located.
   2. The maximum allowable noise level shall correspond to the type of occupancy and area classification as specified and as shown in the Drawings.

H. Personal Hearing Protection: Where specified, CONTRACTOR shall supply, in their original unopened packaging, three pairs of high attenuation hearing protectors.
   1. Capable of meeting the requirements of ANSI S12.6, producing a noise level reduction of 25 dBA at a frequency of 500 Hz.
   2. Have fluid filled ear cushions and an adjustable, padded headband.
   3. Provide a weatherproof, labeled, steel cabinet, mounted in an approved location near the noise producing equipment.

I. Service Factors: Service factors shall be applied in the selection or design of mechanical power transmission components. Unless otherwise specified, the following load classifications shall apply in determining service factors:

Type of Equipment Load Classification	Load Classification
Pump:	
Centrifugal or Rotary:	Uniform
Reciprocating:	Moderate Shock

2.2 MATERIALS

A. All materials furnished as part of the equipment shall be suitable for its intended use and service. Materials not specifically called for shall be high-grade, standard commercial quality, free from all defects and imperfection that might affect the serviceability of the product for the purpose for which it is intended

B. Pipe Hangers, Supports, and Guides: All pipe connections to equipment shall be supported, anchored, and guided to avoid stresses and load on equipment flanges and equipment.

C. Flanges and Pipe Threads: All flanges on equipment and appurtenances provided under this Section shall conform to ANSI B16.1, Class 125; or B16.5, Class 150, unless otherwise shown. All pipe threads shall be in accordance with ASNI/ASME B1.20.1.

D. Couplings:
1. Flexible couplings shall be provided between the driver and the driven equipment to accommodate slight angular misalignment, parallel misalignment, end load, and to cushion shock loads. Where required for vertical shafts, 3-piece spacer couplings or universal type couplings for extended shafts shall be installed. Selection of flexible coupling shall include service factor of driven equipment.
2. CONTRACTOR shall have the equipment manufacturer select or recommend the size and type of coupling required to suit each specific application.
3. Taper-lock bushings may be used to provide for easy installation and removal on shafts of various diameters.
4. Where universal type couplings are shown, they shall be of the needle bearing type construction, equipped with commercial type grease fittings.

E. Shafting:
1. General: All shafting shall be continuous between bearings and sized to transmit the power required. Keyways shall be accurately cut parallel with shaft centerline. Unless otherwise specified and justified by calculation, shafting shall not be turned down at the ends to accommodate bearings or sprockets whose bore is less than the diameter of the shaft. All shafts shall rotate in the end bearings and shall be turned and polished, straight and true.
2. Materials: Shafting materials shall be appropriate for the type of service and torque transmitted. Environmental elements such as corrosive gases, moisture, and fluids shall be taken into consideration. Materials shall be as shown or specified unless furnished as part of an assembly.
   a. Low carbon cold-rolled steel shafting shall conform to ASTM A 108, Grade 1018.
   b. Medium carbon cold-rolled shafting shall conform to ASTM A 108, Grade 1045.
   c. Corrosion-resistant shafting shall be stainless steel or Monel, whichever is most suitable for the intended service.
3. Differential Settlement: Where differential settlement between the driver and the driven equipment may be expected, a shaft of sufficient length with 2 sets of universal type couplings shall be provided.

F. Bearings: Bearings shall conform to the standards of the Anti-Friction Bearing Manufacturers Association, Inc. (AFBMA). To assure satisfactory bearing application, fitting practice, mounting, lubrication, sealing, static rating, housing strength, and other important factors shall be considered in bearing selection.

1. Bearing Life: Minimum L-10 rating life of 50,000 hours. The rating life shall be determined using the maximum equipment operating speed.
2. Lubricated-for-life bearings shall be factory-lubricated with the manufacturer's recommended grease to insure maximum bearing life and best performance.
3. Grease lubricated bearings, except those specified to be factory sealed and lubricated, shall be fitted with easily accessible grease supply, flush, drain and relief fittings. Extension tubes shall be used when necessary. Grease supply fittings shall be standard hydraulic alemite type.
4. Oil lubricated bearings shall be equipped with either a pressure lubricating system or a separate oil reservoir type system. Each oil lubrication system shall be of sufficient size to safely absorb the heat energy normally generated in the bearing under a maximum ambient temperature of 60^0 C and equipped with a filler pipe and an external level indicator gage.
5. Sleeve-type bearings shall have a Babbitt or bronze liner.

G. Bearing Housing: Cast iron or steel with bearing mounting arrangement shall be as specified or shown, or as recommended in the published standards of the manufacturer. Split-type housings may be used to facilitate installation, inspection, and disassembly.

H. Gears and Gear Drives:
1. Unless otherwise specified, gears shall be of the helical or spiral-bevel type, designed and manufactured in accordance with AGMA Standards, with a gear teeth minimum service factor of 1.7, a minimum B-10 bearing life of 60,000 hours and a minimum efficiency of 94 percent.
2. Gear speed reducers or increases shall be of the enclosed type, oil-or grease-lubricated and fully sealed, with a breather to allow air to escape but keep dust and dirt out. The casing shall be of cast iron or heavy duty steel construction with lifting lugs and an inspection cover for each train. An oil level glass and an oil flow indicator shall be provided, arranged for easy reading.
3. Gears and gear drives as part of an equipment assembly shall be shipped fully assembled for field installation.
4. Gear design, manufacture and material selections shall be left to the discretion of the manufacturer, provided the above AGMA level of quality suitable for the application are met. Input and output shafts shall be adequately designed for the service and load requirements. Gears shall be computer-matched for minimum tolerance variation. The output shaft shall have two position seals to prevent oil leakage.
5. Oil level and drain location relative to the mounting arrangement shall be easily accessible. Oil coolers or heat exchangers with all required appurtenances shall be furnished when necessary.

I. Drive Chains:
1. Power drive chains shall be commercial type roller chains and meet ANSI Standard.
2. A chain take-up or lightener shall be provided in every chain drive arrangement to provide easy adjustment.
3. A minimum of one connecting or coupler link shall be provided with each length of roller chain.
4. Sludge collector chain and attachments shall be of the manufacturer's best standard material and suitable for the process fluid.

J. Sprockets:
1. General: Matching sprockets shall be furnished with all chain drives and chain-type material handling equipment.
2. Materials: Unless otherwise specified, materials shall be as follows:
   a. Sprockets with 25 teeth or less, normally used as a drive, shall be made of medium carbon steel in the 0.40 to 0.45 percent carbon range.
   b. Type A and B sprockets with 26 teeth or more, normally used as driven sprockets, shall be made of minimum 0.20 percent carbon steel.
   c. Large diameter sprockets with Type C hub shall be made of cast iron conforming to ASTM A 48, Class 30.
3. Sprockets shall be accurately machined to ANSI Standards. Sprockets shall have deep hardness penetration in tooth sections.

4. Finish bored sprockets shall be furnished complete with keyseat and set screws.
5. To facilitate installation and disassembly, sprockets shall be of the split type or shall be furnished with taper-lock bushings as required.
6. Idler sprockets shall be furnished with brass or Babbitt bushings, complete with oil hole and axial or circumferential grooving. Steel collars with set screws may be provided in both sides of the hub.

K. V-Belt Drives:
1. V-belts and sheaves shall be of the best commercial grade and shall conform to ANSI and RMA Standards.
2. Unless otherwise specified, sheaves shall be machined from the finest quality gray cast iron.
3. Sheaves shall be statically balanced. For high speed application, where vibration is a problem, sheaves shall be dynamically balanced. Sheaves operating at high belt speeds may be required to be constructed of special materials.
4. To facilitate installation and disassembly, sheaves shall be furnished complete with taper lock or QD bushings as required.
5. Finish bored sheaves shall be furnished complete with keyseat and set screws.
6. Sliding motor bases shall be provided to adjust the tension of V-belts.

L. Drive Guards: All power transmission, prime movers, machines, shaft extensions, and exposed moving machine parts shall be guarded to conform with OSHA standards. The guards shall be constructed of minimum 14 gage expanded, flattened steel, with smooth edges and corners, galvanized after fabrication and securely fastened. Where required for lubrication or maintenance, guards shall have hinged latched access doors. Reinforced-fiberglass-plastic constructed guards may be used.

M. Flexible Connections: Flexible connectors shall be installed in all piping connections to engines, blowers, compressors, other vibrating equipment, and in piping systems.
1. General: Install flexible couplings to facilitate installation of piping, connections to equipment and pumping units, and to permit disassembly of valve, instrumentation components in accordance with approved Shop Drawings.
2. Flexible Joints at Concrete Backfill or Encasement: Install within 18 inches from the termination of any concrete backfill or encasement.
3. Flexible Joints at Concrete Structures:
   a. Install 18 inches or less from the face of structure; joint may be flush with face.
   b. Install a second flexible joint, whether shown or not:
      1) Pipe Diameter 18 Inches and Smaller: Within 18 inches of the first flexible joint.
      2) Pipe Diameter Larger Than 18 Inches: Within one pipe diameter of the first flexible joint.

N. Flexible Couplings and Flanged Coupling Adapters:
1. Install per Drawings and in accordance with manufacturer’s instructions at locations to facilitate removal of equipment, valves, and other elements.
2. All flexible couplings and flanged couplings shall be restrained.

O. Insulating Connections: Where dissimilar materials are connected, insulating bushings, unions, couplings, or flanges, as appropriate.

P. Gaskets and Packing:
1. Packing: Packing around valve stems and reciprocating shafts shall be compressible material, compatible with the fluid being used. Chevron-type "V" packing shall be Garlock No. 432, John Crane "Everseal," or equal.
2. Pump seals shall be as specified in Division 11 Section 11000 “Non-Clog Submersible Sewage Pumps”
3. Packing Around Rotating Shafts: "O"-rings, stuffing boxes, or mechanical seals, as recommended by the manufacturer.

Q. Overload Protection:

1. General: Unless otherwise specified in individual equipment Sections, all sludge collectors, clarifier raking mechanisms, conveyors, and bar screen equipment drives shall be provided with an overload protection device as follows:
   a. Mechanical System:
      1) Provide a mechanical device to provide for reliable protection in the event of excessive overload; ball detent type designed for long term repeatability and life; and infinitely adjustable by a single adjusting nut.
      2) Once set it shall be tamperproof, and incorporate a torque monitoring and control system.
      3) Activate an alarm set at 85 percent, and a motor cutout switch set for 100 percent of maximum continuous running torque.
      4) Provide a visual torque indication, oriented so it may be read from the walkway. The dial shall be calibrated from 0 to 100 percent of maximum continuous running torque.
      5) Design of the torque limiter should initiate the mechanical disengagement of the drive upon overload.
      6) Unit shall be suitable for outdoor/corrosive environments with a protective finish, corrosion inhibiting lubricants, and a stainless steel cover.
   b. Electronic System:
      1) As an alternative to the mechanical system, the overload protection may be an Electronic Torque Monitoring Control System capable of displaying torque, rpm's, one level of overload, and two levels of overload of the drive system.
      2) It shall incorporate a time delay for start-up and a voltage monitoring and compensation circuit for up to 15 percent variation.
      3) Provide a visual torque indication, oriented so it may be read from the walkway.
      4) Calibrated to alarm and shut down the system in the event the torque drops to 50 percent of normal running; alarm at 85 percent of maximum continuous running torque and shut down the motor at maximum continuous running torque.
      5) Overload device shall have an enclosure suitable for outdoor installation at temperatures of 0-110^0 F, and relative humidity up to 95 percent.
      6) System shall be calibrated at the factory of the equipment manufacturer and it shall be capable of monitoring twice the maximum continuous running torque of the equipment.

2.3 APPURTENANCES

A. Manufacturer Nameplate: Equipment shall be equipped with a stainless steel nameplate indicating manufacturer's name and model number, design and performance requirement, and other appurtenant information.

B. Equipment Identification Plates: A 16-gauge stainless steel identification plate shall be securely mounted on the equipment in a readily visible location. The plate shall bear 1/4-inch die-stamped equipment identification number indicated in the individual specification sections and/or on the Drawings.

C. Lifting Lugs: Individual equipment and/or each field disassemble part weighing over 80 pounds shall be provided with lifting lugs

D. Initial Supply of Lubricants: Manufacturer shall indicate types, brands, and quantities of initial lubricants, oil, grease, etc. necessary to startup equipment. CONTRACTOR shall provide and install the recommended lubricants and shall comply with all manufacturer recommended procedures.

E. Safety Signs: Provide the following safety signs:
   1. Equipment with guarded moving parts which operates automatically or by remote control shall be identified signs reading "CAUTION - EQUIPMENT STARTS AND STOPS AUTOMATICALLY."

2. Place a caution sign on the guard reading “CAUTION- KEEP GUARD IN PLACE.”

2.4 EQUIPMENT SUPPORTS AND FOUNDATIONS

A. Equipment Supports: Unless otherwise shown, all equipment supports, anchors, and restrainers shall be adequately designed for static, dynamic, wind, and seismic loads. The design horizontal seismic force shall be greater of that noted in the general structural notes or as required by the governing building code, or 10 percent of gravity, whichever is greater.

B. Equipment Foundations: Equipment foundations shall be as per manufacturer's written recommendations. All mechanical equipment, tanks, control cabinets, etc., shall be mounted on minimum 4-inch high reinforced concrete bases, unless otherwise shown or specified.

C. Shop Drawings: Shop drawings shall be submitted to the ENGINEER. Shop Drawings will be considered incomplete unless clear, concise calculations are presented showing equipment anchorage forces and capacitates of the anchorage elements provided by the CONTRACTOR.

2.5 SOURCE QUALITY CONTROL

A. Testing and inspection of the factory assembled equipment shall be accomplished by manufacturer prior to shipment. Upon satisfactory completion of testing, the units will be disassembled into subcomponent assemblies for shipment and installation. At the manufacturer’s option, the units may also be shipped to the site as complete units, providing said units can be installed as a complete assembly.

B. All control panels shall be factory tested under simulated operating conditions verifying all devices function.

C. Complete factory performance assurance testing shall be required prior to shipment.

D. Results of factory performance assurance testing shall be provided to the OWNER.

PART 3 - EXECUTION

3.1 GENERAL

A. Install and adjust equipment in accordance with the Drawings, approved shop drawings, and the manufacturer's instructions. Do not operate the equipment until the installation is approved by the manufacturer’s representative.

3.2 ASSEMBLY AND INSTALLATION

A. Assemble and install equipment in accordance with the manufacturer's instructions and the following:
   1. Support all piping independently of the pump.
   2. Level baseplate by means of steel wedges (steel plates and steel shims). Wedge taper not greater the 1/4-inch per foot. Use double wedges to provide a level bearing surface. Accomplish wedging so that there is no change of level or springing of the base elbow when anchor bolts are tightened.
   3. Adjust equipment such that the driving units are properly aligned, plumb, and level with the driven units and all interconnecting shafts and couplings. Do not compensate for misalignment by use of flexible couplings.
   4. After the equipment have been set in position, aligned, and shimmed to the proper elevation, grout the space between the bottom of the baseplate and the concrete foundation with a poured, non-shrinking grout. Remove wedges after grout is set and pack void with grout.
   5. Complete equipment installation with controls, safety devices and auxiliary support systems necessary to start the equipment and verify that the equipment functions correctly under no load conditions. Turn rotating equipment by hand to check. Complete cleaning and testing of piping systems. Inspect and clean equipment, devices, piping, and structures of debris and foreign material.

6. Remove temporary bracing supports and other construction debris that may damage equipment.
7. Remove protective coatings and oils used for protection during shipment and installation.
8. Flush, fill, and grease lubricated systems in accordance with manufacturer's instructions.

B. Install temporary connections and devices required to fill, operate, checkout and drain the system. Provide temporary valves, gauges, piping, test equipment, and other materials and equipment necessary to conduct testing and startup.

C. Equipment
1. Check equipment for correct direction of rotation and freedom of moving parts.
2. Align equipment to Manufacturer's tolerances. Adjust clearances and torques.
3. Check installation prior to start-up for conformance to manufacturer's instructions.
4. Adjust or modify equipment to ensure proper operation.

D. Correct any deficiencies or problems noted in manufacturer's representative's installation reports.

3.3 PROTECTIVE COATING

A. Provide polyurethane, pigmented (over epoxy zinc rich primer and high build epoxy) in accordance with Section 915 and Section 916. Pump shall receive surface preparation, prime coat and finish coat in factory.

B. Shop painted items which suffered damage to the shop coating shall be touched up as specified in Section 915 and Section 916.

3.4 FIELD QUALITY CONTROL

A. Functional Tests: Prior to plant startup, the CONTRACTOR, with the assistance of the manufacturer’s representative, shall inspect all equipment for proper assembly and alignment, quiet operation, and proper operation.

B. Performance Test: The manufacturer’s representative shall conduct performance test on the equipment to certify compliance with the performance requirements.
1. Place each piece of equipment in the system in operation until the entire system is functioning. All components shall continue to operate without alarms or shutdowns, except as intended, for eight consecutive hours to be considered ready for facility startup.
2. Operate the equipment through the design performance range consistent with available flows. Adjust, balance, and calibrate and verify that the equipment, safety devices, controls, and process system operate within the design conditions. Each safety device shall be tested for proper setting and signal. Response shall be checked for each equipment item and alarm. Simulation signals may be used to check equipment and alarm responses.

C. A copy of all information from functional tests, including data, worksheets, and other materials shall be turned over to the OWNER at the completion of the testing program.

3.5 MANUFACTURER’S SERVICES

A. Manufacturer’s representative shall be provided present at Project site or classroom designated by OWNER, and depending of the Construction Schedule, provide the number of trips required to provide the minimum person-days listed in the individual specification sections, travel time excluded.

B. Inspection, Startup, and Field Adjustment: CONTRACTOR shall demonstrate that all equipment meets the specified performance requirements. CONTRACTOR shall provide the services of an experienced, competent, and authorized service representative of the manufacturer of each item of major equipment and shall visit the site of work to perform the following tasks.
1. Assist the CONTRACTOR in the installation of the equipment.

2. Inspect, check, adjust if necessary and approve the equipment installation.
3. Start-up and field-test the equipment for proper operation, efficiency, and capacity.
4. Perform necessary field adjustments during the test period until the equipment installation and operation are satisfactory to the ENGINEER.
5. Instruct OWNER's personnel in the operation and maintenance of the equipment. Instruction prior to system testing of the equipment shall include step-by-step troubleshooting procedures with all necessary equipment testing.

C. Manufacturer's Certificates:
1. Provide equipment manufacturer's Certificate of Installation stating that the equipment is installed per the manufacturer's recommendations and in accordance with the Drawings and Specifications.
2. Provide equipment manufacturer's Certificate of Performance stating that the equipment meets or exceeds the performance requirements as defined hereinbefore.

3.6 FACILITY STARTUP

A. After initial startup under the supervision of a qualified representative of the manufacturer, a preliminary "running-in" period will be provided for the CONTRACTOR, per the Contract Documents, to make field tests and necessary adjustments.

B. Place each piece of equipment in the system in operation until the entire system is functioning. All components shall continue to operate without alarms or shut downs, except as intended, for five (5) consecutive days to be considered started up.

C. Operate the equipment through the design performance range consistent with available flows. Adjust, balance, and calibrate and verify that the equipment, safety devices, controls, and process system operate within the design conditions. Each safety device shall be tested for proper setting and signal. Response shall be checked for each equipment item and alarm. Simulation signals may be used to check equipment and alarm responses.

D. Prepare manufacturer's installation report and submit within 30 days after completion of field testing. Including the following information:
1. Field testing results.
2. Descriptions of installation deficiencies not resolved to the manufacturer's satisfaction.
3. Description of problems or potential problems.
4. Names of the OWNER'S personnel who attended operations and maintenance training sessions.
5. Record copy of materials used for training session including outlined summary of course.
6. Manufacturer's Certificate of Installation and Certificate of Performance.

E. At the end of the specified period of operation, the equipment system will be accepted if, in the opinion of the ENGINEER, the system has operated satisfactorily without excessive power input, wear, lubrication, or undue attention required for this operation, and if all rotating parts operate without excessive vibration or noise and the desired performance has been obtained.

END OF SECTION

SECTION 11266
ODOR CONTROL AND AERATION SYSTEM EQUIPMENT

PART 1 – GENERAL

1. SCOPE OF WORK

a. Contractor shall furnish all labor, materials, equipment, accessories and incidentals required to provide odor control system equipment as specified herein and shown on the plans. Contractor shall provide services of manufacturer's representative for a complete installation, start-up supervision and Operation and Maintenance instruction and manuals.

2. GENERAL DESCRIPTION

a. The system shall be a Reliant Water Technologies Wet Well Wizard. It shall consist of at least three major parts, with specific fitting hardware, for the purpose of aerating and vigorously agitating lift station wet well on a continuous basis. All equipment, material, parts, and accessories to be provided as part of this specification shall be new and free from any defects. The Contractor shall be responsible for the inspection of all equipment prior to installation and shall be responsible for replacement at no additional cost to the owner.

3. QUALITY ASSURANCE

a. The manufacturer shall have furnished similar equipment for at least 5 other installations performing a similar duty. Each installation shall have performed satisfactorily for at least 2 years and are still in operation.

b. All manufacturer parts and components shall be engineered for long, continuous and uninterrupted service. Provisions shall be made for easy lubrication, adjustment, or replacement of all parts.

c. Where like items are incorporated into equipment systems (i.e. motors, push buttons, etc.), such items must be identical to achieve standardization for appearance, operation, maintenance, spare parts, and service. Corresponding parts of multiple units shall be interchangeable.

d. Assembly and wiring shall be to the point where only field interconnections to numbered terminal blocks are required.

e. It is imperative that parts and service shall be available within 50 miles of the lift station and project site for immediate repairs should service become necessary. Unless it can be demonstrated that parts are available at a service center through the same financially sound firm on a continuing basis.

4. SUBMITTALS

a. All equipment and materials shall be new and shall be specifically designed or selected for the function and service specified. No equipment for materials may be used in the project that has not been approved by the OWNER and ENGINEER. Submittals shall be complete and shall contain data to confirm compliance or exception to all sections of these specifications. Any exception must be clearly indicated. Absence of data will be considered as noncompliance and basis for disapproval. Approval for incorporation into the project will be made only after the review of shop drawings, specifications, and data. Before manufacture, the CONTRACTOR shall furnish for OWNER and ENGINEER's review and approval as the data as required hereinafter.

b. Contractor shall submit dimensional drawings for odor control equipment and accessories.

c. Contractor shall submit documentation of warranty, including specific items covered and time periods.

a. Contractor shall submit test results for odor control equipment by verifying the equipment runs as expected with no visible or audible leaking. Ensure motors/blowers turn on and off when functioned. Verify isolation valves properly isolate the line and ejector while still allowing the rest of the system to function.

b. Contractor shall submit typical installation guides for the odor control equipment and accessories.

a. Contractor shall submit location and description of service centers and spare parts stock.

5. PERFORMANCE (OPERATING CONDITIONS AND DUTY POINTS)

a. Refer to Appendix A

6. WARRANTY

a. The equipment manufacturer must provide against defective or deficient equipment, workmanship and materials under normal use, operation and service. This warranty shall end two (2) years from accepted start-up or thirty months from delivery, whichever is longest. The warranty shall be in printed form and shall apply to all units.

b. This warranty shall not apply to any product or part of product which has been subjected to misuse, misapplication, accident, alteration, neglect, or physical damage and monitoring equipment has been bypassed or removed.

c. Warranty does not cover costs for standard and/or scheduled maintenance or parts that, by virtue of their operation require replacement through normal wear, unless a defect in material or workmanship can be determined by manufacturer.

PART 2 – PRODUCTS

1. Wet Well Aerator System for Primary Odor Control

    a. The aerator system shall be designed and sized by the design engineer and shall consider the wet well size, depth, operating levels, inflow variation and cycling time from the initial development to the ultimate built-out.

        1). The primary purpose of the aerator system shall be to eliminate hydrogen sulfide (H_2S) due to septic condition but also to dissolve fats, oils and grease and related odors within the wet well and the gravity system downstream of the lift station.

        2). The design engineer shall be responsible for coordinating the design of the wet well top slab with structural and electrical engineers, wet well aerator manufacturer and SAWS.

    b. Shall have no moving parts inside the wet well, shall be non-corrosive for the municipal wastewater and raw sewage application media, and shall not utilize any electricity within the wet well.

    c. The complete aerator system shall be installed in a manner to avoid obstruction with conduits, cables, pumps, lifting chains, float switches and level transducers.

    d. Blower must be installed over the wet well top slab as shown in the standard drawings and shall be located outside of the 100-year flood plain, including wave action.

    e. The air supply system shall consist of a regenerative blower.

        1). Blower shall be sized to produce the air flow required to provide adequate wet well aeration for the entire pump operating level range, including the Lead pump and all Lag pumps without overheating.

            i Blower shall be selected in a manner that the temperature rise will be as low as possible for the design operating conditions.

        2). The blower shall be dynamically balanced to minimize vibration.

        3). Shall be provided with air inlet filter.

            i At least five (5) spare air intake filters shall be provided for each blower installed.

        4). Shall be provided with a discharge pressure gauge rated in inches of water.

            i Pressure gauge shall be rated for corrosive environment, and shall be designed for operating temperatures of up to 250 ºF.

ii One spare pressure gauge shall be provided for each blower installed.

5). Shall be provided with pressure relief means for overpressure protection.

6). An isolation ball valve of stainless steel 316 shall be installed at the blower discharge header for each aerator installed within the wet well.

f. Blower shall be driven by a three phase induction motor that operates at the voltage system indicated on the design; however, the motor shall be multi voltage rated suitable to operate at 208-Vac, 230-Vac and 460-Vac.

1). Induction motor shall be totally enclosed, fan cooled type.

2). The motor shall be rated for continuous duty.

3). Motor insulation shall be Class H or better.

g. Control panel for aerator blower shall be in a dedicated enclosure located at the service rack and shall be in strict compliance with the applicable requirements of the Electrical Equipment Section and the standard drawings.

1). Minimum blower control panel shall be 24 inches high, 20 inches wide and 10 inches deep. One blower control panel shall be provided for each blower unit installed.

2). Control shall be provided with an On-Off selector switch and be provided with a time delay to start. Start and Stop push buttons shall not be installed.

i Blower shall include overtemperature protection with automatic reset thermal protection switch.

ii When the selector switch is placed in the On position, the blower shall be constantly running. The controls must be designed in a manner that upon a power outage and blower high temperature trip. The blower shall self-start after the time delay when the power is restored or when the blower thermal switch has automatically reset.

iii The blower start delay timer shall be adjustable from 1 to 300 seconds (preadjusted to 30 seconds).

h. Blower enclosure.

1). Blower enclosure shall be provided with full opening to allow free flow through for adequate air circulation to avoid overheating of the blower, motor and discharge header.

2). Air intake shall be located in a manner that wet well gases are not drawn into the blower. Direction of the prevailing wind shall be considered during summer.

i. Air ejector.

1). The air ejector shall be of the coarse bubble type, and shall be constructed of HDPE body with a 10 pound stainless steel 316 weight.

2). The minimum wet well level shall maintained be as low as possible to allow proper performance of the air ejectors.

j. Air distribution line.

1). The inner diameter of the air distribution line shall be sized to minimize pressure loss and to assure even air distribution among all air ejectors, but in no case shall be smaller than 2-inch, Sch 40.

2). Distribution lines, valves and fittings shall be made of stainless steel type 316.

3). Installation shall be embedded in wet well top slab and shall terminate next to wet well access hatch(es) or dedicated penetration sleeves with heavy duty polyethylene cover.

k. Air ejector branch line.

1). The inner diameter of the air ejector branch line shall be sized to minimize pressure loss and to assure proper air supply to its air ejector, but in no case shall be smaller than 1-inch, Sch 40.

2). Air ejector branch lines, valves and fittings shall be made of stainless steel type 316.

3). Each air ejector branch line shall be branched from the larger air distribution line. The air ejector branch line shall be embedded in the wet well top slab and penetrate to terminate at wet well access hatches and dedicated sleeved penetrations.

4). One air ejector branch line shall be provided for each air ejector installed. Isolation means shall be provided for each air ejector branch line.

l. Air ejector supply hose within wet well.

1). The diameter of each air supply hose shall be sized to minimize pressure loss, but in no case be smaller than 1-inch.

2). The hose shall be made of Ethylene Propylene Diene Monomer (EPDM) black tube, with multiple textile plies for reinforcement, and a red EPDM cover with smooth finish.

3). Shall be provided with Cam-Lock quick connectors made of stainless steel 316.

4). One isolation ball valve, of stainless steel 316, shall be provided for each air ejector and shall be located before the Cam-Lok quick connector.

5). Hose operating temperature shall be -40 to 212-ºF.

6). Hose operating pressure shall be 300-psi.

7). The length air supply hoses for each air ejector shall be straight, shall have the same length and without bending.

8). Each hose shall be supported with a cable grip made of stainless steel 316. The cable grip shall be hanged per SAWS standard drawings.

APPENDIX A

PERFORMANCE (Operating Conditions)

A. Quantity of Aerators Required	2
B. Quantity of Blowers	1
C. Blower Motor Rating	1.5 HP
D. Blower Motor Voltage/Cycle/Phase	480/60/3
E. Blower Air Pressure Rating	Per Manufactures' Recommendation
F. Blower Air Volume Rating	Per Manufactures' Recommendation

SECTION 12000
FIBERGLASS REINFORCED POLYESTER (FRP) WET WELLS

PART 1 – GENERAL

1. SCOPE OF WORK

   a. Contractor shall furnish all labor, materials, equipment, accessories and incidentals required to provide the fiberglass reinforced polyester wet well equipment as specified herein and shown on the plans. Contractor shall provide services of manufacturer's representative for a complete installation, start-up supervision and Operation and Maintenance instruction and manuals.

PART 2 – PRODUCT

1. Fiberglass reinforced polyester (FRP) wet wells shall be manufactured from commercial grade unsaturated polyester resin or vinyl ester resin, with fiberglass reinforcements. The wet well shall be manufactured in one-piece including body, bottom and top, and it shall be sit over a concrete slab design to counteract buoyancy forces. Design engineer shall design the top concrete slab. Approved manufacturers are L.F. Manufacturing, and Containment Solutions, or SAWS approved equal.

   a. Materials

      1). The resins used shall be a commercial grade unsaturated polyester resin, and shall be suitable for atmospheres containing hydrogen sulfide and dilute sulfuric acid, as well as other gases associated with the wastewater collection systems.

      2). The reinforcing materials shall be commercial Grade "E" type glass in the form of mat, continuous roving, chopped roving, roving fabric or a combination of the above, having a coupling agent that will provide a suitable bond between the glass reinforcement and the resin.

      3). If reinforcing materials are used on the surface exposed to the contained substance, it shall be a commercial grade chemical-resistant glass that will provide a suitable bond with the resin and leave a resin rich surface.

      4). Fillers, when used, shall be inert to the environment and wet well construction. Additives, such as thixotropic agents, catalysts, promoters, etc., may be added as required by the specific manufacturing process to be used. The resulting reinforced plastic material shall meet the requirement of this specification.

   b. The exterior surface shall be relatively smooth with no sharp projections. Handwork finish is acceptable if enough resin is present to eliminate exposed fiber. The exterior surface shall be free of blisters larger than 1/2 inch in diameter, delamination and exposed fiber.

c. The interior surface shall be resin rich with no exposed fibers. The surface shall be free of grazing, delamination, and blisters larger than 1/2 inch in diameter, and wrinkles of 1/8 inch or greater in depth. Surface pits shall be permitted up to 6 square feet if they are less than 3/4 inch in diameter and less than 1/16 inch deep.

d. The bottom to be fabricated using fiberglass material as stated herein. Material and installation shall meet all physical requirements indicated below. Bottom to be attached to wet well pipe with fiberglass layup to comply with A.S.T.M.-D3299 specifications. Reinforcement, if needed, shall be fiberglass channel laminated to wet well bottom per A.S.T.M.-D3299.

e. The fiberglass wet well top shall be fabricated using fiberglass material as specified herein. Material and installation shall meet the physical requirements indicated below. Top to be attached to wet well pipe with fiberglass layup to comply with A.S.T.M.-D3299 specifications. Reinforcement, if needed, shall be fiberglass channel laminated to wet well bottom per A.S.T.M.-D3299.

   1). Sleeves shall be provided to run discharge lines through. The sleeves shall be located, aligned and sized to perfectly seal the discharge pipes with link-seal.

   2). Opening for installation of the access hatch, guiderails, brackets, electrical conduits, etc., shall be considered and coordinated.

f. Influent pipe shall be Kor-N-Seal or Inserta-Tee (refer to Standard Drawings for details). Sleeve shall be either PVC or Fiberglass Pipe, and it shall be installed and tested by the manufacturer. Installation of stubouts to be fiberglass layup to comply with A.S.T.M.-D3299 specifications.

g. Defects not permitted

   1). Exposed fibers: glass fibers not wet out with resin.

   2). Resin runs: runs of resin and sand on the surface.

   3). Dry areas: areas with glass not wet out with resin.

   4). Delamination: separation of the laminates.

   5). Blisters: light colored areas larger than ½-inch in diameter.

   6). Crazing: cracks caused by sharp objects.

   7). Pits or voids: air pockets.

   8). Wrinkles: smooth irregularities in the surface.

   9). Sharp projections: fiber or resin projections necessitating gloves for handling.

h. Physical Requirements

1). The complete wet well shall have a minimum dynamic load rating of 16,000 ft-lbs as tested in accordance with ASTM D3753 latest edition.

i To establish this rating the wet well shall not leak, crack, or suffer other damage when load tested to 40,000 ft-lbs and shall not deflect vertically downward more than ¼-inch at the point of load application when loaded to 24,000 lbs.

2). The wet well cylinder shall have the following minimum pipe-stiffness values when tested in accordance with ASTM D3753 latest edition.

i Lengths 10 to 20 feet: F/AY = 2.01 psi

ii Lengths 21 to 30 feet: F/AY = 3.02 psi

iii Lengths 31 to 40 feet: F/AY = 5.24 psi

3). Physical Properties:

	HOOP DIRECTION	AXIAL DIRECTION
Tensile Strength (psi)	18,000	5,000
Tensile Modulus (psi)	0.8×10^6	0.7×10^6
Flexural Strength (psi)	26,000	4,500
Flexural Modulus (psi)		
(no ribs – 72")	1.4×10^6	0.7×10^6
(with ribs – 96" and larger)	0.7×10^6	0.7×10^6

a. Require wet well shall be designed for the project service conditions (initial and ultimate build out), assuming fully saturated soil external loading and buoyant uplift, with related design calculations included in the engineering report.

b. The (FRP) wet well shall be installed in strict accordance with the wet well manufacturer's recommendations.

c. Each wet well shall be marked with the following information.

(1) Manufacturer's name or trademark
(2) Manufacturing special number
(3) Total length and nominal diameter

2. Wet Well Testing.

a. An Exfiltration test must be performed immediately after the wet well has been backfilled and compacted.

b. Exfiltration shall not exceed 0.0142 gal/hr per foot diameter per foot depth.

c. The test must be done by plugging the gravity invert and filling up the wet well with water to either 1-foot below the wet well top slab.

d. Once the wet well is filled, it must be left for stabilization for 48 hours minimum prior to beginning the Exfiltration test.

e. After the stabilization period, the wet well must be refilled up to the mark to begin the test.

f. The test shall be done for two hours minimum, and no water may be added to the wet well during the test period.

g. The Exfiltration test must be determined by measuring the amount of water required to raise the wet well level back to the mark at the end of the test period.

h. The maximum allowable water loss to pass the test is determined by the following equation:

$$\text{Water Loss (gallons)} = 0.0142tDh$$

Where:

t = test time period (2 hours)
D = wet well diameter (in feet)
h = water level depth within wet well (in feet)

i. If the Exfiltration test fails the Design Engineer must work with the Contractor to determine all the necessary corrective actions to reduce the exfiltration.

j. Once the repairs are completed the test shall be repeated. The wet well will pass the test when the exfiltration is equal or less then the allowable water loss.

k. SAWS Inspector, Contractor and Design Engineer shall witness the complete Exfiltration test.

l. Design Engineer shall provide a certified letter showing the results of the exfiltration test to SAWS inspector. The certification letter shall include a description of all steps taken to complete the exfiltration test, including water loss, wet well level mark, and any corrective actions taken if a prior test failed.

TECHNICAL SPECIFICATIONS
FOR

NORTHLAKE LIFT STATION & FORCE MAIN

PREPARED BY

CLEARY ZIMMERMANN ENGINEERS, LLC

1344 SOUTH FLORES, SUITE 101
SAN ANTONIO, TEXAS 78204
(210) 447-6100

TBPE FIRM NO. F-9357

Conner B. Sturdivant, P.E., P. ENG.
ENGINEER OF RECORD
99971
TBPE LICENSE No.
September 18, 2024
ISSUE DATE
CLEARY ZIMMERMANN ENGINEERS, INC.
TEXAS REGISTERED ENGINEERING FIRM NO. F-9357

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DIVISION 16 – ELECTRICAL

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END OF SECTION

SECTION 16015

GENERAL ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 SCOPE

A. The General Conditions and Requirements, Special Provisions, are hereby made a part of this Section.

B. The Electrical Drawings and Specifications under this section shall be made a part of the contract documents. The Drawings and specifications of this contract, as well as supplements issued thereto, information to bidders and pertinent documents issued by the Owner's representative are a part of these drawings and specifications and shall be complied with in every respect. All of the above documents will be on file at the office of the Owner's representative and shall be examined by all bidders. Failure to examine all documents shall not relieve the responsibility or be used as a basis for additional compensation due to omission of details of other sections from the electrical documents.

C. Furnish all work, labor, tools, superintendence, material, equipment, and operations necessary to provide for a complete and workable electrical system as defined by the contract documents.

D. Be responsible for visiting the site and checking the existing conditions. Ascertain the conditions to be met for installing the work and adjust bid accordingly.

E. It is intent of the contract document that upon completion of the electrical work, the entire system shall be in a finished, workable condition.

F. All work that may be called for in the specifications but not shown on the drawings; or, all work that may be shown on the drawings but not called for in the specifications, shall be performed by the Contractor as if described in both. Should work be required which is not set forth in either document, but which work is nevertheless required for fulfilling of the intent thereof; then, the contractor shall perform all work as fully as if it were specifically set forth in the current documents.

G. The definition of terms used throughout the contract documents shall be as specified by the following agencies:

1. Underwriters Laboratories
2. National Electrical Manufacturers Association
3. American National Standard Institute
4. Insulated Power Cable Engineers Association
5. National Electrical code
6. National Fire Protection Association

1.2 PERMITS, CODES AND UTILITIES

A. Secure all permits, licenses, and inspections as required by all authorities having jurisdiction. Give all notices and comply with all laws, ordinances, rules, regulations and contract requirements bearing on the work.

B. The minimum requirements of the electrical system installation shall conform to the latest edition of the National Electrical Code as well as state and local codes.

C. Codes and ordinances having jurisdiction and specified codes shall serve as minimum requirements; but, if the Contract Documents indicate requirements which are in excess of those minimum requirements then the requirements of the Contract Documents shall be followed. Should there be any conflicts between the Contract Documents and codes, or any ordinances, report these with bid.

D. Determine the exact requirements for the utility service connections and metering facilities as set forth by the utilities that will serve the project, and pay for and perform all work as required by those utilities.

1.3 STANDARDS

A. All materials and equipment shall conform to the requirements of the Contract Documents. They shall be new, free from defects, and they shall conform to the following standards where these organizations have set standards:

1. Underwriters Laboratories, Inc. (UL)
2. National Electrical Manufacturer's Association. (NEMA)
3. American National Standards Association. (ANSI)
4. Insulated Cable Engineers Association. (ICEA)
5. Institute of Electrical and Electronic Engineers (IEEE)

B. All material and equipment, of the same class, shall be supplied by the same manufacturer unless specified to the contrary.

C. All products shall bear UL labels where standards have been set for listing.

1.4 SUBMITTALS

A. Shop drawings shall be taken mean detailed drawings with dimensions, schedules, weights, capacities, installation details and pertinent information that will be needed to describe material or equipment in detail.

B. Submittal procedures are described in other specification sections

1.5 ACCEPTANCE AND SUBSTITUTIONS

A. All manufacturers named are a basis as a standard of quality and substitutions of any equal product will be considered for acceptance. The judgment of equality of product substitution shall be made by the Engineer.

B. Substitutions after award of contract shall be made only within sixty (60) days after the notice to proceed. Furnish all required supporting data. The submittal of substitutions for review shall not

be cause for time extensions.

C. Where substitutions are offered, the substituted product shall meet the product performance as set forth in the specified manufacturer's current catalog literature, as well as meeting the details of the Contract Documents.

D. The details on the drawings and the requirements of the specifications are based on the first listed item of material or equipment; if any other than the first listed materials or equipment is furnished, then assume responsibility for the correct function, operation, and accommodation of the substituted item. In the event of misfits or changes in work required, either in this Section or other Sections of the Contract, or in both; bear all costs in connection with all changes arising out of the use of other than the first listed item specified.

1.6 OPERATIONS AND MAINTENANCE MANUALS

A. Six (6) weeks prior to the completion of the project, compile an operations and maintenance manual on each item of equipment. These manuals shall include detailed instructions and maintenance, as well spare parts lists.

B. Submit six (6) copies for review.

PART 2 - PRODUCTS

2.1 MATERIALS AND WORKMANSHIP

A. All materials, unless otherwise specified, shall be current United States manufacture, new, free from all defects, and of the best quality. Foreign goods specifically approved for use by the Owner's Representative prior to bidding may be furnished.

B. Materials and equipment shall be installed in accordance with the manufacturers' recommendations and the best standard practice for the type of work involved. All work shall be executed by electricians skilled in their respective trades, and the installations shall present a neat, precise appearance.

C. The responsibility for the furnishing and intended installation of the proper electrical equipment and/or material as intended rests entirely upon the Contract. The Contractor shall request advice and supervisory assistance from the representative of specific manufacturers during the installation.

2.2 MATERIAL AND EQUIPMENT REQUIREMENTS

A. Manufacturer's Instructions: The manufacturer's published instructions shall be followed for preparing, assembling, installing, erecting, and cleaning manufacturer materials or equipment, unless otherwise indicated. The Contractor shall promptly notify the Owner's Representative in writing of any conflict between the requirements of the Contract Documents and the manufacturer's direction and shall obtain the clarification of the Owner's Representative before proceeding with the work. Should the Contractor perform any such work that does not comply with the manufacturer's directions or such clarification by the Owner's Representative, he shall bear all costs arising in connection with the correction of the deficiencies.

B. Storage at Site: The Contractor shall not receive material or equipment at the jobsite until there is suitable space provided to properly protect equipment from rust, drip, humidity, and dust damage from surrounding work. All new or relocated equipment shall be stored inside or protected from the environment. Equipment that is not properly stored shall be replaced by the contractor at no cost to the owner.

C. Capacities shall be not less than those indicated and shall be such that no component or system becomes inoperative or is damaged because of startup or other overload conditions.

D. Conformance to Agency Requirements: Where materials or equipment are specified to be approved, listed, tested, or labeled by the Underwriters Laboratories, Inc., or constructed and/or tested in accordance with the standards as listed in the NEC, the Contractor shall submit proof that the items furnished under this section of the specifications conform to such requirements. The label of the Underwriters Laboratories, Inc. applied to the item will be acceptable as sufficient evidence that the items conform to such requirements.

E. Nameplates: Each major component of equipment shall have the manufacturer's name, address, and model-identification number embossed on a plate securely attached to the item of equipment. All data on nameplates shall be legible at the time of Final Inspection. All equipment starters and disconnects shall be tagged with the equipment designated mark and circuit.

F. Prevention of Rust: Standard factory finish will be acceptable on equipment specified by model number, otherwise surfaces of ferrous metal shall be given a rust-inhibiting coating. The treatment shall withstand 200 hours in salt-spray fog test, in accordance with Method 6061 of Federal Standard No. 141. Immediately after completion of the test, the specimen shall show no signs of wrinkling or cracking and no signs of rust creepage beyond 1/8 inch on either side of the scratch mark. Where rust inhibitor coating is specified hereinafter, any treatment that will pass the above test is acceptable unless a specific coating is specified, except that coal tar or asphalt-type coatings will not be acceptable unless so stated for a specific item. Where steel is specified to be hot-dip galvanized, mill-galvanized sheet steel may be used provided all raw edges are painted with a zinc-pigmented paint conforming to Military Specification MIL-P-26915.

G. Protection of Connections: Switches, breaker handles, keys setscrews, handles and other parts not listed for normal occupied operation (light switches, etc.) shall be located accessible to but out of paths to prevent their accidental shutoff.

H. Verifications of Dimensions: The Contractor shall be responsible for the coordination and proper relation of his work to the Equipment and to the work of all trades. The Contractor shall visit the premises and thoroughly familiarize himself with all details of the work and working conditions, to verify all dimensions in the field, and to advise the Owner's Representative of any discrepancy before performing any work. Adjustments to the work required in order to facilitate a coordinated installation shall be made at no additional cost to the Owner, or Engineer.

I. Standard Products: Materials and equipment to be provided shall be the standard catalog products of manufacturers regularly engaged in the manufacture of products conforming to these specifications, and shall essentially duplicate materials and equipment that have been in satisfactory use at least two years.

PART 3 - EXCAVATION

3.1 EXCAVATION AND BACKFILLING

A. Do all excavating and backfilling necessary for the installation of the work. This shall include shoring and pumping in ditches to keep them dry until the work in question has been installed. All shoring required to protect the excavation and safeguard employees shall be properly performed.

B. All excavations shall be made to the proper depth, with allowances made for floors, forms, beams, piping, finished grades, etc. Ground under conduits shall be well compacted before conduits are installed.

C. All backfilling shall be made with selected soil; free of rock and debris and shall be pneumatically tamped in six (6") inch layers to secure a field density ratio of 90%.

D. All excavated material not suitable and not used in the backfill shall be removed offsite at the Contractors expense.

E. Field check and verify the locations of all underground utilities prior to any excavating. Avoid disturbing these as far as possible. In the event existing utilities are broken into or damaged, they shall be repaired so as to make their operation equal to that before the trenching was started.

F. Where the excavation requires the opening of existing walks, drives, or other existing pavement, these facilities shall be cut as required to install new lines and to make connections to existing lines. The sizes of the cut shall be held to a minimum consistent with the work to be installed. After installation of new work is completed and the excavation has been backfilled in accordance with above, repair existing walks, drives or other existing pavement to match existing installation.

3.2 CUTTING AND PATCHING

A. Cutting and patching required under this section shall be done in a neat workmanlike manner. Cutting lines shall be uniform and smooth.

B. Use concrete saws for large cuts in concrete and core drills for small round cuts in concrete.

C. Where openings are cut through masonry walls, provide lintel or other structural supports to protect the remaining masonry. Adequate support shall be provided during the cutting operation to prevent damage to masonry.

D. Where large openings are cut through metal surfaces, attach metal angles around the opening.

E. Patch concrete openings that are to be filled with non-shrinking cementing compound. Finish concrete patching shall be troweled smooth and shall be uniform with surrounding surfaces.

3.3 WATERPROOFING

A. Provide waterproof flashing for each penetration of exterior walls and roofs.

B. Flashing for conduit penetrations through built-up roofs shall be made with pitch pans filled with pitch. Conduit penetrations through poured concrete roofs shall be made with sleeves and annulus caulked.

C. Penetrations through walls at below ground elevations shall be waterproofed by conduit sealing fittings or other methods as indicated.

D. Interiors of raceways that are likely to have water ingress such as runs from hand holes into below-grade installations shall have water stops installed to prevent water from entering into installations.

3.4 METAL BUILDING SYSTEMS / ELECTRICAL SUPPORTS

A. Metal building systems are required to be designed by the manufacturer to accommodate and support the electrical systems indicated on the electrical drawings and specified in Division 16.

B. The metal building systems manufacturer is required to provide the following:

1. Framed openings through the roofs with supports, roof curbs, and flashings for roof-mounted equipment, fans, vents, and air intakes.
2. Structural support for piping, conduits, and suspended equipment consisting of beam, joists, purlins, and/or blocking above and perpendicular to conduit routes and equipment hangers at intervals not to exceed 8 feet.
3. Structural support for suspended ceilings and light fixtures, including associated raceways.

C. The electrical trade shall:

1. Provide all routes, weights, installation heights, opening locations, etc. for all equipment, conduits, sleeves, etc. to the metal building system manufacturer and coordinate requirements for structural supports, hangers, attachments, etc. with the metal building systems manufacturer.
2. Provide all supporting devices (hangers, attachments, brackets, cross beams, etc.) to attach to the metal building structural system.

3.5 CONDUIT SUPPORT

A. Conduit Support: All conduits throughout the building, both horizontal and vertical, shall be adequately supported from the construction to line of grade, with proper provision for expansion, contraction, vibration elimination, and anchorage. Vertical conduits shall be supported from floor lines with riser clamps sized to fit the lines and to adequately support their weight. At the bases of lines, where required for proper support, provide anchor base fittings or other approved supports.

3.6 HANGERS

A. General: Each hanger shall be properly sized to fit the supported pipe or to fit the outside of the insulation on lines where specified.

B. Attachment:

1. The load on each hanger and/or insert shall not exceed the safe allowable load for any component of the support system, including the concrete which holds the inserts. Reinforcement at inserts shall be provided as required to develop the strength required.
2. Where pipes are supported under steel beams, approved-type beam clamps shall be used.
3. Where conduit is supported under wood joists, hanger rods shall be attached to joists with side beam brackets or angle clips.

C. Spacing: All hangers shall be so located as to properly support horizontal lines without appreciable sagging of these lines. All PVC shall be supported at intervals recommended by the manufacturer, or as otherwise specified or indicated.

D. Trapezes: Where multiple lines are run horizontally at the same elevation and grade, they may be supported on trapezes of Kindorf, Elcen, or approved equal, channel-suspended on rods or pipes. Trapeze members including suspension rods shall each be properly sized for the number, size, and loaded weight of the lines they are to support.

E. Ceiling-Mounted Devices: All lighting and devices or assemblies mounted in lay-in-type ceilings and which are supported by the ceiling grid, directly or indirectly, and which weigh in excess of 2 lbs., shall be provided with at least two 12-gauge minimum wire supports connected securely between the device or assembly and the structure, to serve as a safety support in the event of the collapse of or a disturbance in the support of the ceiling system that might cause the device or assembly to fall through the ceiling. This includes, but is not limited to, light fixtures, J-boxes, and heavy speakers. Provide additional support as required where the weight of the device or assembly will exceed the safe limits of the wire supports.

F. Miscellaneous: Provide any other special foundations, hangers, and supports indicated on the drawings, specified elsewhere herein, or required by conditions at the site. Hangers and supporting structures for suspended equipment shall be provided as required to support the load from the building structure in a manner acceptable to the Owner's Representative.

3.7 EQUIPMENT PROTECTION

A. Provide suitable protection for all equipment, work and property against damage during construction.

B. Assume full responsibility for material and equipment stored at the site.

C. Conduit openings shall be closed with caps or plugs during installation. All outlet boxes and cabinets shall be kept free of concrete, plaster, dirt, and debris.

D. Equipment shall be and tightly sealed against entrance of dust, dirt, and moisture.

3.8 CLEAN-UP

A. Remove all temporary labels, dirt, paint, grease and stains from all exposed equipment. Upon completion of work, clean equipment and the entire installation so as to present a first class job suitable for occupancy. No loose parts or scraps or equipment shall be left on the premises.

B. Equipment paint scars shall be repaired with paint kits supplied by the equipment manufacturer, or with an approved paint.

C. Clean interiors of each item of electrical equipment. At completion of work all equipment interiors shall be free from dust, dirt, and debris.

3.9 TESTS AND INSPECTIONS

A. All equipment shall put through a trial run-in test to ascertain the performance complies with the intent of the specifications. All-in tests shall be made in the presence of the Owner's Representative. All cables shall have an insulation test performed.

B. Cables installed with an unacceptable insulation reading shall be removed and new cable installed and retested at no additional cost to the owner. The Contractor shall make all tests deemed necessary by the inspection departments of the authority having jurisdiction, Board of Underwriters, etc. He shall provide all equipment, materials, and labor for making such tests. Fuel, test equipment materials for system operational tests shall be paid for by the contractor.

C. Other: Additional tests specified hereinafter under the various specifications sections shall be made.

D. Notification: The Owner's Representative shall be notified at his office 36 hours prior to each test and other specifications requirements requiring action on the part of the Owner, Engineer, and/or Owner's Representative.

E. Test Logs: All tests which the Contractor conducts shall have pertinent data logged by the Contractor at the time of testing. Data shall include date, time, personnel, description and extent of system tested, test conditions, test results, specified results, and any other pertinent data. Data shall be delivered to the Owner's representative as specified under "Requirements for Final Acceptance".

3.10 CONDITIONS OF EQUIPMENT AT FINAL ACCEPTANCE

A. At the time of acceptance, the Contractor shall have inspected all installed systems to assure the following has been completed:

1. Fixtures are operating, and lenses and reflectors are free of dust, debris, and fingerprints.
2. Panelboards have all conductors neatly formed, bundled, and made-up tight. Cans shall be vacuum cleaned and surfaces cleaned of stray paint, dust, grease, and fingerprints. All circuit directories to be neatly typed and in place.
3. Wall plates and exposed switch and receptacle parts to be clean, free of paint, plaster, etc.
4. Safety and disconnect switches and motor control centers, Control Panels, etc. to be vacuum cleaned of debris and dust, and all surfaces free of stray paint, grease, and fingerprints.
5. Switchgear, transformers, and system devices shall be cleaned internally and externally and have all surfaces restored to original surface conditions.
6. Touch-up all scratched surfaces using paint matching the existing equipment paint. Where paint cannot be matched, the entire surface shall be repainted in a color and manner approved by the Engineer.

END OF SECTION

SECTION 16050

BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Raceways.
2. Wire and connectors.
3. Supporting devices for electrical components.
4. Concrete equipment bases.
5. Electrical demolition.
6. Cutting and patching for electrical construction.
7. Touchup painting.

1.3 SUBMITTALS

A. Supporting Devices

1.4 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. Comply with NFPA 70.

1.5 COORDINATION

A. Coordinate chases, slots, inserts, sleeves, and openings with general construction work and arrange in structure during progress of construction to facilitate the electrical installations that follow.

1. Set inserts and sleeves in poured-in-place concrete, masonry work, and other structural components as they are constructed.

B. Coordinate electrical service connections to components furnished by utility companies.

1. Coordinate installation and connection of exterior underground and overhead utilities and services, including provision for electricity-metering components.
2. Comply with requirements of authorities having jurisdiction and of utility company providing electrical power and other services.

C. Where electrical identification devices are applied to field-finished surfaces, coordinate installation of identification devices with completion of finished surface.

PART 2 - PRODUCTS

2.1 RACEWAYS

A. See Section 16130 “Raceways and Boxes.”

2.2 CONDUCTORS

A. See Section 16120 “Conductors and Cables.”

2.3 SUPPORTING DEVICES

A. Mounting hardware, nuts, bolts, lock washers, and washers, shall be grade 316 stainless steel.

B. Unless otherwise indicated, slotted channel framing and supporting devices shall be manufactured of ASTM 6063, T-6 grade aluminum; 1-5/8"wide x 3-1/4" deep (double opening type). Clamp nuts for use with slotted channels shall be grade 304 stainless steel.

C. Conduit straps for use with slotted channels shall be aluminum with stainless steel hardware.

D. After-set concrete inserts shall consist of stainless steel expansion bolts, 1/4: minimum diameter, 500 lbs. minimum pull-out resistance. Furnish Phillips, Wej-it, or equal.

E. Hanger rod shall be 3/8": minimum diameter galvanized steel all-thread.

F. Conduit "U" bolts shall be 316 stainless steel with stainless hex-head bolts.

G. Plastic saddles for supporting buried conduits shall be interlocking type that provides separation between conduits vertically and laterally and between bottom of conduits and trench floor.

H. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for nonarmored electrical cables in riser conduits. Plugs have number and size of conductor gripping holes as required to suit individual risers. Body constructed of malleable-iron casting with hot-dip galvanized finish.

2.4 EQUIPMENT FOR UTILITY COMPANY’S ELECTRICITY METERING

A. Current-Transforming Cabinets: Comply with requirements of electrical power utility company.

B. Meter Sockets: Comply with requirements of electrical power utility company.

C. Provide power utility company communication conduit to meter.

2.5 CONCRETE BASES

A. Concrete: 3000-psi, 28-day compressive strength as specified in Division 3 Section "Cast-in-Place Concrete." Provide minimum 4 inches beyond equipment.

B. Bollards: Provide bollards around transformer. Protect equipment on road or driveway sides.

2.6 TOUCHUP PAINT

A. For Equipment: Equipment manufacturer's paint selected to match installed equipment finish.

B. Galvanized Surfaces: Zinc-rich paint recommended by item manufacturer.

PART 3 - EXECUTION

3.1 ELECTRICAL EQUIPMENT INSTALLATION

A. Materials and Components: Install level, plumb, and parallel and perpendicular to other building systems and components, unless otherwise indicated.

B. Equipment: Install to facilitate service, maintenance, and repair or replacement of components. Connect for ease of disconnecting, with minimum interference with other installations.

3.2 ELECTRICAL SUPPORTING DEVICE APPLICATION

A. Damp Locations and Outdoors: Stainless steel or aluminum materials or nonmetallic, U-channel system components.

B. Dry Locations: Stainless Steel or aluminum materials.

C. Support Clamps for PVC Raceways: Click-type clamp system.

D. Selection of Supports: Comply with manufacturer's written instructions.

E. Strength of Supports: Adequate to carry present and future loads, times a safety factor of at least four; minimum of 200-lb design load.

3.3 SUPPORT INSTALLATION

A. Install support devices to securely and permanently fasten and support electrical components.

B. Install individual and multiple raceway hangers and riser clamps to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assemblies and for securing hanger rods and conduits.

C. Support parallel runs of horizontal raceways together on trapeze- or bracket-type hangers.

D. Size supports for multiple raceway installations so capacity can be increased by a 25 percent minimum in the future.

E. Support individual horizontal raceways with separate, stainless steel pipe hangers or clamps.

F. Install 1/4-inch-diameter or larger threaded stainless steel hanger rods, unless otherwise indicated.

G. Arrange supports in vertical runs so the weight of raceways and enclosed conductors is carried entirely by raceway supports, with no weight load on raceway terminals.

H. Simultaneously install vertical conductor supports with conductors.

I. Separately support cast boxes that are threaded to raceways and used for fixture support. Support sheet-metal boxes directly from the building structure or by bar hangers. If bar hangers are used, attach bar to raceways on opposite sides of the box and support the raceway with an approved fastener not more than 24 inches from the box.

J. Install metal channel racks for mounting cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices unless components are mounted directly to structural elements of adequate strength.

K. Install sleeves for cable and raceway penetrations of concrete slabs and walls unless core-drilled holes are used. Install sleeves for cable and raceway penetrations of masonry and fire-rated gypsum walls and of all other fire-rated floor and wall assemblies. Install sleeves during erection of concrete and masonry walls.

L. Securely fasten electrical items and their supports to the building structure, unless otherwise indicated. Perform fastening according to the following unless other fastening methods are indicated:

1. Wood: Fasten with wood screws or screw-type nails.
2. Masonry: Toggle bolts on hollow masonry units and expansion bolts on solid masonry units.
3. New Concrete: Concrete inserts with machine screws and bolts.
4. Existing Concrete: Expansion bolts.
5. Steel: Welded threaded studs or spring-tension clamps on steel.
   a. Field Welding: Comply with AWS D1.1.
6. Welding to steel structure may be used only for threaded studs, not for conduits, pipe straps, or other items.
7. Light Steel: Sheet-metal screws.
8. Fasteners: Select so the load applied to each fastener does not exceed 25 percent of its proof-test load.

3.4 FIRESTOPPING

A. Apply firestopping to cable and raceway penetrations of fire-rated floor and wall assemblies to achieve fire-resistance rating of the assembly.

3.5 CONCRETE BASES

A. Construct concrete bases of dimensions indicated, but not less than 6 inches larger, in both directions, than supported unit and bollards. Follow supported equipment manufacturer's anchorage recommendations and setting templates for anchor-bolt and tie locations, unless otherwise indicated. Use 3000-psi, 28-day compressive-strength concrete and reinforcement.

3.6 DEMOLITION

A. Protect existing electrical equipment and installations indicated to remain. If damaged or disturbed in the course of the Work, remove damaged portions and install new products of equal capacity, quality, and functionality.

B. Accessible Work: Remove exposed electrical equipment and installations, indicated to be demolished, in their entirety.

C. Abandoned Work: Cut and remove buried raceway and wiring, indicated to be abandoned in place, 2 inches below the surface of adjacent construction. Cap raceways and patch surface to match existing finish.

D. Remove demolished material from Project site.

E. Remove, store, clean, reinstall, reconnect, and make operational components indicated for relocation.

3.7 CUTTING AND PATCHING

A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces required to permit electrical installations. Perform cutting by skilled mechanics of trades involved.

B. Repair and refinish disturbed finish materials and other surfaces to match adjacent undisturbed surfaces. Install new fireproofing where existing firestopping has been disturbed. Repair and refinish materials and other surfaces by skilled mechanics of trades involved.

3.8 FIELD QUALITY CONTROL

A. Inspect installed components for damage and faulty work, including the following:

1. Raceways.
2. Building wire and connectors.
3. Supporting devices for electrical components.
4. Electrical identification.
5. Electricity-metering components.

6. Concrete bases.
7. Electrical demolition.
8. Cutting and patching for electrical construction.
9. Touchup painting.

3.9 REFINISHING AND TOUCHUP PAINTING

A. Refinish and touch up paint. Paint materials and application requirements are specified in Division 9 Section "Painting."

1. Clean damaged and disturbed areas and apply primer, intermediate, and finish coats to suit the degree of damage at each location.
2. Follow paint manufacturer's written instructions for surface preparation and for timing and application of successive coats.
3. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
4. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.10 CLEANING AND PROTECTION

A. On completion of installation, including outlets, fittings, and devices, inspect exposed finish. Remove burrs, dirt, paint spots, and construction debris.

B. Protect equipment and installations and maintain conditions to ensure that coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

END OF SECTION

SECTION 16060

GROUNDING AND BONDING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

1.2 SUMMARY

A. This Section includes grounding of electrical systems and equipment. Grounding requirements specified in this Section may be supplemented by special requirements of systems described in other Sections or on the drawings.

1.3 QUALITY ASSURANCE

A. Testing Agency Qualifications: Testing agency as defined by OSHA in 29 CFR 1910.7 or a member company of the InterNational Electrical Testing Association and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association to supervise on-site testing specified in Part 3.

B. 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.

1. Comply with UL 467.

C. Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Grounding Conductors, Cables, Connectors, and Rods:
   a. Apache Grounding/Erico Inc.
   b. Boggs, Inc.
   c. Chance/Hubbell.
   d. Copperweld Corp.
   e. Dossert Corp.
   f. Erico Inc.; Electrical Products Group.
   g. Framatome Connectors/Burndy Electrical.

h. Galvan Industries, Inc.
i. Harger Lightning Protection, Inc.
j. Hastings Fiber Glass Products, Inc.
k. Heary Brothers Lightning Protection Co.
l. Ideal Industries, Inc.
m. ILSCO.
n. Kearney/Cooper Power Systems.
o. Korns: C. C. Korns Co.; Division of Robroy Industries.
p. Lightning Master Corp.
q. Lyncole XIT Grounding.
r. O-Z/Gedney Co.; a business of the EGS Electrical Group.
s. Raco, Inc.; Division of Hubbell.
t. Robbins Lightning, Inc.
u. Salisbury: W. H. Salisbury & Co.
v. Superior Grounding Systems, Inc.
w. Thomas & Betts, Electrical.

2.2 GROUNDING CONDUCTORS

A. For insulated conductors, comply with Division 16 Section "Conductors and Cables."

B. Material: Copper.

C. Equipment Grounding Conductors: Insulated with green-colored insulation.

D. Isolated Ground Conductors: Insulated with green-colored insulation with yellow stripe. On feeders with isolated ground, use colored tape, alternating bands of green and yellow tape to provide a minimum of three bands of green and two bands of yellow.

E. Grounding Electrode Conductors: Stranded cable.

F. Underground Conductors: Bare, stranded, unless otherwise indicated.

G. Bare Copper Conductors: Comply with the following:

1. Solid Conductors: ASTM B 3.
2. Assembly of Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.

H. Copper Bonding Conductors: As follows:

1. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG copper conductor, 1/4 inch in diameter.
2. Bonding Conductor: No. 4 or No. 6 AWG, stranded copper conductor.
3. Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
4. Tinned Bonding Jumper: Tinned-copper tape, braided copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

I. Ground Conductor and Conductor Protector for Wood Poles: As follows:

1. No. 4 AWG minimum, soft-drawn copper conductor.
2. Conductor Protector: Half-round PVC or wood molding. If wood, use pressure-treated fir, or cypress or cedar.

J. Grounding Bus: Bare, annealed copper bars of rectangular cross section, with insulators.

2.3 CONNECTOR PRODUCTS

A. Comply with IEEE 837 and UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.

B. Bolted Connectors: Bolted-pressure-type connectors, or compression type.

C. Welded Connectors: Exothermic-welded type, in kit form, and selected per manufacturer's written instructions.

2.4 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel.

B. Ground Rods: Sectional type; copper-clad steel.

1. Size: 3/4 by 120 inches.

C. Test Wells: Provide handholes for test wells.

PART 3 - EXECUTION

3.1 APPLICATION

A. Use only copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.

B. In raceways, use insulated equipment grounding conductors.

C. Exothermic-Welded Connections: Use for connections to structural steel and for underground connections, except those at test wells.

D. Equipment Grounding Conductor Terminations: Use bolted pressure clamps.

E. Ground Rod Clamps at Test Wells: Use bolted pressure clamps with at least two bolts.

F. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.

1. Use insulated spacer; space 1 inch from wall and support from wall 6 inches above finished floor, unless otherwise indicated.

2. At doors, route the bus up to the top of the door frame, across the top of the doorway, and down to the specified height above the floor.

G. Underground Grounding Conductors: Use bare stranded-copper conductor, No. 4/0 AWG minimum. Bury at least 24 inches below grade or bury 12 inches above duct bank when installed as part of the duct bank.

3.2 EQUIPMENT GROUNDING CONDUCTORS

A. Comply with NFPA 70, Article 250, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.

B. Install equipment grounding conductors in all feeders and circuits.

C. Busway Supply Circuits: Install insulated equipment grounding conductor from the grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.

D. Computer Outlet Circuits: Install insulated equipment grounding conductor in branch-circuit runs from computer-area power panels or power-distribution units.

E. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate grounding conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.

F. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate equipment grounding conductor. Isolate equipment grounding conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.

G. Nonmetallic Raceways: Install an equipment grounding conductor in nonmetallic raceways unless they are designated for telephone or data cables.

H. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate equipment grounding conductor to each electric water heater, heat-tracing, and antifrost heating cable. Bond conductor to heater units, piping, connected equipment, and components.

I. Metal Poles Supporting Outdoor Lighting Fixtures: Provide a grounding electrode in addition to installing a separate equipment grounding conductor with supply branch-circuit conductors

J. Common Ground Bonding with Lightning Protection System: Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.

3.3 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Bonding Straps and Jumpers: Install so vibration by equipment mounted on vibration isolation hangers and supports is not transmitted to rigidly mounted equipment. Use exothermic-welded connectors for outdoor locations, unless a disconnect-type connection is required; then, use a bolted clamp. Bond straps directly to the basic structure taking care not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.

3.4 CONNECTIONS

A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.

1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
2. Make connections with clean, bare metal at points of contact.
3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
4. Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps.
5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

B. Exothermic-Welded Connections: Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.

C. Equipment Grounding Conductor Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.

D. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically noncontinuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.

E. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

F. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.

G. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

END OF SECTION

SECTION 16075

ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

1.2 SUMMARY

A. This Section includes electrical identification materials and devices required to comply with ANSI C2, NFPA 70, OSHA standards, and authorities having jurisdiction.

1.3 SUBMITTALS

A. Product Data: For each electrical identification product indicated.

B. Schedule of Nomenclature: An index of electrical equipment and system components used in identification signs and labels

1.4 QUALITY ASSURANCE

A. Comply with ANSI C2.

B. Comply with NFPA 70.

C. Comply with ANSI A13.1 and NFPA 70 for color-coding.

PART 2 - PRODUCTS

2.1 LABELS

A. Colored banding tape shall be 5 mil stretchable vinyl with permanent solid color. Color shall be as herein after specified. Tape shall be Plymouth “Slipknot 45”, 3M Scotch #35, or equal.

B. Numbered wire marking labels shall be colored vinyl markers, T&B, Brady, or equal. With clear heat shrinking tubing placed over the marking labels.

C. Cable identification labels shall be water resistant polyester with blank write-on space, T&B, Brady or equal. For use in handholds, manholes and boxes.

D. Underground-Conduit Warning Tape: Permanent, bright-colored, continuous-printed, vinyl tape.

1. Not less than 6 inches wide by 4 mils thick

2. Compounded for permanent direct-burial service.
3. Embedded continuous metallic strip or core.
4. Printed legend indicating type of underground line.

2.2 NAMEPLATES AND SIGNS

A. Safety Signs: Comply with 29 CFR, Chapter XVII, Part 1910.145.

B. Engraved Plastic Nameplates and Signs: Engraving stock, melamine plastic laminate, minimum 1/16 inch thick for signs up to 20 sq. in. and 1/8 inch thick for larger sizes.

1. Engraved legend with black letters on white face.
2. Punched or drilled for mechanical fasteners.

C. Baked-Enamel Signs for Interior Use: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for the application. 1/4-inch grommets in corners for mounting.

D. Exterior, Metal-Backed, Butyrate Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing; and with colors, legend, and size required for the application. 1/4-inch grommets in corners for mounting.

E. Fasteners for Nameplates and Signs: Self-tapping, stainless-steel screws or No. 10/32, stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Phase label black pigmented power wires with color banding tape. Color of tape applies shall be that specified below:

CONDUCTOR	120/240V SYSTEMS	480V SYSTEMS
Phase A	Black	Purple
Phase B	Red	Brown
Phase C	Blue	Yellow
Neutral	White	Gray
Equipment Ground	Green	Green

B. Numbered labels shall be installed to identify circuit numbers from panel boards. Install labels on each wire in each panel board, junction, pullbox, and device.

C. Label each wiring run with write-on waterproof labels inside each motor control center and in service switchboard. Install write-on label ties around wire group at conduit entrance and write-on label the wire size, and service.

D. Install numbered marking on each control wiring termination at each terminal strip and at each device. Do this in motor control center, terminal cabinets, safety switches, remote controllers, pilot operators, and instrumentation equipment. Number selected shall correspond to number on terminal strip.

E. Phase bank each power wire and cable with colored banding tape. Do this at each termination

F. Apply numbered wire marking labels to control wires; power wiring in Panelboards, pull and junction boxes, and at outlets to identify circuit numbers. Each control wire shall be labeled at each connection.

G. Apply write-on identification labels to wiring sets in each hand-hole to identify function. Use waterproof labels.

H. Apply write-on identification labels to empty conduits to identify each with information as to terminus of other end and also trade size of conduit.

I. Install micarta nameplates with engraving to identify function and/or load served for the following:

1. Starters
2. Overcurrent Devices
3. Safety Switches
4. Instruments
5. Control Panels
6. Motor Control Centers
7. Panel Boards
8. Switchgear and Switchboards

Micarta nameplates shall be attached with stainless steel screws, use two(2) per each nameplate.

Submit for review a schedule for engraving along with size for each proposed micarta nameplate. Do not fabricate nameplate until review has been completed.

J. Type circuit directory information on circuit directory cards on all panelboards.

END OF SECTION

SECTION 16120

CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

1.2 SUMMARY

A. This Section includes building wires and cables and associated connectors, splices, and terminations for wiring systems rated 600 V and less.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Qualification Data: For testing agency.

C. Field Quality-Control Test Reports: Megohm Meter Test Report

1.4 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. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 WIRE AND CABLE

A. All conductors shall be soft-drawn, stranded annealed copper that meets ANSI 44, ASTM B3-74/38-72.

B. Insulation for all power and controls single conductors not used in cable trays shall be type XHHW-2 and complying with NEMA WC 5 or 7, UL-83 and UL-1063.

C. Conductors shall be color coded for voltage and phase as per NEC and any local amendments.

D. Large conductors shall have taped color coding.

E. Jacket shall be polyamide outer nylon covering per UL-83 and UL-1063.

F. Multiconductor shielded cables shall be polyethylene insulated tinned copper conductors within an aluminium-polyester shield tinned copper drain wire and a chrome PVC jacket. Shield shall provide 100% coverage. Cables shall be UL style 2092 and shall be Beldon Beldfoil #8760 or equal, with number of conductors shown.

G. Multiconductor signal cables shall consist of twisted pairs of insulated copper conductors, size and number of pairs as indicated, with a petroleum-polyethylene compound which fills all cable interstices, a non-hydroscopic core tape, .005" copper shield and a polyethylene jacket. Cable shall be manufactured to REA Specification PE-39 for REA Designation BJCF cables and shall be Okonite type KTC-F or equal.

H. Multiconductor cords shall consist of rubber insulated high-strained copper conductors contained within a neoprene jacket. Furnish type SJO/300V class for 120/240V class applications.

I. Multiconductor cables for installation in cable trays shall consist of stranded tinned copper conductors, 30 mil FR-EPR flame-retardant ethylene-propylene-rubber insulation, color coded, two-conductors flat, three or more conductors twisted with CPE jacket overall. Furnish Belden tray cable, or equal.

J. Variable Frequency Drive (VFD) power cables shall consist of stranded, tinned-copper power conductors contained within a cross-linked polyolefin, 2kV insulation meeting the requirements for Type P of IEEE 1580 and Type X110 of UL 1309/CSA 245. Each conductor shall have printed phase I.D. Cable shall include 3 ground conductors consisting of stranded, tinned-copper insulated with insulation equivalent to the power conductor insulation. The shield shall be constructed of tinned-copper braid with an aluminum/polyester tape providing 100% coverage. The jacket shall meet UL 1309/CSA 245 as well as IEEE1580.

2.2 CONNECTORS

A. Power connectors shall be insulated tap connectors. Furnish NSI Polaris connectors with no equals.

B. Insulated spring-wire connectors, "wire-nuts", for small building wire taps and splices shall be plated spring steel with thermoplastic jacket. Connector shall be rated at 150 degrees Celsius continuous. Furnished 3M "Hyflex", T&B "PT" or equal.

C. Insulated set-screw connectors shall consist of copper body with flame-retardant plastic insulated shield. Furnished Ideal, T&B, or equal.

D. Connectors for control conductor connections to screw terminals shall be crimp-type with vinyl insulated barrell and tin-plated copper ring-tongue style connector. Furnish T&B, "Sta-kon", 3M "Scothlok". Or equal.

2.3 INSULATING PRODUCTS

A. Tape products shall be furnished as herein after specified and shall be Plymouth, Okonite, F.E.,

3M, or equal.

B. General purpose electrical tape shall be 7 mil thick stretchable vinyl plastic, pressure adhesive type,"slipknot Grey", 3M Scotch 33+, or equal.

C. Insulating void-filling tape and high voltage bedding tape shall be stretchable thylene propylene rubber with high-tack and fast fusing surfaces. Tape shall be rated for 90 degrees Celsius continuous, 130 degrees Celsius overload, and shall be moisture proof void filling tape shall be "plysafe", 3M Scotch 23, or equal.

D. High temperature protective tape shall be rated 180 degrees Celsius continuous indoor/outdoor, stretchable, self-bonding silicone rubber. High temperature tape shall be "plysil #3445", 3M Scotch 70, or equal.

PART 3- EXECUTION

3.1 WIRING

A. Conductors shall be sized as shown and where no size is indicated, the conductor size shall be size #12 AWG.

B. All control wiring, 120/240V wiring and insulated equipment grounding conductors shall be type XHHW-2 insulated stranded copper conductors.

C. All 480V wiring in sizes #4/0 and larger shall be made with type RHH, RH, USE, VW-1 wire with stranded copper conductors that has EPR insulation and flame retardant jacket.

D. Branch circuits may be spliced for receptacle, lighting and small appliances load inside appropriate junction boxes. All control and power cables shall be run continuous without splices except where approved by the engineer.

E. Except as otherwise specified, taps and splices with #10 AWG and smaller shall be made with insulated spring wire connectors. Such connectors in damp or wet locations shall be further insulated with an envelope of stretched piece of EPR tape around each wire to fill the interstices between the wires. Then, apply one-half lapped layer of electrical tape over all.

F. Motor connections made with #10 AWG and smaller wire shall be made up with set-screwed copper lugs with threaded-on insulating jacket. After make-up of each connector, install two (2) layers half-lapped, high temperature tape over connector barrel and down over wires into connector on (1") inch.

G. Motor connections made with #8 AWG and larger wire shall be made up with cast copper alloy splice connector. Apply over each connector and down 1.5 inches over each wire entry, wrapping in high temperature tape. Apply at least three (3) layers, half-lapper each layer of such tape with maximum built-up over the connector. Then apply final wrapping of at least three (3) layers, half-lapped each layer of electrical tape.

H. Taps, splices, and connection in #8 AWG and larger wires shall be made with copper alloy bolted pressure connectors. Each such connector shall be insulated by means of applying insulation

putty over sharp edges so as to present a smooth bonding surface. Next, apply at least four (4) layers, half-lapped each layer of EPR tape. Then, make final wrapping of at least three (3) layers, half-lapped each layer of electrical tape.

I. Control wiring connections to stud type and screw type terminals shall be made with ring-tongue type crimp connectors. Label each terminal jacket with wire marking label at each connection.

J. Each wire connection shall be made up tightly so that resistance of connection is as low as equivalent length of associated conductor resistance.

K. Phase label black pigmented power wires with color banding tape. Color of tape applies shall be that specified below.

CONDUCTOR	120/240V SYSTEMS	480V SYSTEMS
Phase A	Black	Purple
Phase B	Red	Brown
Phase C	Blue	Yellow
Neutral	White	Gray
Equipment Ground	Green	Green
DC Positive	Blue	
DC Negative	White w/ blue tracer	

L. Numbered labels shall be installed to identify circuit numbers from panel boards. Install labels on each wire in each panelboard, junction, and pullbox, and device connection.

M. Label each wiring run with write-on waterproof labels inside each motor control center and in service switchboard. Install write-on label ties around wire group at conduit entrance and write-on label the wire size, and service.

N. Install numbered marking on each control wiring termination at each terminal strip and at each device. Do this in motor control center, terminal cabinets, safety switches, remote controllers, pilot operators, and instrumentation equipment. Number selected shall correspond to number on terminal strip.

O. All wiring inside enclosures will be neatly trained and laced with nylon tie-wraps.

P. All wiring shall be installed in raceways unless otherwise noted; however, no wire shall be drawn into a conduit until all work of a nature which may cause injury is completed. Do not exceed wire and cable manufacturer's recommended pulling tensions. A cable pulling compound shall be used as a lubricant and its composition shall not affect the conductor or its insulation.

END OF SECTION

SECTION 16130

RACEWAYS AND BOXES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

1.2 SUMMARY

1.3 SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. Shop Drawings: Show fabrication and installation details of components for raceways, fittings, boxes, enclosures, and cabinets.

1.4 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. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 RACEWAYS

A. Above ground conduit shall be schedule 40 Rigid Aluminum Conduit and shall comply with Article 346 of NEC and U.L. standard UL-6.

B. Below grade conduit shall be non-metallic rigid PVC Schedule 40, rated 90 degrees Celsius and conform to NEMA TC-2 and UL-651 Standards, transitions to above ground to be made with PVC coated hot dipped rigid steel conduit.

C. Connections to motors shall be made using liquid tight flexible conduit and shall consist of aluminum flexible interlocking core with thermoplastic cover.

D. Below grade to above grade conduit elbows shall be PVC-coated rigid aluminum conduit.

2.2 CONDUIT FITTINGS

A. NEMA 1 lock nuts for rigid metallic conduit shall be stainless steel.

B. Outdoor field applied hubs for sheet metal enclosures shall be stainless steel ring, nylon throat, threaded NPT insert and shall be MYERS "SCRU-TITE", or equal.

C. Conduit hubs for non-metallic enclosures shall be fiberglass polyester reinforced with galvanized steel core, complete with lockout and grounding bushing and shall be Square D Type NH, or equal.

D. Rigid metallic conduit chase nipples, slip fittings, unions, reducers shall be alumimum.

E. Rigid metallic conduit grounding bushings shall be aluminum or stainless steel with threaded hub, nylon insulated throat, and ground lug.

F. Liquid tight flexible conduit fittings shall be aluminum body with internal locking ring.

2.3 CONDUIT BODIES, BOXES, AND ENCLOSURES

A. Conduit bodies such as "C", "LB", "T" and the like pulling fittings shall be sand-cast copper free aluminum. Covers shall be gasketed cast metal with stainless steel cover screws and clamp style attachment. Furnish Crouse-Hinds Form 7, or equal.

B. Conduit bodies such as "GUA", "GUAT", "GUAL", and the like pulling/splicing fittings shall be copper free aluminum with cast metal covers. All such conduit bodies shall be Crouse-Hinds GU/EA series, Appleton "GR" series, equal.

C. Cast metal outlet boxes, pullboxes, and junction boxes whose volume is smaller than 100 cubic inches, and cast metal device boxes, shall be sand-cast copper free aluminum. All boxes shall have threaded hubs. Furnish Crouse-Hinds "FD" style Condulets, Appleton "FD" style Unilets, or equal.

D. Covers for cast metal boxes shall be gasketed cast metal covers with stainless steel screws.

E. Enclosures shall be NEMA types as indicated. NEMA 4X types shall be 316 stainless steel with gasketed door and 316 stainless steel hardware.

F. Conduit hubs for NEMA 4X enclosed safety switches shall be aluminum body type with fiberglass reinforced polyester covering and with grounding bushing inside.

G. Conduit hubs for NEMA 3 and NEMA 4 and NEMA 4X enclosures shall be water-tight threaded hubs with grounding bushing inside.

H. Each enclosure shall be equipped with ground lug.

2.4 MISCELLANEOUS MATERIAL

A. Double bushing for insulating wiring through sheet metal panels shall consist of mating male and female threaded phenolic bushings. Phenolic insulation shall be high-impact "ABB", Gedney type "ABB", or equal.

B. Cable grips shall be grip-type wire mesh with machined metal support. Furnish Kellems, Appleton, or equal products.

C. Conduit pull-cords for use in empty raceways shall be glass-fiber reinforced tape with foot-marked along its length. Furnish Thomas, Greenlee, or equal products.

D. Conduit thread coating compound shall be conductive, non-galling, and corrosion-inhibiting. Furnish Crouse-Hinds type "STL", Appleton type "ST", or equal.

E. Wire pulling compound shall be non-injurious to insulation and to conduit and shall be lubricating, non-crumbling, and non-combustible. Furnish Gedney "Wire-Quick", Ideal "Yellow", or equal.

F. Plastic compound for field-coating of ferrous material products shall be PVC in liquid form that sets-up semi-hard upon curing. Furnishing Rob Roy "rob Kote", Sedco "Patch Coat", or equal.

G. Splicing kit shall be provided with insulating and sealing compound to provide a moisture-tight splice. Provide Scotchcast Series 82 or equal splicing kit.

H. Conduit straps for use with slotted channels shall be aluminum with stainless steel hardware.

I. After-set concrete inserts shall consist of stainless steel expansion bolts, 1/4: minimum diameter, 500 lbs. minimum pull-out resistance. Furnish Phillips, Wej-it, or equal.

J. Conduit "U" bolts shall be stainless steel with stainless steel hex-head bolts.

K. Plastic saddles for supporting buried conduits shall be interlocking type that provides separation between conduits vertically and laterally and between bottom of conduits and trench floor.

PART 3 - EXECUTION

3.1 RACEWAYS

A. Install the conduit system to provide the facility with the utmost degree of reliability and maintenance free operation. The conduit system shall have the appearance of having been installed by competent workmen. Kinked conduit, conduit inadequately supported or carelessly installed, do not give such reliability and maintenance free operation and will not be accepted.

B. Raceways shall be installed for all wiring runs except as otherwise indicated.

C. Conduit sizes, where not indicated, shall be N.E.C. code-sized to accommodate the number and diameter of wires to be pulled into the conduit. Unless otherwise indicated, 3/4" trade-size shall be minimum size conduit.

D. Unless otherwise noted, conduit runs shall be installed exposed. Such runs shall be made parallel to the lines of the structure. Where aluminum conduit or supporting devices come in contact with concrete, the conduit and or supporting devices shall be coated with zinc chromate or other suitable coating to prevent galvanic action.

E. Conduit runs installed below-grade in earth shall be PVC. Use manufacturer's approved cement for joining couplings and adapters. Runs shall be installed so that tops of conduits are at least twenty-four (24") inches below finished grade. Support runs on plastic spacers and encase conduits with reinforced 3000 PSI concrete dyed red. Concrete shall be a minimum of 3" beyond conduits on all sides. Cover top of concrete with red colored concrete dye backfill to finished grade with selected soil that is free from clods, debris, rocks and the like. Pneumatically tamp backfill in six (6") inches to eight (8") inches below finished grade, install continuous run of "BURIED CABLE" marking taped. Transitions from below grade to above grade conduit runs shall be accomplished with PVC-coated rigid aluminum conduit.

G. Rigid aluminum conduit runs shall have their couplings and connections made with screwed fittings and shall be made up wrench-tight. Check all threaded conduit joints prior to wire pull.

H. All conduit runs shall be watertight over their lengths of run except where drain fittings are indicated. In which cases, install specified breather-drain fittings.

I. Liquid tight flexible conduit shall be used to connect wiring to motors, limit switches, bearing thermostats, and other devices that may have to be removed for servicing. Unless otherwise indicated, maximum lengths of flex shall be six (6') feet.

J. Each flex connector shall be made-up tightly so that the minimum pull-out resistance is at least 150 lbs.

K. Empty conduits shall have pull-tape installed. Identify each terminus as to location of other end. Use blank plastic waterproof write-on label and write information on each label with waterproof ink. Cap exposed ends of empty conduit with plastic caps.

L. Conduit runs into boxes, cabinets, and enclosures shall be set in a neat manner. Vertical runs shall be set plumb. Conduits set cocked or out of plumb will not be acceptable.

M. Conduit entrances into equipment shall be carefully planned. Cutting away of enclosure structure, torching out sill or braces, and removal of enclosure structural members, will not be acceptable.

N. Use approved hole cutting tools for entrances into sheet metal enclosure. Use of cutting torch or incorrect tools will not be acceptable. Holes shall be cleanly cut and they shall be free from burrs, fagged edges, and torn metal.

O. All raceways shall be swabbed clean after installation. There shall be no debris left inside. All interior surfaces shall be smooth and free from burrs and defects that would injure wire insulation. All conduits shall be sealed after cable installation with electrical insulation putty.

P. All raceways labeled as “spare” or “future” on the construction documents and are indicated to be installed below grade and rise thru the finished floor beneath concrete construction to serve future equipment shall be capped level with the finished floor.

3.2 CONDUIT BODIES AND BOXES

A. Conduit bodies such as "LB", "T", etc., shall be installed in exposed runs of conduit wherever indicated and where required to overcome obstructions and to provide pulling access to wiring. Covers for such fittings shall be accessible and unobstructed by the adjacent construction.

B. Covers for conduit bodies installed shall be gasketed cast metal type.

C. All conduit boxes installed shall be cast metal type. Covers for all such boxes shall be gasketed cast metal type.

D. Install enclosures plumb

3.3 RACEWAY SUPPORT

A. All raceway systems shall be adequately and safely supported. Loose, sloppy and inadequately supported raceways will not be acceptable. Supports shall be installed at intervals not greater than those set forth under Article 300 of N.E.C., unless shorter intervals are otherwise indicated, or unless conditions require shorter intervals of supports.

B. Surface mounted runs of conduit on concrete or masonry surfaces shall be supported off the surface by means of aluminum slotted channels and conduit clamps. Attach each slotted channel support to concrete surface by means of two (2) 1/4" diameter stainless steel bolts into drilled expansion shields. Coat surface contacting concrete or masonry with zinc chromate.

C. Conduit runs that are installed along metallic structures shall be supported by means of beam clamps or other methods as may be indicated. Coat each beam clamp with PVC prior to installation.

D. Below-grade conduits shall be supported with plastic saddles prior to concrete pour.

3.4 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.5 CLEANING

A. After completing installation of exposed, factory-finished raceways and boxes, inspect exposed finishes and repair damaged finishes.

END OF SECTION

SECTION 16140

WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

1.2 SUMMARY

A. This Section includes receptacles, connectors, switches, and finish plates.

1.3 DEFINITIONS

A. GFI: Ground-fault circuit interrupter.

B. TVSS: Transient voltage surge suppressor.

1.4 SUBMITTALS

A. Product Data: For each product specified.

B. Shop Drawings: Legends for receptacles and switch plates.

1.5 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.

B. Comply with NEMA WD 1.

C. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 WIRING DEVICES

A. All wiring devices shall be specification grade and shall meet NEMA WD1 requirements. Furnish following types unless otherwise indicated.

B. Two-pole, 3-wire grounding, 15A/125V, NEMA 5-15R duplex receptacle shall be Arrow-Hart # 5662-S, Hubbel #5262, or equal.

C. Two-pole 3-wire grounding, 20A/125V, NEMA 5-20R duplex receptacle shall be Arrow-Hart#5739-S, Hubbel #5362, or equal.

D. GFI receptacle shall be duplex receptacle in a duplex body containing reset and test push-buttons. Furnish Square D "GFSR", or equal.

E. Two-pole, 3-wire grounding, #20A/250V NEMA 6-20R single receptacle shall be Arrow-Hart # 5861, Hubbel # 5461, or equal.

F. Single-pole, single throw 20A toggle switch shall be Arrow-Hart # 1791, Hubbel #1221, or equal.

G. Single-pole, double throw (three-way) 20A toggle switch shall be Arrow-Hart #1994, Hubbel # 1224, or equal.

H. Double-pole, single-throw 29A toggle switch shall be Arrow-Hart #1992, Hubbel # 1222, or equal.

I. Double-pole, single-throw 29A toggle switch shall be Arrow-Hart# 1992, Hubbell #1222, or Equal.

J. Single-pole, double-throw, momentary/centeroff, 20A toggle switch shall be Arrow-Hart # 1995, Hubbell #1556, or equal.

K. Door Switch, single-throw pressure sensitive shall be Pass & Seymour #1205, or equal.

2.2 FACE PLATES

A. Plant receptacle covers shall be zinc die cast with vertical duplex cover. Furnish Crouse-Hinds #TP7199 or approved equal.

B. Plant switch covers shall be zinc die cast vertical opening cover. Furnish Crouse-Hinds #TP7214 or approved equal.

C. Office areas receptacle and switch covers shall be nylon ivory colored with attachment screws painted to match cover. Furnish Leviton or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install devices and assemblies plumb and secure.

B. Install wall plates when painting is complete.

C. Install wall dimmers to achieve indicated rating after derating for ganging as instructed by manufacturer.

D. Do not share neutral conductor on load side of dimmers.

E. Arrangement of Devices: Unless otherwise indicated mount with long dimension vertical, and grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

3.2 CONNECTIONS

A. Connect wiring device grounding terminal to branch-circuit equipment grounding conductor.

B. Isolated-Ground Receptacles: Connect to isolated-ground conductor routed to designated isolated equipment ground terminal of electrical system.

C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturers torque values are not indicated, use those specified in UL 486A and UL 486B.

3.3 FIELD QUALITY CONTROL

A. Test wiring devices for proper polarity and ground continuity. Operate each device at least six times.

B. Test GFCI operation with both local and remote fault simulations according to manufacturer's written instructions.

C. Replace damaged or defective components.

3.4 CLEANING

A. Internally clean devices, device outlet boxes, and enclosures. Replace stained or improperly painted wall plates or devices.

END OF SECTION

SECTION 16230

STANDBY GENERATOR

PART 1. GENERAL

1.1 SUMMARY

A. Contractor shall be responsible for reading all specifications from all disciplines prior to bid

B. A complete generating system and all related equipment, including cooling system, coolant pumps, expansion tanks, valves, piping lubricating systems, fuel system components, miscellaneous devices and all required appurtenances shall be furnished and installed by the generator Manufacturers Supplier and/or Local Representative. It is the Generator Suppliers responsibility that any and all electrical and mechanical parts of the complete generator system that Supplier sub-assigns for installation by another Contractor be accounted for, approved and coordinated by said Generator Supplier. Any additional electrical and/or mechanical equipment or devices required for the specific generating system for this project shall be accounted for in Supplier and Contractor's bid where or not shown in plan and specifications details for this project

C. Contractor shall contact local Factory Representative to verify all equipment purchased conforms to the requirements of this project. It is accepted that each manufacturer listed may have variation in certain specified parameters that are particular to each specific product, and this is to be accounted for in bid and in the data submitted for Engineer's review. Failure to do so may result in equipment removal and replacement at Contractor's expense

D. Coordinate generator circuit breaker and controls with transfer switch and switchgear supplier and provide interface circuits, equipment and devices as required for a complete operating system

E. Listing of acceptable Equipment Manufacturers does not limit or remove the intent of these specification requirements

1.2 REFERENCES

A. All material and equipment supplied under this specification shall be designed, assembled, and tested in full compliance with the latest edition of the following codes and standards:

NEC - National Electric Code

IEEE - Institute of Electrical and Electronic Engineers

UL - Underwriters Laboratories

NEMA - National Electronic Manufacturers Association

ASA - American Standards Association

ANSI - American National Standards Institute

B. The generator shall be listed by UL2200 as a complete assembly

C. Generator system shall comply with all EPA, state and local requirements. Where generator size shown on plans is not properly rated, the next size up shall be supplied

1.3 SUBMITTALS

A. Refer to specification for Basic Submittal and O&M Requirements 16051

B. Provide CAD files of diagrams, equipment views, and material & device schedules on CD and include with submittals. Only one (1) copy required for Electrical Engineer. Only electronic files will be reviewed. Hard copy submittals are not acceptable and will be returned as rejected.

C. Six (6) copies of the following items are required of the successful bidder prior to manufacture:

Certified dimensional drawings showing weight, outline dimensions, bolting and drilling details, clearances for installation, operation and maintenance, and required ventilation

Elevation views, showing and identifying all items furnished and section views as required to locate all components

Bill of material describing all components and recommended spare parts with pricing and delivery

Brochures on engine, generator, muffler, batteries, charger, control panel, and any accessory equipment showing ratings, construction features, and performance characteristics

Schematic and wiring diagrams of the electrical system showing all factory wiring and clearly indicating wiring and voltage of any electrical strip heaters. Also, submit fully detailed inter-connection drawings indicating each individual connection to any remote equipment, including a separate connection drawing to show point-to-point electrical wiring connections

Submit documentation showing compliance with EPA/TCEQ emission requirements via location and EPA “TIER” rating. Include the current EPA conformity documentation for engine supplied with submittal package for review

Calculations of steps, voltage drops, and kVA

Descriptive literature describing the standard series specified (not a one-of-a- kind fabrication)

Drawing submittal schedule with approval allowance requirements

Shipping time after receipt of order

Exceptions and clarifications to this specification

Factory testing procedures

Drawings of the diesel generator set offered hereunder. Literature describing the diesel engine generator set and indicating its current production status.

Drawings and/or literature describing auxiliary equipment to be furnished.

The following data in tabulated form:

a. Make of engine
b. Number of cylinders
c. Bore, inches (millimeters)
d. Stroke, inches (millimeters)
e. Piston displacement, cubic inches (liters)
f. Piston speed, feet per minute (liters/mim.) at rated RPM
g. BMEP rated KW output
h. Make and type of generator
i. Generator electrical rating, KVA or KW .8 power factor
j. Number and type of bearings
k. Exciter type
l. Generator insulation class and temperature rise
m. Parts and service support
n. Engine manufacturer's certified engine BHP curve and certified gen set fuel consumption curve
o. Electrical loading and performance calculations
p. Foundation design for each location

2.1 RATINGS

A. Diesel Engine Driven Generating Set, complete with accessories, shall be at minimum the KW rating shown on plans and as manufactured by the following:

Cummins

Detroit Diesel (Stewart & Stevenson)

Kohler

Caterpillar

Taylor Power Systems

Generac

MTU

B. Generator shall be at minimum the KVA shown on plans at a 0.8 power factor. If a particular Manufacturer’s unit of kVA shown on plans does not have proper EPA tier ratings or, will not start all loads then, next largest size meeting these requirements shall be used. Voltage rating should be as shown on plans.

C. Generator shall be capable of starting loads in sequential order, smallest to largest loads, with not more than 10% terminal voltage drop, and not more than 5% frequency drop, regardless of

the starter utilized for the equipment. Voltage drop shall be defined as the voltage drop at a period of time specified by the engineer after review of the generator data sheets

D. Contractor shall verify code letter of motors furnished and shall adjust generator size accordingly where code letters vary from design values

E. Generator system shall meet current EPA Tier 1, 2 or 3 status requirements as applicable. Where size shown on plans is not proper tier rated, the next size unit shall be supplied

F. When next size generator is required, all conductor and conduit sizes shall be adjusted accordingly

2.2 ENGINE

A. Type: Liquid cooled, full diesel compression ignition engine, either naturally aspirated or turbocharged. 4-cycled engine required, or as approved by the Engineer.

B. Rating: Provide an engine with brake horsepower not less than required by the full load rating of the generator, including losses, and with all accessories attached.

C. Speed: The engine speed will be suitable for direct connection to the generator without exceeding engine manufacturer's published curves. Speed must not exceed 1800 RPM

D. BMEP: The engine BMEP will not exceed 310 PSI, when producing rated load. Piston speed shall be 1800 feet per minute or less

E. Construction (as required):

Replaceable liners

Two (2) valves per cylinder

Full pressure lube system with crankshaft driven oil pump

Unit injectors

Full flow replaceable oil filter

Lube Oil Heater

Primary and secondary fuel oil filters

Replaceable fuel transfer pump suitable for 6 feet suction lift or, as required for this project

Dry type air intake cleaner

Fuel water separator with see-through polycarbonate bowl and manual drain

F. Starting System

Heavy duty, battery driven electric starter motor.

A fully charged 24-volt lead acid, impact resistant, storage battery or batteries mounted on the unit. Make battery capacity sufficient for four cranking cycles at firing speed of 10 seconds

duration each, with 15 seconds rest periods- Provide all battery cables, connections, electrolyte, and a hydrometer. Battery rack to have rubber coating or epoxy paint

G. Cooling System: The generator set will be furnished with a unit mounted radiator having sufficient capacity for cooling the engine when delivering full rated horsepower at the design ambient. The fan is to be engine driven pusher type. An immersion heater shall be furnished in the jacket water system. Where unit mounted radiator does not have sufficient cooling capacity a remote cooling system shall be furnished by Generator Supplier and shall include all equipment devices and pumps, expansion tanks, piping, and appurtenances required for a complete operating system

H. Exhaust System: High degree, critical rated 316 stainless exhaust system with maximum silencing capacity mounted on unit. Include a suitable length of flexible 316 stainless steel exhaust tubing for mounting between engine and muffler. When V type engines are used, a wye type flex will be furnished all exhaust system components to be 316 stainless steel. Provide (1) digital exhaust gas temperature meter on in-line engine or (2) on "V" engine. Digital readout to be included in engine/generator control panel

I. Fuel System (As Required):

Diesel Generator:

a. Engine driven, self-priming fuel pump suitable for unassisted transfer of fuel from the fuel tank to the engine. Provide fuel pump capable of satisfactory flow from tank to generator at distance shown on plans. Optional fuel pump may be installed at tank location by providing all power and control circuits and equipment required for complete operating fuel system

b. Where shown on plans, provide fuel tank meeting UL 142, unless noted otherwise. Capacity will be for minimum 24 hour operation at 100% maximum generator load.

c. Full flow fuel/water separator with see-through polycarbonate bowl and drain.

d. Full flow replaceable element fuel filter.

e. Fuel connection lines between tank and engine.

f. Provide governor of the full electronic type to maintain frequency stability at any constant load, including no load, within plus or minus 1/4 percent, and to maintain frequency regulation between no load steady state and full load steady within 3 percent

g. Fuel restriction indicators.

h. Air filter restriction indicators.

i. Generator Manufacturer shall designate piping entry into generator and shall consult with Contractor on fuel pipe sizes and routing. It is Contractors responsibility to secure Manufacturer's directions and advise for a proper fuel system operation

j. Contractor shall provide full tank of fuel after testing is completed

J. Provide governor of the full electronic type, Woodward or an approved equal, to maintain frequency stability at any constant load, including no load, within plus or minus 1/4 percent, and to maintain frequency regulation between no load steady state and full load steady within 3 percent.

K. Battery Charger: A static, solid-state type battery charger unit, which automatically controls the charge rate. Include a charging rate ammeter, thermal overload circuit and transformer. The charge shall be suitable for operation at 120 volts single phase, 60 Hertz. The maximum charging time to bring the batteries up to full charge will be 12 hours. Mount charger on unit, using adequate vibration devices. Charger shall be of the dual rate type.

L. Engines used in proposed generator se to be certified to comply with current US EPA and CARB Mobile Off-Highway Emission Limits when tested per ISO 8178 D2. Engines used shall also comply with TCEQ air quality regulations at location and time of installation.

M. Generator Manufacturer shall designate piping entry into generator and shall consult with Contractor on fuel pipe sizes and routing. It is Contractors responsibility to secure Manufacturer's directions and recommendations for a proper fuel system operation.

N. Where installation of sub-base fuel tank is shown on plans and elevates generator controls above normal access level, Contractor to provide an approved stair/platform structure for access to controls and generator components. Provide shop drawings for Engineer's approval

2.3 ALTERNATOR

A. Type: Furnish a direct coupled, synchronous, brushless type alternator with amortisseur windings, revolving field, exciter, and built-in static rectifier and permanent magnet excitation system

B. Rating:

480/277V - 3 phase, 4 W, grounded neutral or 120/240 volt, 3 phase, 4 wire Delta, as shown on plans

Frequency - 60 Hertz.

Minimum KW and KVA, rating as shown on plans.

Power Factor - 0.8.

C. Insulation System: Class H, 150 degrees Celsius rise over a 40°C ambient. Generator not to exceed 105°C rise at 40°C ambient at 100% rated power

D. Maximum Voltage Dip: Less than 15 percent when last pump is started across the line and all other equipment is operating at full load. Locked rotor code for pump motors is H.

E. Voltage Stability: Maintain within plus or minus 2 percent of rated voltage at any constant from no load to full load.

F. Voltage Regulation - Maintain within plus or minus 1-1/2 percent deviation from rated voltage between no load steady state and full load steady state. Voltage regulation shall allow motor

starting with full voltage across-the-line starters and shall maintain continuous power to the starter during the transition from Start to Run phase of operation.

G. Coupling: From engine, drive rotor through a semi-flexible coupling to ensure permanent alignment.

H. Strip Heaters: Provide low surface temperature space heaters to prevent condensation.

I. Generator set shall have automatic controls to protect alternator from overload. Controls shall be independent of main breaker, which shall not be depended on or, used for, generator protection. Controls shall be provided to monitor the output current of the generator set and initiate an alarm when load current exceeds 110% of the rated current of the generator set on any phase for more than 60 seconds. The controls shall shut down and lock out the generator set when output current level approaches the thermal damage point of the alternator for both single phase and three phase fault conditions. The system shall control the alternator output to provide 300% of rated current under short circuit conditions, for both single phase and three phase faults. Systems, which regulate single phase and three phase faults at identical excitation levels, are not acceptable. There shall be no exceptions to this requirement, regardless of standards for manufacturers listed in Item 2.01 – "Ratings."

J. Provide 100% rated circuit breaker. Where alternator is rated for 3 phase, 4 wire service greater than 400 amps, provide GFI trip function per NEC

K. Coordinate generator and accessories such as conductor lugs on breaker and dimensional spaces shown before shipping. Lack of coordination shall be at vendor's risk and at no additional cost to Owner

L. Control and voltage regulator's operation shall not be affected by electrical system leading power factor conditions. Where power factor capacitors may affect generator operation, provide means to disengage capacitors during generator operation

2.4 CONTROL PANEL

A. OVERLOAD PROTECTION CIRCUIT BREAKER- A main line molded case 3-pole circuit breaker shall be installed as a load circuit interrupting and protection device. Circuit breaker shall incorporate shunt trip capability. It shall operate both manually as an isolation switch and automatically during overload and short circuit conditions. The trip unit for each pole shall have elements providing inverse time delay during overload conditions and instantaneous magnetic tripping for short circuit protection. The circuit breaker shall meet standards established by Underwriter's Laboratories, National Electric Manufacturer's Association, and National Electric Code. The circuit breaker shall be mounted in NEMA-1 type enclosure in or adjacent to the generator control panel

B. AUTOMATIC START-STOP SYSTEM- The engine starting panel shall automatically provide a minimum of four cranking and three rest periods. Operation shall be initiated by the closing of contacts in the automatic transfer switch. The automatic starting panel control switch shall include the positions of "Automatic", "Off", and "Test". The automatic starting panel shall contain 24-volt alarm lights energized by the safety controls. A 24-volt visual light shall also

be energized if the engine has started by the end of the final cranking cycle. The panel and selector switch shall be mounted in the generator control panel. A green light shall indicate when the selector switch is in the "automatic" power.

C. General: Provide a solid-state control panel mounted to unit, which includes, but is not limited to, the following instruments and protective devices.

AC ammeter

Phase selector switch.

Current transformers.

AC voltmeter.

Automatic solid-state voltage regulator.

Rheostat for adjusting voltage plus or minus 5 percent of rated voltage.

Engine Malfunction Warning Lights:

a. Low oil pressure.
b. High water temperature.
c. Engine over crank.
d. Engine overspeed.

Frequency meter.

Non-resettable elapsed time meter with a 9,999.9-hour maximum indication.

Coolant temperature gage.

Oil pressure gage.

Main circuit breaker - molded case type.

Combination alarm-shutdown system with manual reset and indicating lights for high engine temperature, low oil pressure, engine overspeed, and engine fail-to-start. Include an additional set of contacts for remote alarms

Manual start/stop switch for control of engine.

Alarm dry contact closures as follows:

a. Low oil pressure
b. High water temperature
c. Engine over crank
d. Engine run
e. Low fuel pressure
f. Generator fault

Remote control contacts as follows:

a. Engine start via transfer switch (which will include power transfer).

Provide latest electronic control panel at engine

Control panel space heater

Provide space heater in generator set mounted control panel to prevent condensation

D. Provide remote annunciator with minimum of (6) six programmable relays for use as alarm outputs unit to be recess mounted in door of automatic transfer switch, except where ATS is outdoors, in which case annunciator shall be installed in the inner panel of the ATS or, on wall in MCC Room as shown on plans or otherwise designated by Engineer. Wall surface mounted annunciator shall be installed in manufacturer's surface mounted style box. Recessed mounted annunciator shall be installed in recessed box with annunciator free place trim flush with wall

E. Contractor shall provide fail and problem alarms and run signals to monitoring station at Operator's room to autodialer/SCADA System, when present. Provide circuits, devices, expansion modules, and programming as required for autodialer/SCADA System

F. Non-resettable elapsed time meter with a 9,999.9-hour maximum indication

G. Provide data port for use with SCADA monitoring of generator status using ModBus protocol via Ethernet. Provide CD with program, information and status display. Provide generator communications interface module with Ethernet connector, power supply, programming for SCADA system use and all appurtenances. Provide compatible HMI template for specific generator. Provide all addresses, HMI templates, and software required for display on SCADA HMI. Provide Owners copy of Manufacturer's software for use in displaying generator data. Include Manufacturers time for assisting in installation and set-up of program. Assist Systems Integration Engineer in setting up plant controller PLC and/or SCADA

H. Provide factory built, U.L. listed, remote annunciator that interfaces with generator control panel

2.5 ENGINE START/STOP CONTROLS

A. The engine controls shall be provided with bypassing of the low oil pressure shutdown circuitry during start-up.

B. B. If unit fails to start in an appropriate time (normally 30 seconds), the starting circuit shall shut down for an appropriate time (approximate 10 seconds) and then repeat the start cycle. If the unit still fails to start after approximately four start attempts, the over crank alarm shall activate, and the starting circuit shall shut down.

C. The engine start/stop control shall be static solid state.

2.6 BASE

A. Mount the assembled packaged unit on a base of welded structural steel, box type construction. Prime all exposed metal parts with a rust inhibitor and finish in durable machinery enamel.

B. Vibration isolators shall be of the steel spring type.

2.7 WEATHERPROOF HOUSING – (WHERE INDICATED ON PLANS)

A. Construction: Provide an overall weather protective housing with removable side panels and a hinged, padlockable meter panel door to make the engine generating plant suitable for outdoor installation. In addition, sound levels shall not exceed 77 db at 7 meters. Where sound attenuating housing is shown on plans, provide according to those specifications

B. Painting: Prime all exposed metal parts with a suitable rust inhibitor applied to the clean, bare metal, followed by two coats of epoxy paint for exterior weather.

C. All doors and access panels shall be lockable. Provide mechanical (non-magnetic) contact switches on all moveable panels and doors to detect entry into generator enclosure

D. Contractor to coordinate with manufacturer on housing size prior to constructing concrete pad

E. Provide low voltage transformer, panel and appurtenance sized for all low voltage requirements at generator. Provide feeder circuit from Motor Control Center.

F. Enclosure manufacturer shall be consulted for piping and conduit entries into housing. Also, coordinate with generator manufacturer and engineer before installing. All hardware with external exposure shall be manufactured from 316 stainless steel.

2.8 GENERATOR CONCRETE FOUNDATION

A. Provide concrete pad as shown on plans. Use 3000-psi concrete with #5 rebar 12” O.C. Coordinate pad construction with generator drawings and weight

2.9 GENERATOR ACCESS

A. Where generator controls or enclosure step-up height is greater than 18 inches above grade, Contractor shall provide concrete or galvanized steel steps for access to controls or to enclosure

2.10 GENERATOR MONITORING SYSTEM

A. Provide interface to the generator solid state controller and route data signal (ModBus TCP) to data switch as shown on plans.

B. Provide all software, programming, and devices required for monitoring trouble status, run status, alternator loading, fuel tank level, and all other available status signals. Provide HMI templates for display on SCADA HMI. Route data cable to monitoring station PLC via Ethernet switch as shown on plans. Assist in setting up system during construction, testing, demonstrations to Owner, and final inspection

C. Provide all addressing information needed to display all alarm, function, and status information at PLC HMI. Send information on CD or via e-mail to Engineer

D. Provide with Form C general trouble alarm relay to indicate generator failure or fault for any reason.

2.11 GENERATOR INSTALLATION

A. Contractor shall consult with Generator Manufacturer on all aspects of generator installation to assure all work is proper and professional

2.12 STORAGE

A. Where generator is stored on site prior to installation, provide any heating or other measures required to prevent moisture accumulation in high humidity areas. Consult Manufacturer for requirements

2.13 INHIBIT RELAYS

A. Where generator is not designed to carry full load of motors, provide inhibit relay for each motor starter over 5 horsepower to inhibit motor starter operation when generator runs. Relay is to be energized by generator run signal from ATS or generator. Provide bypass switch across the inhibit relay contacts to allow selected motors to run on generator power

2.14 GENERATOR ACCESSORIES AND MISCELLANEOUS EQUIPMENT

A. Contractor shall provide power, control, and instrument circuits as well as all fuel source piping and devices, cooling equipment, pumps, and related appurtenances, and all accessory equipment that is standard factory component supplied by the generator manufacturer.as part of this installation. Contractor shall coordinate all requirements with generator vendor and include all materials and design in bid cost

3.1 TESTING

A. All performance and temperature rise data submitted by the manufacturer above and shall be the result of actual test of the same or duplicate generator. Temperature rise data shall be the result for full load, 0.8 power factor heat runs at the rated voltage and frequency. This testing shall be done in accordance with MIL-STD-705 and IEEE standard 115.Before the equipment is installed, a factory test log of the generator set showing a minimum of 3/4 hour testing with 1/2 hour at 100 percent rated load at 0.8 power factor, continuously, shall be submitted to the purchaser. Voltage and frequency stability and transient response at 1/4, 1/2 and full load shall also be recorded. Normal preliminary engine and generator tests shall have been performed before unit assembly. Prior to acceptance of the installation, the equipment shall be subjected to an onsite cold start block test at 100% load followed by 4-hour resistive load bank test with a minimum of 2 hours at 100% load. All consumables necessary for this test operation shall be

furnished by the contractor. Any defects which become evident during this test shall be corrected by the contractor at this own expense. All testing shall be performed by the contractor and witnessed by owner. Test equipment must be calibrated within the previous 12 months

B. Units shall be factory tested under design conditions. Engineer and/or Owner may witness test. Vendor shall give one (1) week notice to Engineer before test is conducted

C. Perform startup test to ensure all systems work properly together to include transfer switches, annunciator panel and other associated accessories

D. Perform a load bank test as follows:

Utilizing a resistive load bank, load test the generator set as follows:

a. Load should be applied as 100% of the generator name plate output for the first 2 hours (cold start) followed by 75% of the generator name plate output for the next 2 hours.

b. At a minimum, record the following at least every 15 minutes during the test:

i. Time
ii. Frequency (Hz)
iii. Battery voltage (DC)
iv. Voltage (AC-L1, L2, L3)
v. Coolant Temperature
vi. Power Factor (1.0)
vii. Ambient temperature
viii. KW
ix. Exhaust temperature
x. Load percentage

E. Perform a plant load test as follows:

After the resistive load bank test has been completed, perform a plant load test to confirm generator can run connected loads as designed. Testing shall be performed as a complete simulation of power loss- ie shut off main disconnect and observe generator starts and ATS transfers to back-up source as required. All loads shown for connection shall be operated for up to 15 minutes (full load) unless system parameters do not allow pumps to run for that amount of time. Coordinate system parameters with plant Operator who shall be present for all plant load testing. Allow plant to run on generator under normal conditions for minimum of 1 hour. Record all values as shown for load bank testing every 5 minutes during plant load test.

Allow generator to run unloaded for at least 5 minutes before shutting down

F. Field Tests

Units shall be factory tested under design conditions. Purchaser, at his option, may witness test. Vendor shall give one (1) week notice before test is made

Perform field tests at the site after installation is complete and in the presence of the Owner's representative to verify that unit meets start up sequences listed

Manufacturer's Representative shall conduct field tests after electrical installation is completed and shall provide a certified report of these tests for the Owner and Engineer. The tests shall include sequential starting of all motor loads (across the line start) and recording the voltage dip as each motor starts. This report shall be sent to Engineer no less than 10 working days prior to "Final Acceptance" testing. Operation of system shall be demonstrated to Owner and Engineer by the Representative during setup tests and at final inspection and testing

Load testing shall be performed using a reactive load bank sized to simulate all loads running with largest load then applied. Provide written report of tests for Engineer's review

The following minimum work shall be performed by the Contractor and Manufacturer's Representative under the technical direction of the manufacturer's service representative. Allow for a minimum of twelve (12) days for factory technician including all expenses for the following services:

a. Inspection and final adjustments for startup, and acceptance testing.
b. Operational and functional test of controllers.
c. Participation in commissioning services. Technical representative shall be present for duration of commissioning test related to vendor equipment

The contractor shall provide three (3) copies of the manufacturer's field start-up report before final payment is made

3.2 LOAD LIMITING

A. Where generator is not sized to carry all motor loads simultaneously, Contractor shall provide inhibit relays and bypass switches to prevent operation of selected loads when on standby power

3.3 INSTALLATION

A. Installation of generator shall be according to Manufacturer's instructions and shall be witnessed and inspected by Manufacturer's Representative

B. Do not install vibration isolation rubber pads at random locations under skids. Place continuous pad, that is width of skids or, do not place at all. Manufacturer is to advise on this requirement.

C. Install on concrete pad that is sloped to avoid any standing water under generator or skids. Standing water test will be conducted and where water stands, the concrete slab shall be reworked to provide satisfactory installation.

D. Generator frame is to be bonded to ground grid via exothermic welded connection with 2/0 bare cu conductor (minimum)

E. Fuel source piping shall be stubbed up in PVC sleeve and routed under generator pad to proper location. Confirm exact location of stub-up in generator with manufacturer

3.4 OIL PAN

A. Provide galvanized steel oil pan beneath engine to catch oil drips. Provide drain valve with oil resistant drain hose extending to the skid and attached with stainless steel clamp to prevent oil spills when draining oil pan.

3.5 OIL DRAIN

A. Provide oil pan valve with oil resistant drain hose extending to the skid and attached with stainless steel clamp to prevent oil spills when draining oil pan

3.6 FIRE EXTINGUISHER

A. Provide two (2) high quality portable fire extinguishers noted for diesel fuel fire suppression. Provide mounting brackets and install on both sides of the enclosure doors located in the electrical control panel area. Coordinate location with Owner.

3.7 EAR PROTECTION

A. Provide dispenser with disposable ear protection devices on inside of generator enclosure near entry at controls section

3.8 FUEL REQUIREMENTS

A. Contractor shall provide all fuel required for use during the construction phase. Fuel tank shall be full when the facility is turned over to the Owner after final acceptance

3.9 MAINTENANCE/WARRANTY

A. Contractor shall provide the Generator Manufacturer's full 5-year comprehensive extended coverage service warranty on the generator installation and shall include all labor and materials required to repair or replace equipment and/or components that are defective or malfunctioning. Included under this warranty shall be all equipment, devices, hardware, and software. This warranty shall begin on date of written "Final Acceptance" of the electrical systems and to be executed as required at no additional cost to the Owner. Contractor's warranty shall also guarantee 24-hour service response time and shall provide labor, work, or materials as necessary to maintain plant operation when replacement parts are on order. In no case shall plant electrical systems be out of service for more than 24 hours from time Owner calls for warranty service. This shall be provided at no additional cost to the Owner. All equipment and materials installed shall have full warranty from Manufacturer that guarantees equipment is rated for harsh industrial electrical/mechanical environment in which it is installed

B. Where Manufacturer's products fail prematurely, Manufacturer shall be fully responsible for new replacement and shall not have the option of declaring that failures were caused by environmental conditions and its effect on the product. Contractor is fully responsible for

assuring that Product Manufacturers are aware of this condition and that warranty statement is included in shop drawing submittals. Failure to do so will be at the Contractor's expense and at no additional cost to the Owner

C. All critical warranted repairs shall be made within 24 hours of receipt of required parts from Manufacturer with reasonable delivery time of overnight shipping. Any repairs not completed within 5 working days from date of notice are subject to Owner making other arrangements for repair and back charging Contractor. This requirement is a condition of this contract

D. Where equipment or instrument problems remain unresolved by Contractor beyond a reasonable time, a Factory Technician shall be provided on-site to take any corrective actions necessary to put equipment or instruments in operating order. Owner and Engineer reserve the right to determine a reasonable time for corrective action by Contractor

END OF SECTION

SECTION16261

AUTOMATIC TRANSFER SWITCHES (ATS's)

PART 1. GENERAL

1.01 SUMMARY

A. This specification is confidentially issued for this specific project only

B. Contractor shall be responsible for reading all specifications from all disciplines prior to bid

C. Contractor shall contact local Factory Representative to verify all equipment purchased conforms to the requirements of this project. Failure to do so may result in equipment removal and replacement at Contractor's expense

D. Under no conditions shall transfer switch ampacity be rated less than main service breaker ampacity

E. Transfer switches with cable linkage when in manual mode are not accepted. Coordinate power and controls with Generator Manufacturer where generator is shown on Plans

F. All equipment, instruments and devices provided for this project shall have means of protection from power line conditions such as surge, phase fail, or other line conditions that may damage equipment, instruments or devices furnished. It is vendors and manufacturers' responsibility to provide protective devices as required for maintaining warranty of furnished items and to assure no damage occurs from power line conditions

1.02 SCOPE OF WORK

A. An automatic transfer switch shall be installed and rated at 200 amperes at 480 Volts and 60 HZ and be mechanically held and electrically operated by a single solenoid mechanism energized from the source to which the load is to be transferred and capable of manual operation by one person. The switch shall be mechanically and electrically interlocked to ensure one of the two positions - normal or emergency. The switch shall be applicable to 50 Hz or 60 Hz and suitable for all common voltages from 110 to 600. Switch shall be service entrance rated and housed in a white enamel painted NEMA 4X 316 stainless steel enclosure and shall conform with the provisions of underwriter's Laboratories 1008 Standards and meet the National Electric Code (NEC) requirements for critical applications.

B. Accessories- Transfer switches shall be equipped with the following accessories:

C. Time delay to retransfer to normal power source: Time delay to be provided for retransfer from emergency power to normal power (if restored and within

acceptable operating parameters). This time delay is to be automatically bypassed in the event the emergency source fails and normal power is available. Retransfer time delay to be field adjustable from 0-30 minutes.

D. Unit to be shipped with the initial transfer to normal power source time delay set at 5 minutes.

E. Time delay on engine cooling, (fixed, non-adjustable 5 minutes, -1 to +2 minutes tolerance)

F. Time delay on engine starting, (adjustable 0.5 to 60 seconds)

G. A test switch to simulate a normal power source failure

H. Pilot contact to initiate engine starting control.

I. Pilot lights to visually indicate the transfer switch position

J. Relay contacts as required plus one spare set of normally open and normally closed relay contacts

K. Provide solid state exerciser clock to set the day, time, and duration of generator set exercise/test period. Provide a with/without load selector switch for the exercise period.

L. Provide with (1) phase fail relay with 3-pole compact circuit protector with class CC fuses for each feeder entering the ATS. (Normal, Emergency and Load)

1.03 REFERENCES

A. National Fire Protection Association (NFPA): NFPA 70 - National Electrical Code (NEC)

B. National Electrical Manufacturers Association (NEMA): NEMA ICS 2-447- AC Automatic Transfer Switches

C. Underwriters Laboratories (UL): UL 1008 - Standard for Automatic Transfer Switches

1.04 SUBMITTALS

A. Refer to specification for Basic Submittal and O&M Requirements 16051

B. Submit all products covered under this specification for engineer's approval. Contractor shall submit transfer switch data to power company for approval prior to submitting to engineer

C. Manufacturer shall submit shop drawings for review, which shall include the following, as a minimum:

Descriptive literature

Plan, elevation, side, and front view arrangement drawings, including overall dimension, weights and clearances, as well as mounting or anchoring requirements and conduit entrance locations.

Installation exhibit showing dimension and spacing between existing equipment

Schematic diagrams

Wiring diagrams

Accessory list

Training outline

Manufacturers testing reports as requested

PART 2. PRODUCTS

2.01 MANUFACTURER'S

A. ASCO

B. Cummins

C. Russelectric

D. Lexington Zenith

E. Generator manufacturer provided ATS, or equal, as pre-approved in writing. No substitutions allowed except where pre-approved in writing by Engineer

F. Listing of acceptable Manufacturers does not relieve obligation of conditions described in this Specification Section

2.02 CONSTRUCTION

A. General:

The delayed transition automatic transfer switch shall be furnished as shown on the drawings. Voltage and continuous current ratings and number of poles shall be as shown. Switches shall be UL listed in accordance with UL-1008

Where transfer switch is shown on one-line diagram or on details as installed directly after service head and, where no overcurrent protection precedes the transfer switch, a service rated, breaker type switch shall be provided

Ampacity of transfer switch contacts shall be rated equal or greater than ampacity of main service breaker. No exceptions

On 3 phase, 4 wire systems, utilizing ground fault protection downstream of the transfer switch, a true 4-pole switch shall be supplied with all four poles mounted on a common shaft. The continuous current rating and the closing and withstand rating of the fourth pole shall be identical to the rating of the main poles and shall have quick-break contacts. See plans for 4 pole requirements. This requirement does not apply for water and wastewater facility installation

The transfer switch shall be mounted in a white enamel painted NEMA 4X 316 S.S. for outdoors, unless otherwise indicated. The enclosure shall be sized to exceed minimum wire bending space required by UL 1008. Outdoor enclosures shall have no exposed controls. Fabricated covers over exposed controls are not allowed. Controls shall be located on inner door of automatic transfer switch. Enclosure shall have three (3) point latching handle with locking hasp. Where shown on plans in MCC, transfer switch enclosure shall match MCC enclosure

The transfer switch shall be equipped with an internal welded steel pocket, housing an operations and maintenance manual

The transfer switch shall be top and bottom accessible

The main contacts shall be capable of being replaced without removing the main power cables, or removing incoming normal power from service rated transfer switches

The main contacts shall be visible for inspection without any major disassembly of the transfer switch

All bolted bus connections shall have Belleville compression type washers

When a solid neutral is required, a fully rated bus bar with required AL-CU neutral lugs shall be provided. All grounding and neutral conductors shall be terminated and labeled per article 250 of latest edition of National Electrical Code

Control components and wiring shall be front accessible. All control wires shall be multi-conductor 18-gauge 600-volt SIS switchboard type point-to-point harness. All control wire terminations shall be identified with tubular sleeve-type markers

The switch shall be equipped with 90 degrees C rated copper/aluminum solderless mechanical type lugs

The complete transfer switch assembly shall be factory tested to ensure proper operation and compliance with the specification requirements. A copy of the factory test report shall be available to engineer with ATS submittal upon request

Transfer time shall be of sufficient duration to allow motor run controls to drop out or, Contractor shall provide additional time delay controls in the neutral position, both directions of transfer to accomplish this function

Provide 480: 120/240-volt, single phase transformer and all required circuit breakers to provide low voltage power to all generator heaters, controls, etc. Feed from load motor control center or, from side of ATS where shown on plans

All power and control circuits to have circuit breakers for overcurrent protection. Fuses are not acceptable. No Exceptions

All doors on outdoor enclosures shall have door restraints, 3-point latching handle and locking hasp. Keyed handles are not acceptable

No devices or controls are to be installed on outer door of outdoor enclosures or where NEMA 4X rated

Provide generator status annunciator with voltage, current, and phase indicators and run time (non-resettable) elapse time meter in panel (door) of indoor transfer switch. Provide nameplate. Flush mount

annunciator. Where ATS is located outdoors or in NEMA 4 X enclosure, mount status annunciator in inner door panel. Installation to be completed by ATS Factory Technician

Install Generator Manufacturer furnished alarm annunciator panel on wall near ATS or as shown on plans

All circuit breakers shall be covered. No exposed circuit breakers. No exceptions

Provide heater with thermostat control in all enclosures. Route 120 VAC circuit from LVP. Provide circuit breaker

Provide all power supplies required to operate transfer switch

Where transfer switch contains two circuit breakers, and where service breaker serves as main breaker, the transfer switch shall be UL listed, "Service Rated," and acceptable to Power Company

B. Automatic Transfer Switch:

The transfer switch shall be double throw, actuated by two electric operators momentarily energized, and connected to the transfer mechanism by a simple over center type linkage. Cable linkage mechanism is not acceptable

The normal and emergency contacts shall be positively interlocked mechanically and electrically to prevent simultaneous closing. Main contacts shall be mechanically locked in both the normal and emergency positions without the use of hooks, latches, magnets, or springs, and shall be silver-tungsten alloy. Separate arcing contacts with magnetic blowouts shall be provided on all transfer switches. Interlocked, molded case circuit breakers or contactors are not acceptable unless specifically shown on Plans, or pre-approved in writing

The transfer switch shall be equipped with a safe external manual operator, designed to prevent injury to operating personnel. The manual operator shall be front accessible and shall provide "quick make-quick break" operation, offering the same contact-to-contact transfer speed as the electrical operator to prevent switching the main contacts slowly. The external manual operator shall be UL listed for operation, under load, from the outside of the transfer switch while the door is closed. Door shall have 3-point latching handle. No automatic transfer switch enclosure shall be installed without door; Exerciser timer shall be readily accessible to operator

Circuit breakers used for service rated transfer switches shall be mechanically or electrically interlocked in a manner acceptable to the local Power Company

Provide all AC and/or DC power supplies required for transfer switch operation. Provide separate batteries and charger where operation requires separate power source independent of normal or generator power sources

C. Automatic Transfer Switch Controls:

The transfer switch shall be equipped with a microprocessor-based control system, to provide all the operational functions of the automatic transfer switch. The controller shall have two asynchronous serial ports. The controller shall have a real-time clock with battery backup

The CPU shall be equipped with self-diagnostics, which perform periodic checks of the memory I/O, and communication circuits, with a watchdog/power fail circuit

The controller shall have industry standard ethernet port connections for communicating with future industrial control system controller via a ethernet data switch

The Ethernet communication port shall allow interface to the Manufacturers and/or the Owner's furnished remote supervisory control. Provide all software, programming, testing, and cables and hardware for a complete operating system. Coordinate with SCADA Provider and Programmer and assist in setting up system. Provide all addresses, HMI templates, and function descriptions for Programmer's use. Functions shall include status of all operating time settings such as transfer time, transition delays, etc.

The controller shall have password protection required to limit access to qualified and authorized personnel

The controller shall include human machine interface with keypad allowing access to the system for generator exercising and time delay modifications

The controller shall include three phase over/under voltage, over/under frequency, phase sequence detection and phase differential monitoring on both normal and emergency sources

The controller shall store the following records in memory for access either locally or remotely:

Number of hours transfer switch is in the emergency position

Number of hours emergency power is available

Total transfer in either direction

Date, time, and description of the last four source failures

Date of the last exercise period

Date of record reset (where applicable)

D. Sequence of Operation:

When the voltage on any phase of the normal source drops below 80% or increases to 120%, or frequency drops below 90%, or increase to 110%, or 20% voltage differential between phases occurs, after a programmable time delay period of 0-300 seconds factory set at 3 seconds to allow for momentary dips, the engine starting contacts shall close to start the generating plant

The transfer switch shall transfer to emergency when the generating plant has reached specified voltage and frequency on all phases

After restoration of normal power on all phases to a preset value of at least 90% to 110% of rated voltage, and at least 95% to 105% of rated frequency, and voltage differential is below 20%, an adjustable time delay period of 0-3600 seconds (factory set at 300 seconds) shall delay retransfer to allow stabilization of normal power. If the emergency power source should fail during this time delay period, the switch shall automatically return to the normal source

After retransfer to normal, the engine generator shall be allowed to operate at no load for a programmable period of 0-3600 seconds, factory set at 300 seconds

E. Automatic Transfer Switch Accessories:

Programmable three phase sensing of the normal source set to pick up at 90% and dropout at 80% of rated voltage and overvoltage to pick up at 120% and dropout out at 110% of rated voltage. Programmable frequency pickup at 95% and dropout at 90% and over frequency to pick up at 110% and dropout at 105% of rated frequency. Programmable voltage differential between phases, set at 20%, and phase sequence monitoring

Time delay for override of momentary normal source power outages (delays engine start signals and transfer switch operation). Programmable 0-300 seconds. Factory set at 3 seconds, if not otherwise specified

Time delay to control contact transition time on transfer to either source. Programmable 0-120 seconds, factory set at 10 seconds

Time delay on retransfer to normal, programmable 0-3600 seconds, factory set at 300 seconds if not otherwise specified, with overrun to provide programmable 03600 second time delay, factory set at 300 seconds, unloaded engine operation after retransfer to normal. Time delay in neutral position of switch shall be adjustable 0-300 seconds

Time delay on transfer to emergency, programmable 0-300 seconds, factory set at 1 second.

A maintained type load test switch shall be included to simulate a normal power failure, keypad initiated.

A remote type load test switch shall be included to simulate a normal power failure, remote switch initiated.

A time delay bypass on retransfer to normal shall be included. Keypad initiated.

Contact rated 10 Amps 30 volts DC, to close on failure of normal source to initiate engine starting.

Contact rated 10 Amps 30 volts DC, to open on failure of normal source for customer functions

Light emitting diodes shall be mounted on the microprocessor panel to indicate switch is in normal position, switch is in emergency position, and controller is running

A plant exerciser shall be provided with ten (10) 7-day events, programmable for any day of the week and (24) calendar events, programmable for any month/day, to automatically exercise generating plant programmable in one-minute increments. Also include selection of either "no load" (switch will not transfer) or "load" (switch will transfer) exercise period. Keypad initiated with password. Provide means to observe and adjust settings locally and via data link to plant PLC controller

Provision to select either "no commit" or "commit" to transfer operation in the event of a normal power failure shall be included. In the "no commit position," the load will transfer to the emergency position unless normal power returns before the emergency source has reach 90% of its rated values (switch will remain in normal). In the "commit position”, the load will transfer to the emergency position after any normal power failure. Keypad initiated

Two auxiliary contacts rated 10 Amp, 120 volts AC (for switches 100 to 800 amps) 15-amp, 120 volts AC (for switches 1000 to 4000 amps), shall be mounted on the main shaft, one closed on normal, the other closed on emergency. Both contacts will be wired to a terminal strip for ease of customer connections

A three-phase voltage readout, with 1% accuracy shall display all three phase-to-phase voltages simultaneously, for both the normal and emergency source

A frequency readout with 1% accuracy shall display frequency for both normal and emergency source

A readout shall display normal source and emergency source availability

Signal before transfer contacts.

Selector switch to allow transfer by manual push button or switch movement

Maintenance Selector Switch: For service rated transfer switches provide means to deactivate switch in "Normal," "Open," or "Emergency" positions when servicing internal parts of switch assembly. Provide means for locking out in any position

Provide means to temporarily switch off "All" control voltages that are tapped on the incoming power side of the Normal circuit break for maintenance purposes. This is to remove all live voltages during service of transfer switches

Provide all available "Options" for transfer switch

F. Ratings:

Delayed transition automatic transfer switches shall have the following 3-cycle short circuit closing and withstand as follows:

RMS Symmetrical Amperes 480 VAC

Amperes	Closing and Withstand	Current Limiting Fuse Rating
100-400	42,000	200,000
600	50,000	200,000
800	65,000	200,000
1000-1200	85,000	200,000
1600-4000	100,000	200,000

During the 3-cycle closing and withstand tests, there shall be no contact welding or damage. The 3-cycle tests shall be performed without the use of current limiting fuses. The test shall verify that contacts separation has not occurred, and there is contact continuity across all phases. Test procedures shall be in accordance with UL-1008, and testing shall be certified by Underwriters' Laboratories, Inc

When conducting temperature rise tests to UL-1008, the manufacture shall include post-endurance temperature rise tests to verify the ability of the transfer switch to carry full rated current after completing the overload and endurance tests

The microprocessor controller shall meet the following requirements:

a. Storage conditions - 25 degrees C to 85 degrees C
b. Operation conditions - 20 degrees C to 70 degrees C ambient
c. Humidity 0 to 99% relative humidity, non-condensing
d. Capable of withstanding infinite power interruptions
e. Surge withstand per ANSI/IEEE C-37.90A-1978

Manufacturer shall provide copies of test reports upon request

G. Provide means to remotely monitor switch positions via a data network. See electrical plans for additional requirements. Provide all programming, software and devices. Provide on CD all addressing information for starter, alarm, and functions available for display at future PLC HMI. Manufacturer's Representative shall provide setup assistance during construction. Coordinate with Generator and Data Monitoring Systems Vendors to assure a unified power system

H. Manufacturer:

The transfer switch manufacturer shall employ a nationwide factory-direct, field service organization, available on a 24-hour a day, 365 days a year, call basis

The Manufacturer shall include an 800-telephone number, for field service contact, affixed to each enclosure

The manufacturer shall maintain records of each transfer switch, by serial number, for a minimum 20 years

I. Warranty: Provide Manufacturer's standard full 5-year comprehensive extended coverage service. Warranty shall be "on site" and warranty service shall be available by the factory service department on an emergency basis if required. Depot or non-site warranties are not acceptable

J. Load Bank Controls:

Where load bank is required, provide all controls, contactors, and devices needed to exercise generator on load bank. Normal plant loads shall not be on generator during load bank operation of generator

Coordinate with Generator Vendor

Submit load bank controls data

K. Provide fiber optic connector interface where indicated on plans

L. Where transfer switches are used ahead of main breaker or include main breaker, unit shall be "service rated" and shall have normal service breaker rated for service ampacity

2.03 PROTECTION

A. All equipment installed on this project shall incorporate all devices and features to protect that equipment from the influence of other equipment, line voltage and phase irregularities, harmonics and other disturbances that may affect the proper and safe operation of that equipment whether these required features are a standard component of that equipment as an off-the-line product. No equipment shall be installed without these features

PART 3. EXECUTION

3.01 INSTALLATION

A. Automatic Transfer Switches shall be provided with adequate lifting means for ease of installation of wall or floor mounted enclosures

B. Provide access and working space as indicated or as required per latest edition of National Electrical Code

C. Where Contractor fails to protect automatic transfer switches before and after installation on site and where excessive dust is observed inside the enclosure, the Contractor shall have a factory warranty service technician clean, inspect and test unit, after which the factory shall issue a written and signed statement that full factory is in effect. There are no exceptions to this requirement except to replace entire unit at Engineer's request

3.02 ADJUSTMENTS

A. Tighten assembled bolted connections with appropriate tools to manufacturer's torque recommendations prior to first energization

3.03 START-UP AND TESTING

A. Provide the services of a Factory Technician to checkout, adjust, set-up, test, and start-up the automatic transfer switch in conjunction with the standby generator. Fully function test the automatic transfer switch to verify proper operation

B. A Factory Technician shall be present for final acceptance testing and shall demonstrate unit operation to Engineer and Owner's Representative

C. Factory Representative shall demonstrate operation of system to Owner and Engineer

D. Where items are not functional at time of generator start-up, generator manufacturer shall return for additional start-up and testing as required for a complete and thorough demonstration

3.04 TRAINING

A. Provide two (2) 4-hour training courses conducted by Manufacturer's Representative at a time approved by Owner and Engineer. Provide training outline to Engineer for approval of contents. Notify Engineer of training schedule. Engineer may be present. Training shall include operation and required owner service and preventative maintenance. Operation and Maintenance Manuals shall be used during training for reference

3.05 WARRANTY

A. Contractor shall provide the Manufacturer's full 5-year comprehensive extended coverage service warranty on the generator installation and shall include all labor and materials required to repair or replace equipment and/or components that are defective or malfunctioning. Included under this warranty shall be all equipment, devices, hardware, and software

B. This warranty shall begin on date of written "Final Acceptance" of the electrical systems and to be executed as required at no additional cost to the Owner. Contractor's warranty shall also guarantee 24-hour service response time and shall provide labor, work, or materials as necessary to maintain plant operation when replacement parts are on order. In no case shall plant electrical systems be out of service for more than 24 hours from time Owner calls for warranty service

C. This shall be provided at no additional cost to the Owner. All equipment and materials installed shall have full warranty from Manufacturer that guarantees equipment is rated for harsh industrial electrical/mechanical environment in which it is installed. Where Manufacturer's products fail prematurely, Manufacturer shall be fully responsible for new replacement and shall not have the option of declaring that failures were caused by environmental conditions and its effect on the product

D. Contractor is fully responsible for assuring that Product Manufacturers are aware of this condition and that warranty statement is included in shop drawing submittals. Failure to do so will be at the Contractor's expense and at no additional cost to the Owner

E. All critical warranted repairs shall be made within 24 hours of receipt of required parts from Manufacturer with reasonable delivery time of overnight shipping. Any repairs not completed within 5 working days from date of notice are subject to Owner making other arrangements for repair and back charging Contractor. This requirement is a condition of this contract

F. Where equipment or instrument problems remain unresolved by Contractor beyond a reasonable time, a Factory Technician shall be provided on-site to take any corrective actions necessary to put equipment or instruments in operating order. Owner and Engineer reserve the right to determine a reasonable time for corrective action by Contractor

END OF SECTION

SECTION16289

SURGE PROTECTIVE DEVICES (SPD's)

FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 - GENERAL

1.1 SCOPE

A. This section describes the materials and installation requirements for surge protective devices (SPD) for the protection of all AC electrical circuits.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

1.3 SUBMITTALS

A. Submit shop drawings and product information for approval and final operation and maintenance documentation in the quantities listed according to the Conditions of the Contract. All transmittals shall be identified by customer name, customer location, and customer order number.

B. Submittals shall include UL 1449 3rd Edition Listing documentation verifiable by visiting www.UL.com, clicking "Certifications" link, searching using UL Category Code: VZCA and VZCA2:

1. Short Circuit Current Rating (SCCR)
2. Voltage Protection Ratings (VPRs) for all modes
3. Maximum Continuous Operating Voltage rating (MCOV)
4. I-nominal rating (I-n)
5. SPD shall be UL listed and labeled as Type 1 or Type 4 intended for Type 1 or Type 2 applications

C. Upon request, an unencapsulated but complete SPD formally known as TVSS shall be presented for visual inspection.

D. Minimum of ten (10) year warranty

1.4 RELATED STANDARDS

A. IEEE C62.41.1, IEEE Guide on the Surge Environment in Low-Voltage (1000 V and Less) AC Power Circuits

B. IEEE C62.41.2, IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits

C. IEEE C62.45, IEEE Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000 V and Less) AC Power Circuits

D. National Electrical Code: Article 285

E. UL1283 - Electromagnetic Interference Filters

F. UL 1449, Third Edition, effective September29, 2009 – Surge Protective Devices

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Engage a firm with at least 5 years' experience in manufacturing transient voltage surge suppressors.

B. Manufacturer shall be ISO 9001 or 9002 certified.

C. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of ten (10) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

D. The SPD shall be compliant with the Restriction of Hazardous Substances (RoHS) Directive 2002/95/EC.

PART 2 - PRODUCT

2.1 MANUFACTURERS

A. Provide a Surge Protective Device (SPD) by Schneider, Siemens, Eaton or pre-approved equal.

2.2 ELECTRICAL DISTRIBUTION EQUIPMENT

A. Distribution Panels, Automatic Transfer Switches and Motor Control Centers

1. SPD shall be UL 1449 labeled as Type 4 intended for Type 1 or Type 2 applications, verifiable at UL.com, without need for external or supplemental overcurrent controls. Every suppression component of every mode, including N-G, shall be protected by internal overcurrent and thermal overtemperature controls. SPDs relying upon external or supplementary installed safety disconnectors do not meet the intent of this specification.
2. SPD shall be factory installed integral to electrical equipment.
3. SPD shall be UL labeled with 20kA I-nominal (I-n)
4. SPD shall be UL labeled with 200kA Short Circuit Current Rating (SCCR).

5. Standard 7 Mode Protection paths: SPD shall provide surge current paths for all modes of protection: L-N, L-G, L-L, and N-G for Wye systems; L-L, L-G in Delta and impedance grounded Wye systems.
6. SPD shall be connected to the buss of the distribution equipment with an appropriately sized 200kA SCCR rated disconnect.
7. SPD shall meet or exceed the following criteria:
   a. Maximum 7-Mode surge current capability shall be 200kA per phase.
   b. UL 1449 - Third Edition Revision; effective September 29, 2009, Voltage Protection Ratings shall not exceed the following:

VOLTAGE	L-N	L-G	N-G	L-L	MCOV
208Y/120	800V	800V	800V	1200V	150V
480Y/277	1200V	1200V	1200V	2000V	320V

8. UL 1449 Listed Maximum Continuous Operating Voltage (MCOV) (verifiable at UL.com):

System Voltage	Allowable System Voltage Fluctuation (%)	MCOV
208Y/120	25%	150V
480Y/277	15%	320V

9. SPD shall incorporate a UL 1283 listed EMI/RFI filter with minimum attenuation of -50dB at 100 kHz.
10. Suppression components shall be heavy duty 'large block' MOVs, each exceeding 30mm diameter.
11. SPD shall include a serviceable, replaceable module.
12. SPD shall be equipped with the following diagnostics:
    a. Visual LED diagnostics including a minimum of one green LED indicator per phase, and one red service LED.
    b. Audible alarm with on/off silence function and diagnostic test function (excluding branch).
    c. Form C dry contacts
    d. Surge Counter

    No other test equipment shall be required for SPD monitoring or testing before or after installation.
13. SPD shall have a response time no greater than 1/2 nanosecond.
14. SPD shall have a 10 year warranty.

B. Branch and Control Panels

1. The panelboard shall be UL 67 Listed and the SPD shall be UL 1449 labeled as Type 1 or as Type 4 intended for Type 1 or Type 2 applications.
2. The unit shall be top or bottom feed according to requirements. A circuit directory shall be located inside the door.
3. SPD shall meet or exceed the following criteria:
   a. Maximum 7-Mode surge current capability shall be 100kA per phase.

   b. UL 1449 - Third Edition Revision; effective September 29, 2009, Voltage Protection Ratings shall not exceed the following:

VOLTAGE	L-N	L-G	N-G	L-L	MCOV
208Y/120	800V	800V	800V	1200V	150V
480Y/277	1200V	1200V	1200V	2000V	320V

4. UL 1449 Listed Maximum Continuous Operating Voltage (MCOV) (verifiable at UL.com):

System Voltage	Allowable System Voltage Fluctuation (%)	MCOV
208Y/120	25%	150V
480Y/347	15%	320V

5. SPD shall incorporate a UL 1283 listed EMI/RFI filter with minimum attenuation of -50dB at 100 kHz.
6. Suppression components shall be heavy duty 'large block' MOVs, each exceeding 30mm diameter.
7. SPD shall include a serviceable, replaceable module.
8. SPD shall be equipped with the following diagnostics:
   a. Visual LED diagnostics including a minimum of one green LED indicator per phase, and one red service LED.
   b. Audible alarm with on/off silence function and diagnostic test function (excluding branch).
   c. Form C dry contacts
   d. Surge Counter

   No other test equipment shall be required for SPD monitoring or testing before or after installation.
9. SPD shall have a response time no greater than 1/2 nanosecond.
10. SPD shall have a 10 year warranty.
11. The unit shall have removable interior.
12. The main bus shall be copper and rated for the load current required.
13. The unit shall include a 200% rated neutral assembly with copper neutral bus.
14. The unit shall be provided with a safety ground bus.
15. The field connections to the panelboard shall be main lug or main breaker.
16. The unit shall be constructed with surface mounted trim and shall be in a NEMA 4X stainless steel enclosure.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install per manufacturer's recommendations and contract documents.

3.2 FIELD TESTS

A. Check tightness of all accessible mechanical and electrical connections to assure they are torqued to the minimum acceptable manufacture's recommendations.

B. Check all installed panels for proper grounding, fastening and alignment.

3.3 CLEANING

A. Remove debris from installation site and wipe dust and dirt from all components.

B. Repaint marred and scratched surfaces with touch up paint to match original finish.

END OF SECTION

SECTION 16345

SHORT-CIRCUIT/COORDINATION STUDY/ARC FLASH HAZARD ANALYSIS

PART 1 - GENERAL

1.1 SCOPE

A. The contractor shall furnish short-circuit and protective device coordination studies as prepared by the electrical equipment manufacturer or an approved engineering firm. The study shall be started and results submitted prior to ordering any distribution equipment.

B. Prior to any rough-in the contractor shall obtain at minimum an approval from the preliminary coordination study. Any installation prior to obtaining the approval shall be at the contractor's risk.

C. The contractor shall furnish an Arc Flash Hazard Analysis Study per the requirements set forth in NFPA 70E – Standard for Electrical Safety in the Workplace. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E-2015, Annex D.

D. The scope of the studies shall include all new distribution equipment supplied by the equipment Manufacturer under this contract.

1.2 REFERENCES

A. Institute of Electrical and Electronics Engineers, Inc. (IEEE):

1. IEEE 141 – Recommended Practice for Electrical Power Distribution and Coordination of Industrial and Commercial Power Systems.
2. IEEE 242 – Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.
3. IEEE 399 – Recommended Practice for Industrial and Commercial Power System Analysis.
4. IEEE 241 – Recommended Practice for Electric Power Systems in Commercial Buildings.
5. IEEE 1015 – Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems.
6. IEEE 1584 – Guide for Performing Arc-Flash Hazard Calculations.

B. American National Standards Institute (ANSI):

1. ANSI C57.12.00 – Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers.
2. ANSI C37.13 – Standard for Low Voltage AC Power Circuit Breakers Used in Enclosures.

3. ANSI C37.010 – Standard Application Guide for AC High Voltage Circuit Breakers Rated on a Symmetrical Current Basis.
4. ANSI C37.41 – Standard Design Tests for High Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches and Accessories.

C. The National Fire Protection Association (NFPA)

1. NFPA 70 – National Electrical Code, latest edition.
2. NFPA 70E – Standard for Electrical Safety in the Workplace.

1.3 SUBMITTALS FOR REVIEW/APPROVAL

A. The short-circuit and protective device coordination studies shall be submitted to the design engineer prior to receiving final approval of the distribution equipment shop drawings and/or prior to release of equipment drawings for manufacturing. If formal completion of the studies may cause delay in equipment manufacturing, approval from the engineer may be obtained for preliminary submittal of sufficient study data to ensure that the selection of device and characteristics will be satisfactory.

1.4 SUBMITTAL FOR CONSTRUCTION

A. The results of the short-circuit, protective device coordination and arc flash hazard analysis studies shall be summarized in a final report. No more than five (5) bound copies of the complete final report shall be submitted. For large system studies, submittals requiring more than five (5) copies of the report will be provided without the section containing the computer printout of the short-circuit input and output data. Additional copies of the short-circuit input and output data, where required, shall be provided on CD in PDF format.

B. The report shall include the following sections:

1. Executive Summary.
2. Descriptions, purpose, basis and scope of the study.
3. Tabulations of circuit breaker, fuse and other protective device ratings versus calculated short circuit duties.
4. Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip unit settings, fuse selection.
5. Fault current calculations including a definition of terms and guide for interpretation of the computer printout.
6. Details of the incident energy and flash protection boundary calculations.
7. Recommendations for system improvements, where needed.
8. One-line diagram.

C. Arc flash labels shall be provided in hard copy only at least 30 days prior to energizing the electrical equipment.

1.5 QUALIFICATIONS

A. The short-circuit, protective device coordination and arc flash hazard analysis studies shall be conducted under the supervision and approval of a Registered Professional Electrical Engineer skilled in performing and interpreting the power system studies.

B. The Registered Professional Electrical Engineer shall be a full-time employee of the equipment manufacturer or an approved engineering firm.

C. The Registered Professional Electrical Engineer shall have a minimum of five (5) years of experience in performing power system studies.

D. The equipment manufacturer or approved engineering firm shall demonstrate experience with Arc Flash Hazard Analysis by submitting names of at least ten actual arc flash hazard analysis it has performed in the past year.

1.6 COMPUTER ANALYSIS SOFTWARE

A. The studies shall be performed using the latest revision of the ETAP software program.

PART 2 - PRODUCTS

2.1 STUDIES

A. Contractor to furnish short-circuit and protective device coordination studies as prepared by equipment manufacturer or an approved engineering firm.

B. The contractor shall furnish an Arc Flash Hazard Analysis Study per NFPA 70E – Standard for Electrical Safety in the Workplace, reference Article 130.3 and Annex D.

2.2 DATA COLLECTION

A. A Contractor shall furnish all data as required by the power system studies. The Engineer performing the short-circuit; protective device coordination and arch flash hazard analysis studies shall furnish the Contractor with a listing of required data immediately after award of the contract. The Contractor shall expedite collection of the data to assure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to the release of the equipment for manufacturing.

B. Source combination shall include present and future motors and generators.

C. Load data utilized shall include proposed loads obtained from Contract Documents provided by Owner or Contractor. Raceway and conductor types and lengths shall be provided to interested parties performing the study by Contractor. Contractor shall obtain fault data from Power Company as required for the study.

2.3 SHORT-CIRCUIT AND PROTECTIVE DEVICE EVALUATION STUDY

A. Use actual conductor impedances if known. If unknown, use typical conductor impedances base on IEEE Standard 141-1993.

B. Transformer design impedances shall be used when test impedances are not available.

C. Provide the following:

1. Calculation methods and assumptions.
2. Selected base per unit quantities.
3. One-line diagram of the system being evaluated.
4. Source impedance data, including electric utility system and motor fault contribution characteristics. The use of infinite bus is unacceptable.
5. Tabulations of calculated quantities.
6. Results, conclusions and recommendations.

D. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault at each:

1. Electric utility's supply termination point.
2. Incoming switchgear.
3. Unit substation primary and secondary terminals.
4. Low voltage switchgear.
5. Motor control centers.
6. Standby generators and automatic transfer switches.
7. Branch circuit panelboards.
8. Other significant locations throughout the system.
9. VFD's

E. For grounded systems, provide a bolted line-to-ground fault current study for areas as defined for the three-phase bolted fault short-circuit study.

F. Protective Device Evaluation:

1. Evaluate equipment and protective devices and compare to short circuit ratings.
2. Adequacy of switchgear, motor control centers, and panelboard bus bars to withstand short-circuit stresses.
3. Notify Owner in writing of circuit protective devices improperly rated for the calculated available fault current.

2.4 PROTECTIVE DEVICE COORDINATION STUDY

A. Proposed protective device coordination time-current curves (TCC) shall be displayed on log-log scale graphs.

B. Include on each TCC graph, a complete title and one-line diagram with legend identifying the specific portion of the system covered.

C. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.

D. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.

E. Plot the following characteristics on the TCC graphs, where applicable:

1. Electric utility's overcurrent protective device.
2. Medium voltage equipment overcurrent relays.
3. Medium and low voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.
4. Low voltage equipment circuit breaker trip devices, including manufacturer's tolerance bands.
5. Transformer full-load current, magnetizing inrush current and ANSI through-fault protection curves.
6. Conductor damage curves.
7. Ground fault protective devices, as applicable.
8. Pertinent motor starting characteristics and motor damage points, where applicable.
9. Pertinent generator short-circuit breaker in each motor control center and applicable panelboard.

F. Provide adequate time margins between device characteristics such that selective operation is provided, while providing proper protection.

2.5 ARC FLASH HAZARD ANALYSIS

A. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E-2015, Annex D.

B. The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchboards, switchgear, motor-control centers, panelboards, busway and splitters) where work could be performed on energized parts.

C. The Arc-Flash Hazard Analysis shall include all significant locations in 240 volt and 208 volt systems fed from transformers equal to or greater than 1285 kVA where work could be performed on energized parts.

D. Safe working distances shall be based upon the calculated arc flash boundary considering an incident energy o 1.2 cal/cm².

E. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model. Ground overcurrent relays should not be taken into consideration when determining the clearing item when performing incident energy calculations.

F. The short-circuit calculations and the corresponding incident energy calculations for multiple system scenarios must be compared and the greatest incident energy must be uniquely reported for each equipment location. Calculations must be performed to represent the maximum and minimum contributions of fault current magnitude for all normal and emergency operating conditions. The minimum calculation will assume that the utility contribution is at a minimum and

will assume a minimum motor contribution (all motors off). Conversely, the maximum calculation will assume a maximum contribution from the utility and will assume the maximum amount of motors to be operating. Calculations shall take into consideration the parallel operation of synchronous generators with the electric utility, where applicable.

G. The incident energy calculation must consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Iterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators should be decremented as follows:

1. Fault contribution from induction motors should not be considered beyond 3-5 cycles.
2. Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible (e.g. contributions from permanent magnet generators will typically decay from 10 per unit to 3 per unit after 10 cycles).

H. For each equipment location with a separately enclosed main device (where there is adequate separation between the lines side terminals of the main protective device and the work location), calculations for incident energy and flash protection boundary shall include both the line and load side of the main breaker.

I. When performing incident energy calculation on the line side of a main breaker (as required per above), the line side and load side contributions must be included in the fault calculation.

J. Miss-coordination should be checked amongst all devices within the branch containing the immediate protective device upstream of the calculation location and the calculation should utilize the fastest device to compute the incident energy for the corresponding location.

K. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584-2002 section B.1.2. Where it is not physically possible to move outside the flash protections boundary in less than 2 seconds during an arc flash event, a maximum clearing time based on the specific location shall be utilitzed.

2.6 REPORT SECTIONS

A. Input data shall include, but not be limited to the following:

1. Feeder input data including feeder type (cable or bus), size, length, number per phase, conduit type (magnetic or non-magnetic) and conductor material (copper or aluminum).
2. Transformer input data, including winding connections, secondary neutral-ground connection, primary and secondary voltage ratings, kVA rating, impedance, % taps and phase shift.
3. Reactor data, including voltage rating, and impedance.
4. Generation contribution data, (synchronous generators and Utility), including short-circuit reactance (X'd), rated MVA, rated voltage, three-phase and single line-ground contribution (for Utility sources) and X/R ratio.
5. Motor contribution data (inductin motors and synchronous motors), including short-circuit reactance, rated horsepower or kVA, rated voltage, and X/R ratio.

B. Short-circuit Output Data shall include, but not be limited to the following reports:

1. Low Voltage Fault Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:
   a. Voltage.
   b. Calculated fault current magnitude and angle.
   c. Fault point X/R ratio.
   d. Equivalent impedance.
2. Momentary Duty Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:
   a. Voltage.
   b. Calculated symmetrical fault current magnitude and angle.
   c. Fault point X/R ratio.
   d. Calculated asymmetrical fault currents.
      1) Based on fault point X/R ratio.
      2) Based on calculated symmetrical value multiplied by 1.6.
      3) Based on calculated symmetrical value multiplied by 2.7.
   e. Equivalent impedance.
3. Interrupting Duty Report shall include a section for three-phase and unbalanced built calculations and shall show the following information for each applicable location:
   a. Voltage.
   b. Calculated symmetrical fault current magnitude and angle.
   c. Fault point X/R ratio.
   d. No AC Decrement (NACD) ratio.
   e. Equivalent impedance.
   f. Multiplying factors for 2, 3, 5 and 8 cycle circuit breakers rated on a symmetrical basis.
   g. Multiplying factors for 2, 3, 5 and 8 cycle circuit breakers rated on a total basis.

C. Recommended Protective Device Settings:

1. Phase and Ground Relays:
   a. Current transformer ratio.
   b. Current setting.
   c. Time setting.
   d. Instantaneous setting.
   e. Recommendations on improved relaying systems, if applicable.
2. Circuit Breakers:
   a. Adjustable pickups and time delays (long time, short time, ground).
   b. Adjustable time-current characteristic.
   c. Adjustable instantaneous pickup.
   d. Recommendations on improved trip systems, if applicable.

D. Incident energy and flash protection boundary calculations.

1. Arcing fault magnitude.
2. Protective device clearing item.
3. Duration of arc.
4. Arc flash boundary.

5. Working distance.
6. Incident energy.
7. Hazard Risk Category.
8. Recommendations for arc flash energy reduction.

PART 3 - EXECUTION

3.1 FIELD ADJUSTMENT

A. Adjust relay and protective device settings according to the recommended settings table provided by the coordination study. Field adjustments to be completed by the engineering service division of the equipment manufacturer under the Startup and Acceptance Testing contract portion.

B. Make minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies.

C. Notify Owner in writing of any required major equipment modifications.

3.2 ARC FLASH WIRING LABELS

A. The contractor of the Arc Flash Hazard Analysis shall provide a 3.5 in. x 5 in. thermal transfer type label of high adhesion polyester for each work location analyzed.

B. All labels will be based on recommended overcurrent device settings and will be provided after the results of the analysis have been presented to the owner and after any system changes, upgrades or modifications have been incorporated in the system.

C. The label shall include the following information, at a minimum:

1. Location designation.
2. Nominal voltage.
3. Flash protection boundary.
4. Hazard risk category.
5. Incident energy.
6. Working distance.
7. Engineering report number, revision number and issue date.

D. Labels shall be machine printed, with no field markings.

E. Arc flash labels shall be provided in the following manner and all labels shall be based on recommended overcurrent device settings.

1. For each 480 and applicable 208 volt panelboard, one arc flash label shall be provided.
2. For each motor control center, one arc flash label shall be provided.
3. For each low voltage switchboard, one arc flash label shall be provided.
4. For each switchgear, one flash label shall be provided.
5. For low voltage VFD’s, one flash label shall be provided.

6. For disconnect switches, one flash label shall be provided.

F. Labels shall be field installed by the engineering service division of the equipment manufacturer under the Startup and Acceptance Testing contract portion.

G. Provide date when arc flash study was performed.

H. Example of Arc Flash Warning Label:

3.3 ARC FLASH TRAINING

A. The contractor of the Arc Flash Hazard Analysis shall train the owner's qualified electrical personnel of the potential arc flash hazards associated with working on energized equipment (minimum 4 hours). The training shall be certified for continuing education units (CEU's) by the International Association for Continuing Education Training (IACET) or equivalent.

END OF SECTION

SECTION 16442

PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

1.2 SUMMARY

A. This Section includes load centers and panel boards, overcurrent protective devices, and associated auxiliary equipment rated 600 V and less for the following types:

1. Lighting and appliance branch-circuit panel boards.
2. Distribution panel boards.
3. Transient voltage surge suppressor panel boards.

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.

B. GFCI: Ground-fault circuit interrupter (GFI).

C. RFI: Radio-frequency interference.

D. RMS: Root mean square.

E. SPDT: Single pole, double throw.

1.4 SUBMITTALS

A. Product Data: For each type of panel board, overcurrent protective device, TVSS device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.

1. Dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings. Include the following:
   a. Enclosure types and details for types other than NEMA 250, Type 1.
   b. Bus configuration, current, and voltage ratings.
   c. Short-circuit current rating of panelboards and overcurrent protective devices.
   d. UL listing for series rating of installed devices.

e. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

2. Wiring Diagrams: Diagram power, signal, and control wiring and differentiate between manufacturer-installed and field-installed wiring.

C. Field Tests Reports: Submit written test reports and include the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

D. Panelboard Schedules: For installation in panel boards. Submit final versions after load balancing.

E. Maintenance Data: For panel boards and components to include in maintenance manuals specified in Division 1. In addition to requirements specified in Division 1 Section **Closeout Procedures**, include the following:

1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
2. Time-current curves, including selectable ranges for each type of overcurrent protective device.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Testing agency that is a member company of the International Electrical Testing Association and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the International Electrical Testing Association or National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. 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.

C. Comply with NEMA PB 1.

D. Comply with NFPA 70.

1.6 COORDINATION

A. Coordinate layout and installation of panel boards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, and encumbrances to workspace clearance requirements.

1.7 EXTRA MATERIALS

A. Keys: Six (6) spares of each type of panel board cabinet lock.

PART 1 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, the following:

1. Panel boards, Overcurrent Protective Devices, Controllers, Contactors, and Accessories:
   a. Siemens
   b. Square D Co.
   c. Eaton
   d. General Electric

2.2 FABRICATION AND FEATURES

A. Enclosures: Flush- and surface-mounted cabinets as indicated on drawings. NEMA PB 1, Type 1, to meet environmental conditions at installed location.

1. Outdoor Locations: Type 4X, gasketed, stainless steel with white enamel finish.

B. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.

C. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.

D. Finish: Manufacturer's white enamel finish over stainless steel.

E. Directory Card: With transparent protective cover, mounted inside metal frame, inside panelboard door.

F. Bus: Hard-drawn copper, 98 percent conductivity. Aluminum is NOT acceptable.

G. Main and Neutral Lugs:

1. Compression type suitable for use with conductor material on MLO panels.
2. Mechanical type suitable for use with conductor material on MCB panels.

H. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment ground conductors; bonded to box.

I. Service Equipment Label: UL labeled for use as service equipment for panel boards with main service disconnect switches.

J. Future Devices: Mounting brackets, bus connections, and necessary appurtenances required for future installation of devices.

K. Feed-through Lugs: Compression type suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.

2.3 PANEL BOARD SHORT-CIRCUIT RATING

A. UL label indicating series-connected rating with integral or remote upstream devices. Include size and type of upstream device allowable, branch devices allowable, and UL series-connected short-circuit rating.

B. Fully rated to interrupt symmetrical short-circuit current available at terminals.

C. See panel schedules for minimum rating.

2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANEL BOARDS

A. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

B. Doors: Front mounted with concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.5 DISTRIBUTION PANEL BOARDS

A. Doors: Front mounted, except omit in fused-switch panelboards; secured with vault-type latch with tumbler lock; keyed alike. Square D I-Line or approved equal.

B. Main Overcurrent Protective Devices: Thermal magnetic circuit breaker.

C. Branch Overcurrent protective devices shall be one of the following:

1. For Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.
2. For Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

2.6 OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker: NEMA AB 1, with interrupting capacity to meet available fault currents. Breakers shall be fully rated for panel AIC rating.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2. GFCI Circuit Breakers: Single- and two-pole configurations with 30-mA trip sensitivity.

B. Molded-Case Circuit-Breaker Features and Accessories. Standard frame sizes, trip ratings, and number of poles.

1. Lugs: Compression style, suitable for number, size, trip ratings, and material of conductors.
2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.

3. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
4. Communication Capability: Circuit-breaker-mounted communication module with functions and features compatible with power monitoring and control system.
5. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.
6. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
7. Auxiliary Switch: Two SPDT switches with **a** and **b** contacts; **a** contacts mimic circuit-breaker contacts, **b** contacts operate in reverse of circuit-breaker contacts.
8. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
9. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.

C. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.

2.7 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

B. Portable Test Set: To test functions of solid-state trip devices without removal from panel board.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install panel boards and accessories according to NEMA PB 1.1. Provide 4-foot clearance in front of panel board. Coordinate with other equipment.

B. Mounting Heights: Top of trim 74 inches above finished floor, unless otherwise indicated. Mount with at least 6 inches of clearance below panel board.

C. Mounting: Plumb and rigid without distortion of box. Mount recessed panel boards with fronts uniformly flush with wall finish.

D. Circuit Directory: Create a directory to indicate installed circuit loads after balancing panel board loads. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable. Use manufacturers supplied card and permanent slot location.

E. Install filler plates in unused spaces.

F. Wiring in Panel board Gutters: Arrange conductors into groups and bundle and wrap with wire ties after completing load balancing.

3.2 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 16 Section “Electrical Identification.”

B. Panel board Nameplates: Label all panel boards with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws. Provide red nameplates for emergency or stand-by power branch fed panels. Nameplate shall include:

1. Normal Power
   a. Panel Name
   b. Voltage **277/480** or **120/208**
2. Generator Powered Panels
   a. Panel Name
   b. Voltage **277/480** or **120/208**
   c. Non-Hospital
      1) Non-emergency, “Stand-By Branch”

3.3 CONNECTIONS

A. Install equipment grounding connections for panel boards with ground continuity to main electrical ground bus.

B. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Test insulation resistance for each panel board bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

B. Testing: After installing panel boards and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

1. Procedures: Perform each visual and mechanical inspection and electrical test indicated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

C. Balance Loads: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes as follows:

1. Measure as directed during period of normal system loading.
2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data-processing, computing, transmitting, and receiving equipment.

3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
4. Tolerance: Difference exceeding 20 percent between phase loads, within a panel board, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.5 ADJUSTING

A. Provide factory technician to set field-adjustable switches and circuit-breaker trip ranges.

3.6 CLEANING

A. On completion of installation, inspect interior and exterior of panel boards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

END OF SECTION

SECTION 16444

MINI-POWER CENTERS

PART 1 - GENERAL

1.1 REFERENCES

A. The mini-power center and all components shall be designed, manufactured and tested in accordance with the latest applicable standards of ANSI and NEMA.

1.2 SUBMITTALS

A. The following information shall be submitted per Division 1:

1. Dimension drawing weights.
2. Technical certification sheet.
3. Transformer ratings including:
   a. kVA.
   b. Primary and secondary voltage.
   c. Taps.
   d. Primary and secondary continuous current.
   e. Insulation class and temperature rise.
   f. Sound level.
4. Component ratings including:
   a. Voltage.
   b. Continuous current.
   c. Interrupting ratings.
5. Cable terminal sizes.
6. Product data sheets.

B. Literature and drawings describing the equipment in sufficient detail, including parts list and materials of construction, to indicate full conformance with the Specifications.

C. Submit a letter certifying full and complete compliance with the Specifications, Drawings and other project requirements. The letter shall list any exceptions or deviations from specified requirements, if any and reasons for same. Exceptions or deviation shall also be clearly marked in a separate color in submittals.

1.3 OPERATION AND MAINTENANCE MANUAL

A. The following information shall be submitted per Division 1:

1. Final (as-built) drawings and information for items listed in Paragraph 1.04, and shall incorporate all changes made during the manufacturing process.
2. Connection diagrams.
3. Installation information.
4. Instruction leaflets.
5. Instruction Bulletins.

6. Complete assembly.

1.4 QUALIFICATIONS

A. The manufacturer of the assembly shall be the manufacturer of the secondary distribution equipment.

B. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years.

1.5 REGULATORY REQUIREMENTS

A. The assembly and all components shall be U.L. listed.

1.6 DELIVERY, STORAGE AND HANDLING

A. Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Eaton.

B. General Electric.

C. Siemens.

D. Square D/Schneider Electric.

2.2 RATINGS

A. kVA and voltage ratings shall be as shown on the drawings.

B. Units shall be designed for continuous operation at rated kVA, for 24 hours a day, 365 days a year operation, with normal life expectancy as defined in ANSI C57.96.

C. Transformer sound levels shall not exceed the following ANSI and NEMA levels for self-cooled ratings:

1. Up to 9 kVA 40 db
2. 10 to 30 kVA 45 db

2.3 CONSTRUCTION

A. Each mini-power center shall include a primary main breaker, an encapsulated dry-type transformer and a panelboard with secondary main breaker.

B. Primary main, secondary main and feeder breakers shall be enclosed with a pad lockable hinged door.

C. Mini-power centers shall be suitable for service entrance application.

D. Insulation Systems

1. Transformers shall be insulated with a 185 degrees C insulation system and rated at 115 degrees C temperature rise.
2. Required performance shall be obtained without exceeding the above-indicated temperature rise in a 40 degrees C maximum ambient, with a 30 degrees C average over 24 hours.
3. All insulation materials shall be flame-retardant and shall not support combustion as defined in ASTM Standard Test Method D635.

E. Core and Coil Assemblies

1. Transformer core shall be constructed with high-grade, nonaging, silicon steel with high magnetic permeability, and low hysteresis and eddy current losses. Maximum magnetic flux densities shall be substantially below the saturation point. The transformer core volume shall allow efficient transformer operation at 10% above the nominal tap voltage. The core laminations shall be tightly clamped and compressed. Coils shall be wound of electrical grade copper with continuous wound construction.
2. The core and coil assembly shall be completely encapsulated in a proportioned mixture of resin and aggregate to provide a moisture proof, shock-resistant seal. The core and coil encapsulation system shall minimize the sound level.
3. The core of the transformer shall be grounded to the enclosure.
4. Provide two (2) 5% FCBN taps.

2.4 BUS

A. Secondary bus shall be tin plated copper.

2.5 WIRING/TERMINATIONS

A. All interconnecting wiring between the primary breaker and transformer, secondary main breaker and transformer and distribution section shall be factory installed.

B. All transformers shall be equipped with a wiring compartment suitable for conduit entry and large enough to allow convenient wiring.

2.6 MAIN DEVICES

A. Each mini-power center shall include a primary main breaker with an interrupting rating of 22kA at 277/480 volts; and a secondary main breaker with an interrupting rating of 10kA at 120/208 volts, and a panelboard.

2.7 FEEDER DEVICES

A. The secondary distribution section shall be provided with the same size breakers as the removed mini-power center and shall be bolt-on breakers with 10 kA interrupting capacity.

2.8 ENCLOSURE

A. The enclosure shall be made of stainless steel and the maximum temperature of the enclosure shall not exceed 90 degrees C.

B. The enclosure shall be NEMA 3R, 316 Stainless Steel with a white enamel finish.

C. All the connection shall be bottom entrance to prevent water intrusion.

D. Connection shall be gasketed.

PART 3 - EXECUTION

3.1 FACTORY TESTING

A. The following standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of ANSI and NEMA.

1. Ratio tests at the rated voltage connection and at all tap connections.
2. Polarity and phase-relation tests on the rated voltage connection.
3. Applied potential tests.
4. Induced potential test.
5. No-load and excitation current at rated voltage on the rated voltage connection.

3.2 INSTALLATION

A. The Contractors shall install all equipment per the manufacturer’s recommendations and the contract drawings.

3.3 FIELD ADJUSTMENTS

A. Adjust taps to deliver appropriate secondary voltage.

3.04 FIELD TESTING

END OF SECTION

SECTION 16940

INSTRUMENTATION HEAT TRACE SYSTEM

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK:

A. Furnish and install thermostatically controlled heat trace system for freeze protection.

B. The system shall include controls, control cabinet, cable, insulation and jacket as indicated on the Contract Drawings and as specified hereinafter.

C. Furnish and install all weather-tight LB fittings, liquid-tight connectors, liquid-tight flexible metal conduit and wiring, etc, to provide power and controls for a complete operating system.

D. Items to be protected by heat trace include:

1. Instrument fluid housings and all associated piping, valves, fittings, etc. This includes pressure switches, pressure gauges, pressure transmitters, process piping associated with gauges/transmitters and process piping.

1.02 SUBMITTALS:

A. Heat Trace Cable.

B. Heat Trace Cable Insulation and Jacket.

C. Heat Trace Thermostat.

D. Heat Trace Panel Wiring.

PART 2 - PRODUCTS

2.01 HEAT TRACE CABLE:

A. Heat cable shall be U.L. listed, self-regulating, with additional footage at all valves, instruments, and pipe supports, as recommended by the manufacturer. Maximum circuit lengths shall be in accordance with the manufacturer's recommendations.

B. Manufacturer: Heat cable shall be Raychem "5BTV1", 6 watts/ft at 40°F for operation at 120 volts, or equal product as manufactured by Chromalox or Thermon.

2.02 HEAT TRACE CABLE INSULATION AND JACKET:

A. The insulation shall be preformed cellular glass insulation, 1" thick minimum, non-absorptive, impermeable to moisture and impervious to hydrochloric acid.

B. A weather-resistant, watertight, protective finish or jacket shall be applied over all insulation as recommended and manufactured by the insulation manufacturer.

C. Manufacturer: Heat trace insulation shall be Pittsburg Corning "Foamglas", Armstrong Armaflex II pipe insulation, or approved equal.

2.03 HEAT TRACE THERMOSTAT (HTT) AND CONTACTOR (HTC):

A. Heat trace circuits shall be switched through a thermostat, set at 40°F.

B. Manufacturer: Heat trace thermostat shall be Chromalox B100 or Thermon model B4X.

PART 3 - EXECUTION

3.01 HEAT TRACE CABLE:

A. Spiral the heat cable around the pipe, criss-cross around valves, and attach cable to pipe with GT-66 glass fiber adhesive tape or plastic tie wraps.

B. All power connections to heat trace cable shall be made in watertight j-boxes or with power connection kits recommended by the cable manufacturer. Tees, splices, terminations, and cable shall be of the same manufacturer.

3.02 HEAT TRACE CABLE INSULATION:

A. Install insulation over the entire length of piping protected with heat cable. Insulation shall be mitered and nested to cover all tees, fittings, supports, valves, etc. Fitting covers may be preformed or field fabricated. The inner bore and joint surfaced shall be coated to fill the surface cells, and all joints shall be sealed as recommended by the manufacturer and secured in place with ½" wide stainless steel bands.

END OF SECTION

SECTI0N 17300

INSTRUMENTATION - GENERAL PROVISIONS

PART 1 - GENERAL

1.01 SCOPE:

A. Furnish all labor, materials and equipment required to provide, install, test, and make fully operational, a Process Instrumentation and Control System as specified herein and as shown on the Drawings.

B. The work shall include designing, furnishing, installing, and testing the equipment and materials detailed in each Section of Division 17.

C. Equipment furnished as a part of other Divisions and shown on the Electrical Drawings shall be integrated into the overall Process Instrumentation and Control System under this Division. Instrumentation specified in other Divisions shall meet the Specification requirements of this Division.

D. The Contractor shall provide the services of a Process Control Systems Integrator (PCSI) who shall perform all work necessary to select, furnish, configure, customize, debug, install, connect, calibrate, and place into operation all instrumentation and control hardware specified within this Division, except for application software programming, which is specified in Section 17305, Application Services. The PCSI shall coordinate with the Owner, Engineer, and ASP (Application Services Provider, defined in paragraph 1.06 below) for all scheduling, installation, and startup services. The PCSI shall have qualifications as described herein

E. The PCSI shall coordinate and schedule all required testing with the General Contractor, Owner, Engineer and Applications Services Supplier (ASP).

F. The work shall include the following:

1. Design, furnish and install new SCADA (PLC) Panels as shown on the contract drawings.

2. Furnish, install, configure, and calibrate all instruments as shown in Specification 17310 FIELD INSTRUMENTS and Specification 17410 FIELD INSTRUMENT LIST.

3. Furnish, configure, calibrate, and install all instruments as listed in the Instrument List (Specification Section 17310) and shown on the Drawings.

4. Surge suppression devices shall be provided at control panels interfacing the instruments and at the instruments as shown on the Drawings and specified in Division 17 Instrumentation and Controls specification sections.

5. Furnish and install all communications network devices required per the Contract Drawings.

6. Coordinate with the ASP and equipment suppliers to deliver a complete and fully functional process control system.

7. Coordinate all PCSI work giving consideration to specified construction sequencing constraints.

8. Make connections, including field connections and interfacing between instrumentation, controllers, control devices, control panels and instrumentation furnished under other Divisions. The PCSI shall coordinate his construction schedule and instrumentation and control interface with the supplier of instrumentation and control equipment specified under other Divisions.

9. Make wiring terminations for all field-mounted instruments furnished and mounted under other Divisions, including process instrumentation primary elements, transmitters, local indicators, and control panels. Install vendor furnished cables specified under other
Divisions.

10. Auxiliary and accessory devices necessary for system operation or performance to interface with existing equipment or equipment provided by other suppliers under other Sections of these specifications, shall be included whether or not they are shown on the Drawings. These devices include but are not limited to, transducers, current isolators, signal conditioners or interposing relays.

11. Equipment shall be fabricated, assembled, installed, and placed in proper operating condition in full conformity with detail drawings, specifications, engineering data, instructions, and recommendations by the equipment manufacturer as approved by the Engineer.

12. Actual installation of the system need not be performed by the PCSI's employees; however, the PCSI shall provide the on-site technical supervision of the installation.

13. The PCSI shall furnish equipment which is the product of one manufacturer to the maximum practical extent. Where this is not practical, all equipment of a given type shall be the product of one manufacturer.

14. All materials, equipment, labor, and services necessary to achieve the monitoring and control functions described herein shall be provided in a timely manner so that the monitoring and control functions are available when the equipment is ready to be placed into service.

15. All bidders shall visit the site of the project, prior to submitting a bid, and satisfy themselves as to any question that they might have, relating to existing equipment, condition, or construction.

16. Each calibration certificate shall be signed and dated by an authorized representative of the CONTRACTOR. Three copies of each completed certificate shall be submitted to the ENGINEER.

17. Required calibration data are listed in Part 3 Testing.

1.02 RELATED SECTIONS:

A. Where references are made to the Related Work paragraph in each Specification Section, referring to other Sections and other Divisions of the Specifications, the Contractor shall provide such information or work as may be required in those references, and include such information or work as may be specified.

B. All Instrumentation work related to Process and Mechanical Divisions equipment that is shown on the Instrumentation Drawings shall be provided under Division 17.

C. All instrumentation work provided under any Division of the Specifications shall fully comply with the requirements of Division 17.

D. Related Sections:

1. Section 17302 Testing
2. Section 17305 Application Services
3. Section 17310 Field Instruments
4. Section 17325 Control Panels
5. Section 17327 Panel Mounted Equipment
6. Section 17400 Control Loop Descriptions
7. Section 17405 Input/Output List
8. Section 17410 Field Instrument List
9. Section 17500 Programmable Logic Controller (PLC)
10. Section 17515 Communications Interface Equipment

1.03 SUBMITTALS

A. Submit catalog data for all items supplied from this specification Section as applicable. Submittal shall include catalog data, functions, ratings, inputs, outputs, displays, etc. sufficient to confirm that the equipment provides every specified requirement. Any options or exceptions
shall be clearly indicated.

B. Submittals for equipment specified herein, for other Sections or Divisions, shall be made as a part of equipment submittals furnished under other Sections or Divisions.

C. General Requirements:

1. Refer to Section 01300 for general submittal requirements.
2. Other Division 17 Sections have additional submittal requirements. Refer to other

Division 17 Sections for details.

3. Shop drawings shall be submitted as detailed herein. Shop drawings shall demonstrate that the equipment and services to be furnished comply with the provisions of these Specifications and shall provide a complete record of the equipment as manufactured and delivered.

4. Submittals shall be complete, giving equipment specifications, details of connections, wiring, ranges, installation requirements, and specific dimensions. Submittals consisting of only general sales literature shall not be acceptable.

5. Submittals shall be bound in separate three-ring binders, with an index and sectional dividers, with all Drawings reduced to a maximum size of 11-inch by 17-inch, then folded to 8.5-inch by 11-inch for inclusion within the binder. Maximum binder size shall be 3 inches.

6. The submittal Drawings' title block shall include, as a minimum, the PCSI's registered business name and address, owner and project name, Drawing name, revision level, and personnel responsible for the content of the Drawing.

7. Each Section submittal shall be complete, contain all of the items listed in the Specification Section, and shall be clearly marked to indicate which items are applicable on each cut sheet page. All submittals shall list any exceptions to the Specifications and Drawings, and the reason for such deviation. Shop drawings, not so checked and noted, will be returned without review.

8. The Contractor shall check shop drawings for accuracy and compliance with the requirements of the Contract Documents prior to submittal to the Engineer. Errors and omissions on approved shop drawings shall not relieve the Contractor from the responsibility of providing materials and workmanship required by the Specifications and Drawings. Shop drawings shall be stamped with the date checked and a Statement indicating that the shop drawings conform to Specifications and Drawings. Only one Specification Section submittal will be allowed per transmittal unless it has been indicated that grouping is permitted in the individual sections.

9. Material shall not be ordered or shipped until the shop drawings have been approved. No material shall be ordered or shop work started if shop drawings are marked "EXCEPTIONS NOTED", "RESUBMIT (RETURNED FOR CORRECTION)" or "REJECTED".

10. Shop Drawings, O&M Manuals, and other documentation, shall be submitted as listed in each of the individual specification Sections.

    a. Submit operations and maintenance data for equipment furnished under this Division, in accordance with Division 1. The manuals shall be prepared specifically for this installation and shall include catalog data sheets, drawings, equipment lists, descriptions, parts lists and operating and maintenance instructions.
    b. Manuals shall include the following as a minimum:

        1) A comprehensive index

2) A complete "As-Built" set of approved shop drawings.
3) A complete list of the equipment supplied, including serial numbers, ranges and pertinent data.
4) A table listing of the “as left” settings for all timing relays and alarm and trip setpoints.
5) System schematic drawings "As-Built", illustrating all components, piping and electric connections of the systems supplied under this Division.
6) Detailed service, maintenance and operation instructions for each item supplied.
7) Special maintenance requirements particular to this system shall be clearly defined, along with special calibration and test procedures.
8) The operating instructions shall also incorporate a functional description of the entire system, with reference to the systems schematic drawings and instructions.
9) Complete parts list with stock numbers, including spare parts.

11. Record Drawings shall be promptly furnished when the equipment installation is complete.
Payment will be withheld until Record Drawings have been furnished and approved. The PCSI shall provide markups on all Process and Instrumentation Contract Drawings.
12. At the time of delivery of the equipment, the Contractor shall have an approved shop drawing in his possession for the Owner’s Inspector and Owner’s Engineer’s verifications.

D. Installation experience documentation shall be submitted for approval with the Section Equipment Submittal.

E. Operations and Maintenance Manuals:

1. Operations and Maintenance manuals shall be constructed in accordance with Division 1 and shall include the following information:

a. Manufacturer’s contact address and telephone number for parts and service.
b. Instruction books and/or leaflets
c. Recommended renewal parts list
d. Record documents for the information required by the Submittals section above.

1.04 REFERENCE CODES AND STANDARDS:

A. The equipment in this specification shall be designed and manufactured according to latest revision of the following standards (unless otherwise noted):

1. National Electrical Safety Code (NESC)

2. Occupational Safety and Health Administration (OSHA)

3. National Fire Protection Association (NFPA)

4. National Electrical Manufacturers Association (NEMA)

5. American National Standards Institute (ANSI)

6. Insulated Cable Engineers Association (ICEA)

7. International Society of Automation (ISA)

8. Underwriters Laboratories (UL)

9. UL 508, the Standard of Safety for Industrial Control Equipment

10. UL 508A, the Standard of Safety for Industrial Control Panels

11. UL 50, the Standard of Safety for Enclosures for Electrical Equipment

12. NFPA 79, Electrical Standard for Industrial Machinery

13. Factory Mutual (FM)

14. City of San Antonio, Texas Electrical Code

15. All equipment and installations shall satisfy applicable Federal, State, and local codes.

16. All meters, relays and associated equipment shall comply with the requirements of the National Electric Code and Underwriters Laboratories (UL) where applicable.

17. Each specified device shall also conform to the standards and codes listed in the individual device paragraphs.

B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

C. All material and equipment, for which a UL standard exists, shall bear a UL label. No such material or equipment shall be brought onsite without the UL label affixed.

D. If the issue of priority is due to a conflict or discrepancy between the provisions of the Contract Documents and any referenced standard, or code of any technical society, organization or association, the provisions of the Contract Documents shall take precedence if they are more stringent or presumptively cause a higher level of performance. If there is any conflict or discrepancy between standard specifications, or codes of any technical society, organization, or association, or between Laws and Regulations, the higher performance requirement shall be binding on the Contractor, unless otherwise directed by the Owner/Engineer.

E. In accordance with the intent of the Contract Documents, the Contractor accepts the fact that compliance with the priority order specified shall not justify an increase in

Contract Price or an extension in Contract Time nor limit in any way, the Contractor's responsibility to comply with all Laws and Regulations at all times.

F. All control panels shall be constructed and the labeling shall be affixed in a UL 508 facility.

1.05 PROCESS CONTROL SYSTEMS INTEGRATOR (PCSI):

A. The Contractor shall provide the services of a Process Control Systems Integrator (PCSI) for work under this Division and other Divisions, as described in this Division and other Divisions.

B. Where shown on the Bid Documents, the Contractor shall name the proposed PCSI. Qualifications:

1. The PCSI shall be a "systems house," regularly engaged in the design and installation of control and instrumentation systems and their associated subsystems as they apply to the municipal water or wastewater industry. For the purposes of this and other applicable Divisions, a "systems house" shall be interpreted to mean an organization that complies with all of the following criteria.

2. Employs a registered professional Control Systems Engineer or Electrical Engineer in the state of Texas to supervise or perform the work required by this Specification Section.

3. Employs personnel on this project who have successfully completed a manufacturer's training course on the hardware configuration and implementation of the specific programmable controllers, computers, and software proposed for this project.

4. Has been in the water/wastewater industry performing the type of work specified in this specification section for a minimum of five (5) continuous years.

5. The PCSI shall maintain a fully equipped office/production facility with full-time employees capable of fabricating, configuring, installing, calibrating, troubleshooting, and testing the system specified herein. Qualified repair personnel shall be available and capable of reaching the facility within 24 hours.

C. Recommended PCSIs:

1. Prime Controls
   815 Office Park Circle
   Lewisville, Texas 75057
   Attention: Gary McNeil
   Telephone: 972.221.4849

2. Richardson Logic Control
   8115 Hicks Hollow
   McKinney, Texas 75071
   Attention: Michel Cunningham
   Telephone: 972.542.7375

3. Wunderlich – Malec
   2855 Trinity Square Drive, Suite 100
   Carrollton, Texas 75006
   Attention: Adrian Beaty
   Telephone: 469.574.2500

4. Control Panels USA
   16310 Bratton Lane, Suite 100
   Austin, Texas 78728
   Attn: Martin Salyer
   Phone: 512.863.3224

5. Johnson Controls, Inc.
   12915 Wetmore Rd
   San Antonio, Texas 78247
   Attn: Evan Gerald
   Phone: 210.524.7099

E. The listing of specific PCSI organizations above does not imply acceptance of their products and capabilities that do not meet the specified ratings, features and functions. PCSI's listed above are not relieved from meeting these specifications in their entirety.

1.06 APPLICATION SERVICES PROVIDER (ASP):

A. Owner shall act as ASP and provide programming for PLC, radio, and top-end graphics for the project. Owner will require 30 days to complete programming requirements for the project and shall be notified as soon as possible upon completion of SCADA panel installation.

1.07 QUALITY ASSURANCE:

A. The manufacturer of this equipment shall have produced similar instrumentation equipment for a minimum period of five (5) years. When requested by the OWNER/ENGINEER, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

B. The equipment as submitted shall be located as shown on the project plans and shall fit within this location. Equipment with does not fit in the space as shown on the project plans is not acceptable.

C. For the equipment specified herein, the manufacturer shall be ISO 9001 2000 certified.

1.08 ENCLOSURE TYPES FOR AREA CLASSIFICATIONS:

A. Unless otherwise specified herein or shown on the Drawings, enclosures and associated installations shall have the following ratings:

1. Provide NEMA 4X 316 Stainless Steel enclosures for outdoor, wet locations or specifically shown on the Drawings.

2. NEMA 1 or 1A enclosures will not be permitted, unless specifically stated on the Drawings.

3. All enclosures shall be lockable and provided with a padlock location.

1.09 CODES, INSPECTION AND FEES:

A. Equipment, materials and installation shall comply with the requirements of the local authority having jurisdiction.

B. Obtain all necessary permits and pay all fees required for permits and inspections.

1.10 RECORD DRAWINGS:

A. As the work progresses, legibly record all field changes on a set of Project Contract Drawings, hereinafter called the "Record Drawings". The Record Drawings and Specifications shall be kept up to date throughout the project.

B. Record Drawings shall accurately show the installed condition of the following items:

1. One-line Diagram(s)

2. Raceways and pull boxes

3. Conductor sizes

4. Panel Schedule(s)

5. Control Wiring Diagram(s) including all wire tags

6. Process Instrumentation Diagram(s)

7. Mounting Details

C. Submit a typical example of a schedule of control wiring raceways and wire numbers, including the following information:

1. Circuit origin, destination and wire numbers.

2. Field wiring terminal strip names and numbers with field connection wire color.

D. As an alternate, submit a typical example of point-to-point connection diagrams showing the same information, may be submitted in place of the schedule of control wiring raceways and wire numbers.

E. Submit the record drawings and the schedule of control wiring raceways and wire numbers (or the point-to-point connection diagram) to the Owner/Engineer.

F. The Contractor’s retainage shall not be paid until the point-to-point connection diagrams have been furnished to and approved by the Owner/Engineer.

1.11 EQUIPMENT INTERCONNECTIONS:

A. Review shop drawings of equipment furnished under other related Divisions and prepare coordinated wiring interconnection diagrams or wiring tables. Submit copies of wiring diagrams or tables with Record Drawings.

B. Furnish and install all equipment interconnections.

1.12 MATERIALS AND EQUIPMENT:

A. Materials and equipment shall be new, except where specifically identified on the Drawings to be re-used.

B. The Contractor shall not bring onsite, material or equipment from a manufacturer, not submitted and approved for this project. Use of any such material or equipment, will be rejected, removed and replaced by the Contractor, with the approved material and equipment, at his own expense.

C. Material and equipment shall be UL listed, where such listing exists.

D. The Contractor shall be responsible for all material, product, equipment and workmanship being furnished by him for the duration of the project. He shall replace the equipment if it does not meet the requirements of the Contract Documents.

1.13 DELIVERY, STORAGE AND HANDLING:

A. Equipment shall be handled and stored in accordance with manufacturer's instructions. Two (2) copies of these instructions shall be included with the equipment at time of shipment, and shall be made available to the Contractor and Owner.

B. Shipping groups shall be designed to be shipped by truck, rail, or ship. Indoor groups shall be bolted to skids. Accessories shall be packaged and shipped separately.

C. Equipment shall be equipped to be handled by crane. Where cranes are not available, equipment shall be suitable for skidding in place on rollers using jacks to raise and lower the groups.

D. Equipment shall be installed in its permanent, finished location shown on the Drawings within seven (7) calendar days of arriving onsite. If the equipment cannot be installed within seven (7) calendar days, the equipment shall not be delivered to the site, but stored offsite, at the Contractor’s expense, until such time that the site is ready for permanent installation of the equipment.

E. Where space heaters are provided in equipment, provide temporary electrical power and operate space heaters during jobsite storage, and after equipment is installed in permanent location, until equipment is placed in service.

1.14 EQUIPMENT IDENTIFICATION:

A. Identify equipment furnished under Division 17 with the name of the equipment it serves. Control panels, Instruments, meters junction or terminal boxes, etc, shall have nameplate designations as shown on the Drawings.

B. Nameplates shall be engraved, laminated impact acrylic, black lettering on a white background, matte finish, not less than 1/16-in thick by 3/4-in by 2-1/2-in, Rowmark 322402. Nameplates shall be 316 SS screw mounted to all enclosures except for NEMA 4 and 4X. Nameplates for NEMA 4 and 4X enclosures shall be attached with double faced adhesive strips, TESA TUFF TAPE 4970, .009 X ½”. Prior to installing the

nameplates, the metal surface shall be thoroughly cleaned, with a 70% alcohol solution, until the metal surface residue has been removed. Epoxy adhesive or foam tape is not acceptable.

1.15 WARRANTY:

A. The Manufacturer shall warrant the equipment to be free from defects in material and workmanship for two (2) years from the date of acceptance of the equipment containing the items specified in this Section. Within such period of warranty the Manufacturer shall promptly furnish all material and labor necessary to return the equipment to new operating condition. Any warranty work requiring shipping or transporting of the equipment shall be performed by the CONTRACTOR at no expense to the OWNER.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 – EXECUTION

3.01 PCSI COORDINATION MEETINGS:

A. The PCSI shall schedule and administer a minimum of three (3) mandatory Coordination Meetings during the submittal phase of the project. The PCSI shall make arrangements for the meetings and prepare and send a proposed agenda to all participants at least one (1) week before scheduled meetings. The PCSI shall be responsible for promptly preparing and distributing meeting minutes to all attendees.

B. The PCSI shall prepare meeting minutes and distribute them to all attendees and others affected by any decisions made at the meetings. The meeting minutes shall be distributed within one (1) week following the meeting.

C. The meetings shall be held at the General Contractor's field office at the project site and shall include, at a minimum, attendance by the Owner, Engineer, General Contractor's project engineer, PCSI project engineer, ASP's project engineer, and the electrical subcontractor.

1. The First Coordination Meeting shall be held in advance of the first Shop Drawing submittal. The purpose of the first meeting shall be for the PCSI to:

    a. Summarize their understanding of the project
    b. Discuss any proposed deviations, substitutions or alternatives
    c. Present the PCSI project schedule
    d. Schedule testing and delivery milestone dates
    e. Provide a forum for the PCSI to coordinate hardware and software related issues
    f. Request any additional information required from the Owner and/or Engineer.
    g. The PCSI shall bring a draft version of shop drawings to the meeting to provide the basis for the Owner/Engineer's input into their development.

2. The Second Coordination Meeting shall be held after the Field Instruments and Control Panel submittals have been reviewed and returned to the PCSI. The purpose

of the second meeting shall be for the PCSI to:

a. Discuss comments made during submittal process
b. Refine schedule milestone dates
c. Coordinate installation activities
d. Discuss any remaining coordination requirements.

3. The Third Coordination Meeting shall be held no more than one month prior to site testing for each location. The purpose of the third meeting shall be to discuss any remaining coordination needs and requirements.

4. A typical agenda may include, but shall not be limited to, the following:

a. Review minutes of previous meetings
b. Review of work progress
c. Field observations, problems, and decisions
d. Identification of problems which may impede planned progress
e. Review of submittal schedule and submittal status
f. Review of offsite fabrications and delivery schedules
g. Maintenance of progress schedule
h. Corrective measures to regain projected schedules
i. Planned activities for subsequent work period
j. Coordination of projected progress
k. Maintenance of quality and work standards
l. Effect of proposed changes on progress schedule and coordination
m. Other business relating to work

3.02 INTERPRETATION OF DRAWINGS:

A. Raceways and conductors for switches and other miscellaneous low voltage power and signal systems as specified are not shown on the Drawings. Raceways and conductors shall be provided as required for a complete and operating system. Refer to riser diagrams for signal system wiring.

B. The Contractor shall run all conduit and wire to PLC Termination Cabinets, where designated on the Drawings. The conduit and wire, as shown on the interface drawings, may not necessarily be shown on the floor plan.

C. Install conductors carrying low voltage signals (typically twisted shielded pair cables) in raceways totally separate from all other raceways containing power or 120 volt control conductors, Refer to NEC article 725. DC and AC control wiring shall be installed in separate raceways.

D. Raceways and conductors for the fire alarm, sound and page party systems are not shown on the Drawings. Provide raceways and conductors as required by the system manufacturer for a complete and operating system. All raceways and power conductors shall be in accordance with Division 16. Raceways shall be installed concealed in all finished spaces and may be installed exposed or concealed in process spaces.

E. Redesign of electrical or mechanical work, which is required due to the Contractor's use of a pre-approved alternate instrumentation or control item, or arrangement of equipment and/or layout other than specified herein, shall be done by the Contractor at

his/her own expense. Redesign and detailed plans shall be submitted to the Owner/Engineer for approval. No additional compensation will be provided for changes in the work, either his/her own or others, caused by such redesign.

3.03 INSTRUMENTATION EQUIPMENT PADS AND SUPPORTS:

A. Equipment pads and supports, of concrete or steel including structural reinforcing and foundations, are shown on the Structural Drawings.

3.04 SLEEVES AND FORMS FOR OPENINGS:

A. Provide and place all sleeves for conduits penetrating floors, walls, partitions, etc. Locate all necessary slots for Electrical and Instrumentation work and form before concrete is poured.

B. Obtain shop drawings and templates from equipment vendors or other subcontractors and locate the concealed conduit before the floor slab is poured.

C. Where setting drawings are not available in time to avoid delay in scheduled floor slab pours, the Owner/Engineer may allow the installations of such conduit to be exposed. Requests for this deviation must be submitted in writing. No additional compensation for such change will be allowed.

D. Seal all openings, sleeves, penetration and slots as specified in Section 16110.

3.05 CUTTING AND PATCHING:

A. Cutting and patching shall be done in a thoroughly workmanlike manner. Saw cut all concrete and masonry prior to breaking out sections.

B. Core drill holes in concrete floors and walls as required. Contractor shall obtain written permission from the Owner/Engineer before core drilling any holes larger than 2 inches.

C. Install work at such time as to require the minimum amount of cutting and patching.

D. Do not cut joists, beams, girders, columns or any other structural members.

E. Cut opening only large enough to allow easy installation of the conduit.

F. Patching to be of the same kind and quality of material as was removed

G. The completed patching work shall restore the surface to its original appearance or better.

H. Patching of waterproofed surfaces shall render the area of the patching completely waterproofed.

I. Remove rubble and excess patching materials from the premises.

J. When existing conduits are cut at the floor line or wall line, they shall be filled with

grout of suitable patching material.

3.06 INSTALLATION:

A. Any work not installed according to the Drawings and this Section shall be subject to change as directed by the Owner/Engineer. No extra compensation will be allowed for making these changes.

B. All dimensions shall be field verified at the job site and coordinated with the work of all other trades.

C. Equipment shall be protected at all times against mechanical injury or damage by water. Equipment shall not be stored outdoors. Equipment shall be stored in dry permanent shelters as required by each Specification Section. Do not install equipment in its permanent location until structures are weather-tight. If any apparatus has been subject to possible injury by water, Equipment shall be thoroughly dried out and tested as directed by the Owner/Engineer, or shall be replaced at no additional cost at the Owner/Engineer's discretion.

D. Equipment that has been damaged shall be replaced or repaired by the equipment manufacturer, at the Owner/Engineer's discretion.

E. Repaint any damage to the factory applied paint finish using touch-up paint furnished by the equipment manufacturer. If the metallic portion of the panel or section is damaged, the entire panel or section shall be replaced, at no additional cost to the Owner.

F. Contractor shall coordinate with SAWS inspector to begin programming of PLC, Radio and top-end graphics as soon as the SCADA Panel has been installed on the lift station equipment rack.

3.07 MANUFACTURER’S SERVICE:

A. Provide manufacturer's services for testing and start-up of the equipment as listed in each individual Specification Section.

B. Testing and startup shall not be combined with training. Testing and start-up time shall not be used for manufacturer’s warranty repairs.

C. Check interlocking, control and instrument wiring for each system and/or part of a system to prove that the system will function properly as indicated by schematics, wiring diagrams and Control Descriptions.

D. Testing shall be scheduled and coordinated with the Owner/Engineer at least two weeks in advance. Provide qualified test personnel, instruments and test equipment.

E. Refer to the individual Instrumentation Equipment Sections for additional specific testing requirements.

F. Make adjustments to the systems and instruct the Owner's personnel in the proper operation of the systems.

3.08 TESTING:

A. Test systems and equipment furnished under Division 17 and repair or replace all

defective work. Make adjustments to the systems and instruct the Owner's personnel in the proper operation of the systems.

B. Make the tests and checks prior to energizing instrumentation equipment in accordance with Section 17302, and the individual Specification sections.

C. Testing shall be scheduled and coordinated with the Owner/Engineer at least two weeks in advance. Provide qualified test personnel, instruments and test equipment, including manufacturer's services, as specified in the individual Specification sections.

D. Where test reports show unsatisfactory results, the Owner/Engineer will require the removal of all defective or suspected materials, equipment and/or apparatus, and their replacement with new items, all at no cost to the Owner. The Contractor shall bear all cost for any retesting.

3.09 TRAINING:

A. The Contractor shall provide manufacturer's training as specified in each individual section of the Specifications.

END OF SECTION

SECTION 17302

PROCESS INSTRUMENTATION AND CONTROL SYSTEM TESTING

PART 1 - GENERAL

1.01 SCOPE:

A. The PCSI shall provide, in coordination with the ASP as required, all labor and materials necessary to coordinate and perform the testing of the Process Instrumentation and Control System as specified herein.

B. The Process Control Systems Integrator (PCSI) shall supervise and/or perform the requirements of this Section. As part of these services, the PCSI shall include, for those equipment items not manufactured by him, the services of an authorized manufacturer's representative to check the equipment installation and place that portion of the equipment in operation. The manufacturer's representative shall be thoroughly knowledgeable about the installation, operation, and maintenance of the manufacturer’s equipment.

C. The Contractor shall provide all test equipment necessary to perform the testing as specified herein.

D. All Process Instrumentation and Control System hardware and software shall be thoroughly tested to verify proper operation as an integrated system.

E. Any defects or problems found during the testing activities shall be corrected by the Contractor and then retested to demonstrate proper operation.

F. Check and confirm the proper installation of all instrumentation and control components and all cable and wiring connections between the various system components prior to placing the various processes and equipment into operation.

G. Conduct a complete system checkout and adjustment, tuning of control loops, checking operation functions, and testing of final control actions. All problems encountered shall be promptly corrected to prevent any delays in startup of the various unit processes.

H. The PCSI shall be responsible for initial operation of the Process Instrumentation and Control System and shall make any required changes, adjustment or replacements for operation, monitoring, and control of the various processes and equipment necessary to perform the functions intended.

I. All spare parts must be on site and accepted prior to commencement of field testing.

J. The Contractor shall provide the following documentation for use during the testing activities.

1. Complete panel schematic and internal point-to-point wiring interconnect drawings.

2. Complete electrical control schematics in accordance with JIC standards.

3. Complete panel layout drawings.

4. Complete field wiring diagrams.

5. Complete instrument loop diagrams.

6. Completed Calibration/Recalibration Certificates for all field and panel devices that require adjustment or calibration.

K. Contractor shall provide one set of the above listed documentation for the Owner's personnel, one set for the Engineer's use, one set for field use, and the required number of sets for the Contractor's use.

L. The drawings corrected and modified during testing shall form the basis for the "As-Built" record drawing requirement.

M. Contractor shall furnish to Engineer two copies of an installation inspection report certifying that all equipment has been installed correctly and is operating properly. The report shall be signed by authorized representatives of both Contractor and the system supplier.

1.02 TESTS – GENERAL:

A. The PCSI shall test all equipment prior to shipment to the project site. Unless otherwise specified in the individual specification sections, all equipment provided by the PCSI shall be tested as a single fully integrated system as far as possible.

B. At a minimum, the testing shall include the following:

1. Factory Testing

a. Un-witnessed Factory Test (UFT)

1) The Un-witnessed Factory Test shall be performed by the PCSI at his facility.

2. Field Testing

a. Operational Readiness Test (ORT)

1) The Operational Readiness Test shall be a joint test performed by the PCSI and ASP, with coordination as required, with the electrical subcontractor and other subcontractors or equipment suppliers if needed.

b. Functional Demonstration Tests (FDT)

1) The Functional Demonstration Tests shall be performed by the PCSI in coordination with the ASP as necessary to demonstrate the system operating in compliance with the requirements of the Contract Documents. The FDT(s) shall be conducted by the PCSI and witnessed by the Owner's representative(s) and the Engineer.

c. 30-Day Site Acceptance Tests (SAT)

1) The SAT shall be a 30-day field test of the fully operating system as detailed below in this Section.

C. Each test shall be in the cause and effect format. The person conducting the test shall initiate an

input (cause) and, upon the system's or subsystem's producing the correct result (effect), the specific test requirement shall be satisfied.

D. All tests shall be conducted in accordance with prior Engineer-approved procedures, forms, and check lists. Each specific test shall be described and followed by a section for sign off by the appropriate party after its satisfactory completion.

E. Copies of these sign off test procedures, forms, and check lists will constitute the required test documentation.

F. Provide all special testing materials and equipment. Wherever possible, perform tests using actual process variables, equipment, and data. Where it is not practical to test with real process variables, equipment, and data, provides suitable means of simulation. Define these simulation techniques in the test procedures.

G. The General Contractor shall require the Integration Subcontractor to coordinate all testing with the Engineer, all affected Subcontractors, and the Owner.

H. The Engineer reserves the right to test or retest all specified functions whether or not explicitly stated in the prior approved Test Procedures.

I. The Engineer's decision shall be final regarding the acceptability and completeness of all testing.

J. No equipment shall be shipped to the Project Site until the Engineer has received all test results and approved the system as ready for shipment.

K. The PCSI shall furnish the services of servicemen, all special calibration and test equipment and labor to perform the field tests.

L. Contractor shall be responsible for verifying and adjusting contact logic, adjusting the antenna direction and simulating all alarms for the site.

L. Correction of Deficiencies:

1. All deficiencies in workmanship and/or items not meeting specified testing requirements shall be corrected to meet specification requirements at no additional cost to the Owner.

2. Testing, as specified herein, shall be repeated after correction of deficiencies is made until the specified requirements are met. This work shall be performed at no additional cost to the Owner.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.01 UN-WITNESSED FACTORY TESTS (UFT):

A. The entire system, except primary elements, final control elements, and field mounted transmitters, shall be interconnected and tested to ensure the system operates as specified. All analog and discrete input/output points not interconnected at this time shall be simulated to ensure

proper operation of all alarms, monitoring devices/functions, and control devices/functions.

B. All panels and assemblies shall be inspected and tested to verify that they are in conformance with related submittals, specifications, and Contract Drawings.

C. During the tests all digital system hardware and software shall have operated continuously for five (5) days without a failure to verify the system is capable of continuous operation. The Un-Witnessed Factory Test results shall be submitted to the Engineer for approval prior to the scheduling of the Operational Readiness Test (ORT).

3.02 OPERATIONAL READINESS TESTS (ORT):

A. Prior to startup and the Functional Demonstration Test, the entire system shall be certified (inspected, tested, and documented) that it is ready for operation.

B. Loop/Component Inspections and Tests: The entire system shall be checked for proper installation, calibrated, and adjusted on a loop-by-loop and component-by-component basis to ensure that it is in conformance with related submittals and these Specifications.

1. The Loop/Component Inspections and Tests shall be implemented using Engineer approved forms and check lists.

a. Each loop shall have a Loop Status Report to organize and track its inspection, adjustment, and calibration. These reports shall include the following information and check off items with space for sign off by the PCSI.

1) Project Name
2) Loop Number
3) Tag Number for each component
4) Check offs/sign offs for each component

b. Tag/identification
c. Installation
d. Termination – wiring
e. Calibration/adjustment – Check offs/sign offs for the loop
f. Panel interface terminations
g. I/O interface terminations
h. I/O signal operation
i. Inputs/outputs operational: received/sent, processed, and adjusted
j. Total loop operation – Provide space for comments
k. Each active Analog Subsystem element and each I/O module shall have a ComponentCalibration Sheet. These sheets shall have the following information, spaces for data entry, and a space for sign off by the PCSI:

1) Project Name
2) Loop Number
3) Component Tag Number of I/O Module Number
4) Component Code Number Analog System
5) Manufacturer (for Analog system element)
6) Model Number/Serial Number (for Analog system)
7) Summary of Functional Requirements:

a) Indicators: Scale
b) Transmitters/Converters: Scale
c) Computing Elements: Function
d) Controllers: Action (direct/reverse) control Modes (PID)
e) Switching Elements: Unit range, differential (FIXED/ADJUSTABLE), Preset (AUTO/MANUAL)
f) I/O Modules: Input or output

2. Calibrations:

a. Analog Devices: Required and actual inputs and outputs at 0, 25, 50, 75, and 100 percent of span, rising and falling.
b. Discrete Devices: Required and actual trip points and reset points
c. Controllers: Mode settings (PID)
d. I/O Modules: Required and actual inputs or outputs for 0, 25, 50, 75, and 100 percent of span, rising and falling.

1) Provide space for comments
2) Space for sign off by the PCSI

3. The General Contractor shall require the PCSI to maintain the Loop Status Reports and Component Calibration Sheets at the job-site and make them available to the Engineer/Owner at any time.

4. These inspections and tests do not require witnessing. However, the Engineer shall review and initial all Loop Status Sheets and Component Calibration Sheets and spot-check their entries periodically and upon completion of the Operational Readiness Test. Any deficiencies found shall be corrected.

3.03 FUNCTIONAL DEMONSTRATION TEST (FDT):

A. Prior to startup and the 30-Day Test, the entire installed instrument and control system shall be certified that it is ready for operation. All preliminary testing, inspection, and calibration shall be complete as defined in the Operational Readiness Tests and be 100% ready for testing prior to SAWS personnel arrival at project site. The FDT will be a joint test by the PCSI and the Equipment suppliers.

B. Once the facility has been started up and is operating, a witnessed Functional Demonstration Test shall be performed on the complete system to demonstrate that it is operating and in compliance with these Specifications. Each specified function shall be demonstrated on a paragraph-by-paragraph and loop-by-loop basis.

C. Loop-specific and non-loop-specific tests shall be the same as specified under Functional Demonstration Tests except that the entire installed system shall be tested and all functionality demonstrated.

D. Updated versions of the documentation specified to be provided for during the tests shall be made available to the Engineer at the job-site both before and during the tests. In addition, one (1) copy of all O&M Manuals shall be made available to the Engineer at the job-site both before and during testing.

E. The daily schedule specified to be followed during the tests shall also be followed during the Functional Demonstration Test.

F. The system shall operate for 100 continuous hours without failure before this test shall be considered successful.

G. Demonstrate communication failure and recovery.

3.04 30-DAY SITE ACCEPTANCE TEST (SAT):

A. After completion of the Operational Readiness and Functional Demonstration Tests, the PCSI shall be responsible for operation of the entire system for a period of 30 consecutive days, under conditions of full pump station process operation, without a single non-field repairable malfunction.

B. During this test, station operating and PCSI personnel shall be present as required. For this test, the PCSI is expected to provide personnel who have an intimate knowledge of the system hardware and software.

C. While this test is proceeding, the Owner shall have full use of the system. Only station operating personnel shall be allowed to operate equipment associated with live station processes.

D. Any malfunction during the tests shall be analyzed and corrected by the PCSI. The Engineer and/or Owner will determine whether any such malfunctions are sufficiently serious to warrant a repeat of this test.

E. During this 30 consecutive day test period, any malfunction which cannot be corrected within 24 hours of occurrence by PCSI personnel, or more than two similar failures of any duration, will be considered a non-field-repairable malfunction.

F. Upon completion of repairs by the PCSI, the test shall be repeated as specified herein.

G. In the event of rejection of any part or function, the PCSI shall perform repairs or replacement within 90 days.

H. The total availability of the system shall be greater than 99.5 percent (99.5%) during this test period. Availability shall be defined as:

1. Availability = (Total Testing Time-Down Time) / Total Testing Time

I. Down times due to power outages or other factors outside the normal protection devices or back-up power supplies provided shall not contribute to the availability test times above.

J. Upon successful completion of the 30-day site acceptance test and subsequent review and approval of complete system final documentation, the system shall be considered substantially complete, and the two year warranty period shall commence.

END OF SECTION

SECTION 17310

FIELD INSTRUMENTS

PART 1 - GENERAL

1.01 SCOPE:

A. The CONTRACTOR shall furnish, install and test all field instruments, process control devices and appurtenances, as shown on the project plans, specified in the Related Sections and Divisions as specified herein.

B. Field instruments specified in other Divisions shall be manufactured in accordance with this Section and submitted as part of the equipment specified in the other Divisions.

C. The CONTRACTOR shall furnish to the ENGINEER certified calibration/recalibration (for existing Instruments) reports for field instruments and devices specified herein immediately upon completion of calibration:

1. Receipt of any calibration/recalibration certificate shall in no way imply acceptance of any work or instrument.

2. Each calibration/recalibration certificate shall be signed and dated by an authorized representative of the CONTRACTOR. Three copies of each completed certificate shall be submitted to the ENGINEER.

3. Required calibration data are listed in Part 3 Testing.

1.02 RELATED SECTIONS:

A. Division 16

B. Process Equipment Divisions

C. Mechanical Equipment Divisions

D. Section 17300 Instrumentation General Provisions

E. Section 17302 Testing

F. Section 17305 Application Services

G. Section 17327 Panel Mounted Equipment

H. Section 17400 Control Loop Descriptions

I. Section 17405 Input/Output List

J. Section 17410 Field Instrument List

K. Section 17500 Programmable Logic Controller (PLC)

L. Section 17515 Communications Interface Equipment

1.03 SUBMITTALS:

A. Submit catalog data for all items supplied from this specification Section as applicable. Submittal shall include catalog data, functions, ratings, inputs, outputs, displays, etc. sufficient to confirm that the equipment provides every specified requirement. Any options or exceptions shall be clearly indicated.

B. Submittals for equipment specified herein, for other Sections or Divisions, shall be made as a part of equipment submittals furnished under other Sections or Divisions.

C. Installation experience documentation shall be submitted for approval with the Section Equipment Submittal.

D. Operations and Maintenance Manuals:

1. Operations and Maintenance manuals shall be constructed in accordance with Division 1 and shall include the following information:

a. Manufacturer's contact address and telephone number for parts and service.

b. Instruction books and/or leaflets

c. Recommended renewal parts list

d. Record documents for the information required by the Submittals section above.

1.04 REFERENCE CODES AND STANDARDS:

A. The equipment in this specification shall be designed and manufactured according to latest revision of the following standards (unless otherwise noted):

1. All meters, relays and associated equipment shall comply with the requirements of the National Electric Code and Underwriters Laboratories (UL) where applicable.

2. Each specified device shall also conform to the standards and codes listed in the individual device paragraphs.

1.05 QUALITY ASSURANCE:

A. The manufacturer of this equipment shall have produced similar instrumentation equipment for a minimum period of five (5) years. When requested by the OWNER/ENGINEER, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

B. The equipment as submitted shall be located as shown on the project plans and shall fit within this location. Equipment with does not fit in the space as shown on the project plans is not acceptable.

C. For the equipment specified herein, the manufacturer shall be ISO 9001 2000 certified.

1.06 WARRANTY:

A. The Manufacturer shall warrant the equipment to be free from defects in material and workmanship for two (2) years from the date of acceptance of the equipment containing the items specified in this Section. Within such period of warranty the Manufacturer shall promptly furnish all material and labor necessary to return the equipment to new operating condition. Any warranty work requiring shipping or transporting of the equipment shall be performed by the CONTRACTOR at no expense to the OWNER.

PART 2 - PRODUCTS

2.01 GENERAL:

A. All devices shall be Factory Mutual (FM) approved:

1. Explosion Proof for Class I division 1 group B, C, and D.

2. Dust-Ignition Proof for Class II and Class III, division 1, group E, F and G.

3. Factory Sealed.

B. Hardware:

1. All hardware used for outdoor instrument mounting shall be Stainless Steel.

C. Instrument Stand:

1. Aluminum C6X3.25 channel with aluminum ¼" x 6" x 8" floor plate, if required.

D. Process Pipe:

1. All tubing and fitting shall be made of 316 Stainless Steel.

2.04 PRESSURE TRANSMITTER (PRESSURE IN PSI):

A. Electronic Gage Pressure Transmitter:

1. Local and remote indication.

2. Provide with Ray self-cleaning pressure snubbers.

3. Input isolated with silicone filled stainless steel diaphragms.

4. Local indication LCD meter scaled in PSI and mounted integral to the transmitter. Transmitter operation ranges should operate at bottom 25% of full-scale range of transmitter.

5. Outdoor application:

a. NEMA 4 housing

b. View port for local indication

c. Stainless steel flanges

d. C channel mounting

6. Stainless Steel certification tag for Factory Mutual (FM) Explosion Proof rating.

7. Provide with glycerin-filled diaphragm seal.

B. Ratings:

1. Overpressure Limit without damage: 1500 psi

2. Input Range: 150 psi

3. Accuracy: +/- 0.075% of span

4. Analog Output: 4 – 20 mA

5. Power Supply: 24 Vdc

6. Operating Temperature Limits: -4° to 175°F

C. Manufacturer: Rosemount, Model: 2088, Model Number 2088G2S22A1B4E5M5.

2.05 SUBMERSIBLE LEVEL TRANSDUCER:

A. Electronic Level Transmitter.

1. 316 Stainless Steel construction

2. 316 Stainless Steel diaphram

3. Intrinsically safe for Class I, Div. 1, Groups A, B, C, D; Class II, Div. 1, Groups E, F, G.

4. Polyether Polyurethane or ETFE cable.

5. Seals to be fluoroelastomer

6. 0-20 psi.

B. Ratings:

1. Minimum accuracy required: +/- 25%, Full Scale.

2. Power supply: 10-28 VDC

3. Output: 4-20ma.

4. Pressure Limit: 2X Full Scale.

3. Compensated Temperature Range: 0° – 176°F

C. Manufacturers and Models:

1. Dwyer Mercoid Model PBLTX

2. Or Equivalent.

2.06 LEVEL CONTROLLER:

A. Electronic Level Controller.

1. Power Supply: 100-230VAC, 36VA

2. Range: 1-50ft.

3. Input: 4-20ma.

4. Output: 4-20ma, 6 relays – 4 Form A, 2 Form C

5. Temperature Compensation: -50-150C

6. Ambient conditions: -20-50C.

7. Accuracy .25% full scale.

8. Resolution: .1% of range.

9. Maximum distance between transducer and controller: 1200 ft.

B. Manufacturers and Models:

1. Siemens HydroRanger 200; no equal.

2.07 FLOAT SWITCHES:

A. Electronic Level Transmitter.

1. Mercury free.

2. Polymer construction.

3. Intrinsically safe for Class I, Div. 1, Groups A, B, C, D;
Class II, Div. 1, Groups E, F, G.

4. Polyether Polyurethane or ETFE cable. Cable length shall be confirmed prior to procurement to ensure adequate length.

5. Form C contacts – NC-Common-NO.

B. Ratings:

1. Minimum differential 3.5".

2. Power

C. Manufacturers and Models:

1. Anchor Scientific Eco-Float Type SE

2. Or Equivalent.

PART 3 - EXECUTION

3.01 INSTALLER'S QUALIFICATIONS:

A. Installer shall be specialized in installing this type of equipment with minimum 5 years documented experience.

3.02 EXAMINATION:

A. Examine installation area to assure there is sufficient clearance to install the equipment.

B. Verify that the equipment is ready to install.

C. Verify field measurements are as instructed by the manufacturer.

3.03 INSTALLATION:

A. PRESSURE TRANSMITTERS AND PRESSURE SWITCHES:

1. Shall be installed with heat trace freeze protection around the fluid housing of the instrument and all piping, valves, and fittings.

2. Installation of the process line:

a. A ½" bore through the process line shall be done along the upper half of the radius of that line.

b. A ½" NPT weld a-let shall be installed over the bore

c. A ½" NPT block (root) valve shall be installed after the weld a-let for the isolation of the process from the pressure device.

d. A ½" NPT to ¼" NPT bushing will be installed on the isolation valve to bush down to allow for the installation of ¼" static or process lines from the process to the pressure measuring device.

e. A 4" expansion loop shall be made after a 1' straight run off the root valve.

f. A ¼" tubing isolation valve shall be installed and a calibration port shall be installed at the device for bleeding off pressure and calibrations can be performed.

3.04 HEAT TRACE SYSTEM:

A. Reference Section, 16940, INSTRUMENTATION HEAT TRACE SYSTEM.

3.05 CONDUIT AND IDENTIFICATION:

A. When the use of flexible conduit is required a minimum of 18" shall be provided but the flexible conduit shall not exceed 36".

B. All Instrumentation runs shall be the full length of the conduit no splices will be allowed.

C. The following nomenclature shall be used for identification:

1. tag # (0-10) for instrumentation info: tags, devices type and termination point

2. jb# (0-10) for junction box, power panel lighting panel and termination point

3. r# (0-10) for rack location and termination point

4. s# (0-10) for slot location and termination point

5. p# (0-10) for point location and termination point

D. Install stainless steel instrument labels with instrument ID, secured with safety wire.

3.06 RACEWAY SEALING:

A. Where raceways enter terminal boxes, junction boxes, or instrumentation equipment, all entrances shall be sealed with 3M 1000NS Watertight Sealant.

3.07 FIELD QUALITY CONTROL:

A. Inspect installed equipment for anchoring, alignment, grounding and physical damage.

B. Check tightness of all accessible electrical connections. Minimum acceptable values shall be specified in the manufacturer's instructions.

3.08 FIELD ADJUSTING:

A. Adjust all equipment for proper range and field conditions, as described in the manufacturer's instructions.

B. Any field adjustments, required for proper system operation, shall be included in the Final O&M Manuals.

3.09 TESTING:

A. Perform all electrical field tests recommended by the manufacturer.

B. Full testing (loop check) shall be done on all instrumentation and all SCADA I/O points and will be witnessed by the OWNER.

C. A calibration sheet shall be supplied for all the instruments and at the time of any instrument test.

1. Analog device calibration sheet shall include the following:

a. Time of calibration

b. Date of calibration

c. Name of the person performing the calibration

d. Name of the witness, OWNER

e. Test equipment used and their calibration dates

f. Device identification S/N, device name and tag number

g. As found voltage reading

h. As left voltage reading

i. As found milliamp reading @ 0%, 25%, 50%, 75% and 100%

j. As left milliamp reading @ 0%, 25%, 50%, 75% and 100%

k. Calibration ranges

l. I/O points

2. I/O point data sheet for each I/O analog and discrete through SCADA:

a. Field point location

b. Analog or Discrete

c. Software point location

d. Point function

e. Time of verification

f. Date of verification

g. Name of the person verifying the point

h. Name of the witness, OWNER

3.10 CLEANING:

A. Remove all rubbish and debris from inside and around the equipment. Remove dirt, dust, or concrete spatter from the interior and exterior of the equipment using brushes, vacuum cleaner,

or clean, lint free rags. Do not use compressed air.

3.11 EQUIPMENT PROTECTION AND RESTORATION:

A. Touch up and restore damaged surfaces to factory finish, as approved by the manufacturer. If the damaged surface cannot be returned to factory specification, the surface shall be replaced.

3.12 MANUFACTURER'S CERTIFICATION:

A. A qualified factory-trained and certified representative shall certify in writing that the equipment has been installed, adjusted, including all settings as defined in the Contract Documents.

END OF SECTION

SECTION 17325

CONTROL PANELS

PART 1 - GENERAL

A.01 SCOPE OF WORK:

A. Design, furnish and install fully functional Lift Station Pump Control Panel to manually or automatically operate the lift station pumps as specified in the detailed requirements of this Section, and logic and schematics as shown on the Electrical and Instrumentation Drawings.

B. Control panels as specified in Electrical Equipment Division or Mechanical Equipment Divisions, except as specifically stated herein shall not be submitted under this Section.

C. Provide the following Pump Control Panel as depicted in the Drawings and as specified herein.

1.02 RELATED WORK:

A. Division 16

B. Section 17300 Instrumentation General Provisions

C. Section 17302 Testing

D. Section 17305 Application Services

E. Section 17310 Field Instruments

F. Section 17327 Panel Mounted Equipment

G. Section 17400 Control Loop Descriptions

H. Section 17405 Input/Output List

I. Section 17410 Field Instrument List

J. Section 17500 Programmable Logic Controller (PLC)

1.03 SUBMITTALS:

A. Submittal Process:

1. Submittals shall be made in accordance with the requirements of Section 01300, Section 17300 and as specified herein.

2. Submittals require information on related equipment to be furnished under this Specification, and described in the related Sections listed in the Related Work paragraph above. Incomplete submittals not containing the required information on the related equipment will be returned un-reviewed.

B. Submittal Content:

1. The original equipment manufacturer shall create all equipment shop drawings, including

all wiring diagrams, in the manufacturer's Engineering department. All equipment shop drawings shall bear the original equipment manufacturer logo, drawing file numbers, and shall be maintained on file in the original equipment manufacturers archive file system. Photocopies of the Engineer's ladder schematics are unacceptable as shop drawings.

C. Required Submittals:

1. Copies of previously Approved Related Work submittals

2. Documentation confirming that the Panel Assembly Facility is a UL-508 certified panel shop

3. Facsimile of the UL label that is to be applied to the completed panels

4. Shop Drawings:

a. Shop Drawings shall include the following:

1) Drawings shall be to scale and shall show the location of panel mounted devices, including doors, louvers, and sub panels
2) Equipment outline drawings showing elevation, plan and interior views, front panel arrangement, dimensions, weight, shipping splits, conduit entrances and anchor bolt pattern. Indicate all options, special features, ratings and deviations from this Section's requirements.
3) The first sheet of each Panel Drawing Packet shall contain a Bill of Materials for that panel. The Bill of Materials shall list all devices mounted within the panel, and shall include the tag number, description, manufacturer, and model number of each item.
4) Following the Bill of Material shall be a listing, uniquely identifying each component of the Panel, and a description of the item used, i.e. devices by their assigned tag numbers, nameplate inscriptions, service legend, and annunciator inscriptions.
5) Power and control schematics including external connections. Show wire and terminal numbers and color-coding.

b. Interconnecting Wiring Diagrams:

1) Provide interconnecting wiring diagrams showing electrical connections between equipment, consoles, panels, terminal junction boxes, and field mounted components.
2) Diagrams shall show component and panel terminal board identification numbers, and external wire and cable numbers.
3) Circuit names corresponding to the Circuit and Raceway Schedule shall be shown. The diagram shall include intermediate terminations between field elements and panels (e.g., terminal junction boxes, pull boxes, etc.).

5. Factory Tests:

a. Submittals shall be made for factory tests as specified herein. Owner/Engineer approval of required factory tests is required prior to shipment of the equipment.

6. Field Tests:

a. Submittals shall be made for field tests as specified herein

7. Operation and Maintenance Manuals:

a. Operation and maintenance manuals shall include the following information:

1) Manufacturer's contact address and telephone number for parts and service
2) Instruction books and/or leaflets
3) Recommended renewal parts list
4) Record Documents for the information required by the Submittals paragraph above

D. Operation and Maintenance Manuals:

1. Operation and maintenance manuals shall include the following information:

a. Manufacturer's contact address and telephone number for parts and service
b. Instruction books and/or leaflets
c. Recommended renewal parts list
d. Record Documents for the information required by the Submittals paragraph above

1.04 REFERENCE CODES AND STANDARDS:

A. Instrumentation equipment, materials and installation shall comply with the National Electrical Code (NEC and with the latest edition of the following codes and standards:

1. National Electrical Safety Code (NESC)

2. Occupational Safety and Health Administration (OSHA)

3. NEMA ICS 1-101 Diagrams, Designations and Symbols

4. ANSI/ISA-5.06.01-2007 - Functional Requirements Documentation for Control Software Applications

5. ISA-TR20.00.01-2001 - Specification Forms for Process Measurement and Control Instruments Part 1: General Considerations Updated with 27 New Specification Forms in 2004-2005

6. ISA-5.4-1991 Instrument Loop Diagrams

7. ISA-5.5-1985 Graphic Symbols for Process Displays

8. ISA-5.1-1984 (R1992) Instrumentation Symbols and Identification

9. ISA-5.3-1983 Graphic Symbols for Distributed Control/Shared Display Instrumentation, Logic, and Computer Systems

10. ISA-20-1981 Specification Forms for Process Measurement and Control Instruments, Primary Elements, and Control Valves

11. ISA-5.2-1976 (R1992) Binary Logic Diagrams for Process Operations
12. NEMA ICS 6 Enclosures for Industrial Controls and Systems
13. National Fire Protection Association (NFPA)
14. National Electrical Manufacturers Association (NEMA)
15. American National Standards Institute (ANSI)
16. Insulated Cable Engineers Association (ICEA)
17. International Society of Automation (ISA)
18. Underwriters Laboratories (UL)
19. UL 508, the Standard of Safety for Industrial Control Equipment
20. UL 508A, the Standard of Safety for Industrial Control Panels
21. UL 50, the Standard of Safety for Enclosures for Electrical Equipment
22. NFPA 79, Electrical Standard for Industrial Machinery
23. Factory Mutual (FM)
24. NFPA 70 National Electrical Code (NEC)
25. NFPA 70E Standard for Electrical Safety in the Workplace
26. ANSI C37.90.2 Standard Withstand Capability of Relay Systems to Radiated Electromagnetic Interference From Transceivers
27. NEMA ICS 4 Terminal Blocks for Industrial Use
28. NEMA LS1 Low Voltage Surge Protection Devices
29. UL 1283 Standard for Safety-Electromagnetic Interference Filters
30. UL 1449 Third Edition Surge Protective Devices
31. City of San Antonio, Texas Electrical Code
32. All equipment and installations shall conform to applicable Federal, State, and local codes

1.05 QUALITY ASSURANCE:

A. The manufacturer of this equipment shall have produced similar equipment for a minimum period of five (5) years. When requested by the Owner/Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement

B. The control panels shall be assembled in a UL-certified panel shop, experienced in the

assembled of control panels for wastewater and water treatment systems. A submittal of the documentation, that certifies the panel fabrication shop is a UL-certified shop, is required

C. Equipment components and devices shall be UL labeled wherever UL standards exist for such equipment. The completed control panel shall be UL Labeled in accordance with UL 508 and 508A and other applicable UL standards. The panel shall also be UL labeled for the environment in which it is to be placed. A UL label shall be affixed to the inside of the external door by the panel fabrication assembly. Submit a facsimile of the UL label in the submittal information

D. Equipment submitted shall fit within the space shown on the Drawings. Equipment which does not fit within the space is not acceptable

1.06 DELIVERY STORAGE AND HANDLING:

A. Equipment shall be handled and stored in accordance with manufacturer's instructions. Two (2) copies of these instructions shall be included with the equipment at time of shipment, and shall be made available to the Contractor and Owner/Engineer.

B. Shipping groups shall be designed to be shipped by truck, rail, or ship. Accessories shall be packaged and shipped separately.

C. Within (5) five days after shipment of all equipment, Manufacturer shall ship all software, supplied under this Section of the Specifications, by Registered Mail or Approved Courier, to the Owner’s Representative, with a copy of the Shipment Manifest

D. Visibly damaged panels shall be returned to the Manufacturer’s UL 508 facility, for examination and damaged equipment replaced at no expense to the Owner.

E. Equipment shall be installed in its permanent finished location shown on the Drawings within seven (7) calendar days of arriving onsite. If the equipment cannot be installed within seven (7) calendar days, the equipment shall not be delivered to the site, but stored offsite, at the Contractor’s expense, until such time that the site is ready for permanent installation of the equipment.

F. Where space heaters are provided in equipment, provide temporary electrical power and operate space heaters during storage, and after equipment is installed in permanent location, until equipment is placed in service.

1.07 WARRANTY:

A. The Manufacturer shall warrant the equipment to be free from defects in material and workmanship for two (2) years from date of final acceptance of the equipment. Within such period of warranty the Manufacturer shall promptly furnish all material and labor necessary to return the equipment to new operating condition. Any warranty work requiring shipping or transporting of the equipment shall be performed by the Manufacturer, at no expense to the Owner.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Subject to compliance with the Contract Documents, the following enclosure Manufacturers are acceptable:

1. Hoffman Enclosures

2. Rittal Enclosures

B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

2.02 RATINGS

A. Enclosure Ratings for Area Classifications:

1. Unless otherwise specified herein or shown on the Drawings, enclosures and associated installations shall have the following ratings:

2. Provide white enamel painted, NEMA 4X 316 Stainless Steel enclosures for outdoor, wet locations. In addition NEMA 4X Aluminum enclosures will be allowed on an individual basis, but only where specifically designated herein or specifically shown on the Drawings.

B. The complete control panel assembly shall be UL certified or carry a UL listing for "Industrial Control Panels".

C. The control panel shall meet all applicable requirements of the National Electrical Code.

D. For additional ratings and construction notes, refer to the Drawings.

E. The service voltage shall be as specified and as shown on the Drawings. The overall short circuit withstand and interrupting rating of the equipment and devices shall be equal to or greater than the overall short circuit withstand and interrupting rating of the feeder device immediately upstream of the Control Panel, but not less than 10,000 amperes at 120 volts single phase.

F. The Manufacturer shall produce and install on each panel, an Arc Flash Warning Label listing the various Flash Hazard Protection Boundaries, calculated from NFPA 70E, Annexes, as listed below:

1. Flash Hazard Protection Boundary

2. Limited Approach Boundary

3. Restricted Boundary

4. Restricted Boundary

5. Incident Energy Level

6. Required Personal Protective Equipment Class

7. Type of Fire Rated Clothing

G. Provide an Arc Flash Warning Label, printed in color and affixed to the front of each panel

provided.

1. Shown below is a typical label. Size of each label shall be not less than 8 inches wide and 6 inches tall.

2.03 CONSTRUCTION:

A. General:

1. Refer to the Drawings for: schematics, actual layout and location of equipment and components; current ratings of devices, bus bars, components; protective relays, voltage ratings of devices, components and assemblies; and other required details.

B. Enclosures:

1. Free Standing:

a. Enclosures shall be of factory white enamel painted 316 stainless steel, rear and side panels, with lifting eyes, without knockouts or holes. Enclosures shall have fully sized rear and side panels. Panels shall have factory cutouts where required for environmental ducts. Enclosures shall not be less than 12 gauge metal. All enclosures shall have continuous hinged doors with handle latch, 3-point. All enclosures shall have bonding provisions on door. Enclosures shall be NEMA 12 rated if located in doors. Outdoor areas require a NEMA 4X 316 Stainless Steel rating.

3. Each enclosure less than 4 ft. wide shall be shall have one overhead interior LED light fixture, with Off/On switch, powered from a dedicated non UPS circuit. Each enclosure greater than 4 ft. wide shall have one overhead florescent light for every 4 ft. of length, or every fraction thereof.

4. Each enclosure shall have one, UPS powered, 150 watt receptacle.

5. Each enclosure shall have, factory installed, full sized removable back and side panels, on which control components shall be mounted. Back panel shall be secured to the enclosure with collar studs for wall mounted enclosures, and 316 SS hardware for free standing enclosures.

6. The enclosure outer door shall have a rear mounted pocket in the lower portion, which shall containing laminated copies of the panel schematics and wiring.

7. Electrical tables shall be laminated and adhered to the inside of the door.

8. All enclosures shall be lockable, and keyed alike.

9. All operating control devices, indicators, and instruments shall be securely mounted on the swing panel door. All controls and indicators shall be 30mm, clearly labeled to indicate function and shall be NEMA 12 rated. Auxiliary contacts shall be provided for remote run indication and indication of each status and alarm condition. Additional controls shall be provided as specified herein and as required by the detailed mechanical and electrical equipment requirements.

a. All indicating lamps shall be LED push-to test type. Equipment shall have Run indicating lamps. Lens color shall be red for RUN and amber for FAIL or ALARM. For all control applications, indicator lamps shall incorporate a push-to-test feature.
b. Mode selector switches (HAND-OFF-AUTO, etc) shall be as shown on the Drawings. Units shall have the number of positions and contact arrangements, as required. Each switch shall have an extra dry contact for remote monitoring as shown on the contract drawings.
c. Push-buttons shall be momentary or maintained contacts as required by the Drawings. Contact arrangement shall be as required.

C. Environmental Controls:

1. Enclosure Condensate Heaters:

a. A self-contained enclosure condensation heater with thermostat and fan shall be mounted inside the control panel, if panel is mounted outdoors or in a non-air-conditioned spaced.

1) Enclosure heaters shall be energized from 120 volt, single-phase power supply and sized to prevent condensation within the enclosure.
2) Locate enclosure heaters to avoid overheating electronic hardware or producing large temperature fluctuations on the hardware.
3) Enclosure heaters shall have an internal fan for heat distribution and shall be controlled with adjustable thermostats. The thermostat shall have an adjustment range of 40 degrees Fahrenheit to 90 degrees Fahrenheit. Provide a circuit breaker or fused disconnect switch within the enclosure.
4) Enclosure heaters shall be Hoffman type DAH.

b. Strip heaters may be provided if they are 240 volt rated, powered at 120 volts AC and do not have a surface temperature higher than 60°C. Strip heaters and thermostats shall be as manufactured by Chromalox.

1) Strip heaters shall be Chromalox, Type OT, 1.5-in wide, 240 Volts, single phase, 150 watts, energized at 120 volts, with rust resisting iron sheath, Catalog No. OT-715, Product Code No. 129314. Provide sufficient wattage in heaters to prevent condensation should the interior temperature of the enclosure drop below the dew point.
2) A control thermostat mounted inside the control Panel shall be Chromalox, Type WR, single stage, Catalog No. WR-80, Product Code No.263177.
3) The strip heater terminals shall be guarded by a protective terminal cover.
4) High temperature connecting lead wire shall be used between the thermostat and the heater terminals. Wire shall be No. 12 AWG stranded nickel-plated copper with Teflon glass insulation and shall be the product of Chromalox, Catalog No. 6-CFI-12, and Product Code No. 263783.

2. NEMA 4X Enclosure Air Conditioner:

a. NEMA 4X enclosures containing electronic devices or electrical equipment shall have air conditioners that will maintain the internal temperature at or below 85F at an ambient temperature of 105F without violating the NEMA 4X rating of the enclosure.
b. The panel builder shall provide panel internal heat rise calculations to show that the

panel internal temperatures will be maintained below 85F at an ambient temperature of 105F.

1) For enclosures mounted indoors in non-air-conditioned spaces, include an ambient air temperature of 40 degree C and a humidity of 100% non-condensing
2) For enclosures mounted in direct sunlight add the appropriate solar heat gain component to the calculation, and raise the ambient temperature to 60 degrees C.
3) The calculation shall show all the internal and external heat gain loads, the expected internal temperature rise in degrees C above the specified ambient without the air conditioner. Provide a calculation showing the expected temperature rise in degrees C above the specified ambient with the air conditioner running.

c. The air conditioner shall have the following features:

1) Use CFC-free R134a refrigerant
2) Have fully gasketed flanges on all four mounting edges for a watertight seal that maintains NEMA 4X rating of the panel.
3) Thermostatic low temperature control to provide energy efficient operation and prevents over-cooling.
4) EMI/RFI suppressor to minimize transient spikes during compressor on/off cycling.
5) Separated blower-driven evaporator and condenser air systems for closed loop cooling.
6) UL listed
7) Stainless steel enclosure
8) Internal corrosion resistant coating and/or galvanized steel components.
9) Low ambient kit
10) Short cycle protector
11) Provide an air conditioner manufactured by McLean.

2.04 PANEL EQUIPMENT:

A. Equipment Requirements:

1. The requirements for equipment, controls, meters, converters, etc, for the Pump Control Panel, shall be as shown on the Drawings, panel schematics, and the functions specified in the Loop Descriptions.

2. All other equipment, controls, meters, converters that are designed as a part of the control panel, shall be as specified in Section 17327 Panel Mounted Equipment, Related Work Sections specified herein, as shown on the Drawings, panel schematics, and the functions specified in the Loop Descriptions.

3. Provide a main circuit protective device, DIN rail mounted, to protect the panel equipment.
4. Provide and install a 316 stainless steel-folding shelf and located on the control panel internal swing panel door. Folding shelf shall be catalog number ACSHELF1818SS as manufactured by Hoffman Enclosures.
5. Terminal blocks shall be single stack only. Cooper Bussman DP series or equivalent.
6. Wiring troughs shall be manufactured by Panduit or equivalent.

2.05 EQUIPMENT INSTALLATION:

A. Equipment Mounting:

1. The location of the installed equipment shall be as shown on the Panel Layouts on the Drawings.

2. Each piece of equipment shall be securely mounted to the backplate or side plate in accordance with the manufacturer's installation instructions. All mounting hardware shall be from the front of the backplate or side plate with threaded screws. Attaching hardware shall not be installed from the rear of the backplate or side plate. Removal of any piece of equipment shall not require the removal or loosening of any other piece of equipment.

3. Operator interface equipment installed on the door shall be arranged as shown on the Drawings in accordance with the manufacturer's installation instructions. No penetrations of the door shall be made except for equipment mounting. Provide adequate clearance between pieces of equipment and door latching mechanisms.

B. Nameplates:

1. Furnish nameplates for each device as indicated in Drawings. Nameplates shall be engraved, laminated impact acrylic, matte finish, black lettering on a white background, not less than 1/16-in thick by 1/2-in by 1-1/2-in, Rowmark 322402. Nameplates shall be attached to the backplate with double faced adhesive strips, TESA TUFF TAPE 4970, .009 X ½". Prior to installing the nameplates, the metal surface shall be thoroughly cleaned with 70% alcohol until all residues has been removed. Epoxy adhesive or foam tape is not acceptable.

C. Wiring Trough and Terminal Block Installation:

1. Space between wiring troughs and equipment shall be such that space for terminal blocks is provided for termination of each conductor or group of conductors before connection to the equipment. Removal of equipment for service shall not leave any exposed conductors hanging unconnected.

2. Install the wiring troughs such that one may be removed without interference from the other. Troughs shall be installed such that trough covers may be removed without cover interference.

3. Install terminal blocks on DIN rail with adequate space for access to the terminal with clear view of the wire identification label. All incoming or outgoing wiring shall enter or leave the panel on terminal blocks. Terminal blocks or wiring troughs shall not be installed on the doors. Provide terminal blocks on side plates/backplate for all door mounted equipment.

4. In no case shall internal and external wiring share a wiring trough.

5. Provide 600 volt rated terminal blocks for any conductor carrying any voltage over 120 volts to ground.

6. Provide 600 volt rated strap screw terminal blocks for any power conductors carrying over 20 amps, at any voltage. Terminals shall be double sided and supplied with removable covers to prevent accidental contact with live circuits.

7. Power conductors carrying over 20 amps, at any voltage shall be terminated to strap-screw type terminal blocks with crimp type, pre-insulated, ring-tongue lugs. Lugs shall be of the appropriate size for the terminal block screws and for the number and size of the wires terminated. Do not terminate more than one conductor in any lug, and do not land more than two conductors under any strap-screw terminal point.

8. Terminals shall have permanent, legible identification, clearly visible with the protective cover removed. Each terminal block shall have 20 percent spare terminals, but not less than two spare terminals.

9. Do not land more than two conductors per terminal point. Use the manufacturer's provided bridge connectors to interconnect terminal blocks terminating common or ground conductors.

10. Twisted shielded pair or triad cables shall have each individual conductor and shield drain wire landed on individual terminal blocks. Use the manufacturer's provided bridge connectors to interconnect terminal blocks terminating the shield drain wire conductors.

11. Provide an AC ground bar bonded to the panel enclosure, if metal, with 20 percent spare terminals.

12. Provided ground terminal blocks for each twisted-shielded pair drain wire.

D. Internal Panel Wiring:

1. Power and control wiring shall be tinned stranded copper, minimum size No. 14 AWG, with 600 volt, 90 degree C, flame retardant, Type MTW thermoplastic insulation. Line side power wiring shall be sized for the full fault current rating or frame size of the connected device, and as shown on the Drawings.

2. Analog signal wires shall be 600 Volt Class, insulated stranded tinned copper, twisted shielded #16 AWG pair.

3. All interconnecting wires between panel mounted equipment and external equipment shall be terminated at numbered terminal blocks. Field wiring shall not be terminated directly on any panel-mounted device.

4. All wiring shall be tagged and coded with an identification number as shown on the Drawings. Coding shall be typed on a heat shrinkable tube applied to each end showing origination and destination of each wire. The marking shall be permanent, non-smearing, solvent-resistant type similar to Raychem TMS-SCE.

5. All wiring shall be enclosed in PVC wire trough with slotted side openings and removable cover. Plan wire routing such that no low twisted shielded pair cable conducting analog 4-20 mA signals or low voltage analog signals are routed in the same wire trough as conductors carrying discrete signals or power.

6. All control panel wiring shall use the following color code:

   a. Black: AC power at line voltage
   b. Red: switched AC power
   c. Orange: May be energized while the main disconnect is in the off position

d. White: AC neutral
e. Orange/white stripe or white/orange stripe: separate derived neutral
f. Red/white stripe or white/red stripe: switched neutral
g. Green or green w/ yellow tracer: ground/earth ground
h. Blue: Ungrounded DC power
i. Blue/white stripe or white/blue stripe: DC grounded common
j. Purple: 480V AC 3 phase - phase A
k. Yellow: 480V AC 3 phase - phase B
l. Brown: 480V AC 3 Phase - phase C

E. Field Entrance Internal Wiring:

1. Field entrance internal wiring shall be neatly grouped by circuit and bound by plastic tie wraps. Circuit groups shall be supported so that circuit terminations are not stressed. In addition, low signal wiring (millivolt and milliamp) shall be bundle separately from the rest of the control wiring.

2. All field wiring shall be tagged and coded with an identification number. Coding shall be typed on a heat shrinkable tube applied to each end of the wire. The marking shall be a permanent, non-smearing, solvent-resistant type similar to Raychem TMS-SCE.

3. All conduit entering or leaving equipment shall be coordinated, in advance with the panel installer, so that the conduit entrances to the enclosure are directly below the termination area for immediate termination. Conduits shall not enter the top or side of the panel unless approved in writing by the Owner/Engineer.

2.06 FACTORY TESTING:

A. The entire control panel shall be completely assembled, wired, and adjusted at the factory and shall be given the manufacturer's routine shop tests and any other additional operational test to insure the workability and reliable operation of the equipment.

B. Factory test equipment and test methods shall conform to the latest applicable requirements of ANSI, IEEE, UL, and NEMA standards.

C. The operational test shall include the proper connection of supply and control voltage and, as far as practical, a mockup of simulated control signals and control devices shall be fed into the boards to check for proper operation.

D. Factory test equipment and test methods shall conform to the latest applicable requirements of ANSI, IEEE, UL, and NEMA standards, and shall be subject to the Owner/Engineer's approval.

PART 3 - EXECUTION

3.01 INSTALLER'S QUALIFICATIONS:

A. Installer shall be specialized in installing this type of equipment with minimum 5 years documented experience. Experience documentation shall be submitted for approval prior to beginning work on this project.

3.02 EXAMINATION:

A. Examine installation area to assure there is enough clearance to install the equipment. Housekeeping pads shall be included for the floor mounted panels as detailed on the Drawings.

B. Check concrete pads and base plates for uniformity and level surface.

C. Verify that the equipment is ready to install.

D. Verify field measurements are as instructed by manufacturer.

3.03 INSTALLATION:

A. The Contractor shall install all equipment per the manufacturer's recommendations and Contract Drawings.

B. Conduit hubs for use on raceway system pull and junction boxes shall be watertight, threaded aluminum, insulated throat, stainless steel grounding screw, as manufactured by T&B H150GRA Series.

C. Conduits entering a control Panel or box containing electrical equipment shall not enter the enclosure through the top.

D. Install required safety labels.

3.04 RACEWAY SEALING:

A. Where raceways enter junction boxes or control panels containing electrical or instrumentation equipment, all entrances shall be sealed with 3M 1000NS Watertight Sealant.

B. This requirement shall be strictly adhered to for all raceways in the conduit system.

3.05 FIELD QUALITY CONTROL:

A. Inspect installed equipment for anchoring, alignment, grounding and physical damage.

B. Check tightness of all accessible electrical connections. Minimum acceptable values are specified in manufacturer's instructions.

3.06 FIELD ADJUSTING:

A. Adjust all circuit breakers, switches, access doors, operating handles for free mechanical and electrical operation as described in manufacturer's instructions.

B. The breaker protective devices shall be set in the field by a qualified representative of the manufacturer, retained by the Contractor, in accordance with settings designated in a coordinated study of the system as required in Section 16411 Power System Study.

3.07 FIELD TESTING:

A. Perform all electrical field tests recommended by the manufacturer. Disconnect all connections to solid-state equipment prior to testing.

B. Test all control logic before energizing the equipment.

3.08 CLEANING:

A. Remove all rubbish and debris from inside and around the panel. Remove dirt, dust, or concrete spatter from the interior and exterior of the equipment using brushes, vacuum cleaner, or clean, lint free rags. Do not use compressed air.

3.09 EQUIPMENT PROTECTION AND RESTORATION:

A. Touch-up and restore damaged surfaces to factory finish, as approved by the manufacturer. If the damaged surface cannot be returned to factory specification, the surface shall be replaced.

3.10 MANUFACTURER'S CERTIFICATION:

A. A qualified factory-trained manufacturer's representative shall certify in writing that the equipment has been installed, adjusted, including all settings designated in the Power System Study, and tested in accordance with the manufacturer's recommendations.

B. The Contractor shall provide three (3) copies of the manufacturer's representative's certification.

3.11 TRAINING:

A. Provide manufacturer's services for training of plant personnel in operation and maintenance of the equipment provided under this Section.

B. The training for each type of equipment shall be for a period of not less than one (1) eight hour day.

C. The cost of training program to be conducted with Owner's personnel shall be included in the Contract Price. The training and instruction, insofar as practicable, shall be directly related to the system being supplied.

D. Provide detailed O&M manuals to supplement the training course. The manuals shall include specific details of equipment supplied and operations specific to the project.

E. The training session shall be conducted by a manufacturer's qualified representative. Training program shall include instructions on the assembly, motor starters, protective devices, metering, and other major components.

F. The Owner reserves the right to videotape the training sessions for the Owner's use.

END OF SECTION

SECTION 17327

PANEL MOUNTED EQUIPMENT

PART 1 - GENERAL

1.01 SCOPE OF WORK:

A. This Section of the Specifications describes the requirements for panel mounted equipment to be furnished under other Sections of the Specifications as listed in the Related Work paragraph of this Section.

B. All equipment described herein shall be submitted and furnished as an integral part of equipment specified elsewhere in these Specifications.

C. Provide all flow rate displays configured to also display corresponding totalized flow.

1.02 RELATED WORK:

A. Section 17300 Instrumentation General Provisions

B. Section 17302 Testing and Commissioning

C. Section 17305 Application Services

D. Section 17310 Field Instruments

E. Section 17400 Control Loop Descriptions

F. Section 17405 Input/Output List

G. Section 17410 Field Instrument List

H. Section 17500 Programmable Logic Controller (PLC)

I. Section 16050 Basic Electrical Materials and Methods

1.03 SUBMITTALS:

A. Submittals for equipment specified herein shall be made as a part of equipment furnished under other Sections. Individual submittals for equipment specified herein will not be accepted and will be returned un-reviewed.

B. Submit catalog data for all items supplied from this specification Section as applicable. Submittal shall include catalog data, functions, ratings, inputs, outputs, displays, etc., sufficient to confirm that the equipment provides every specified requirement. Any options or exceptions shall be clearly indicated.

C. Operation and Maintenance Manuals:

1. Operation and Maintenance manuals shall include the following information:

a. Manufacturer’s contact address and telephone number for parts and service.

b. Instruction books and/or leaflets

c. Recommended renewal parts list

d. Record Documents for the information required by the Submittals above.

1.04 REFERENCE CODES AND STANDARDS:

A. The equipment in this specification shall be designed and manufactured according to latest revision of the following standards (unless otherwise noted):

1. NEMA/ISCI 109 Transient Over voltage Withstand Test

2. IEEE Std. 472/ANSI C37.90.2 Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers.

3. IEC 255.4 Surge Withstand Capability Tests.

4. NEMA/ICS 1 General Standard for Industrial Control Systems.

5. NEMA/ICS 4 Terminal Blocks for Industrial Use.

6. NEMA/ICS 6 Enclosures for Industrial Control Systems.

7. NEMA LS 1 Low Voltage Surge Protective Devices.

8. UL 1449 Third Edition – Surge Protective Devices

B. All equipment shall comply with the requirements of the National Electric Code and Underwriters Laboratories (UL) where applicable.

C. Each specified device shall also conform to the standards and codes listed in the individual device paragraphs.

1.05 QUALITY ASSURANCE:

A. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years. When requested by the OWNER/ENGINEER, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

B. Equipment submitted shall fit within the space or location shown on the Drawings. Equipment which does not fit within the space or location is not acceptable.

C. For the equipment specified herein, the manufacturer shall be ISO 9001 2000 certified.

1.06 WARRANTY:

A. The Manufacturer shall warrant the equipment to be free from defects in material and workmanship for two (2) year from date of acceptance of the equipment containing the items specified in this Section. Within such period of warranty the Manufacturer shall promptly

furnish all material and labor necessary to return the equipment to new operating condition. Any warranty work requiring shipping or transporting of the equipment shall be performed by the CONTRACTOR at no expense to the OWNER.

PART 2 - PRODUCTS

2.01 WIRE TROUGHS:

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:

1. Panduit

2. Taylor

B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

2.02 DIN RAILS:

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:

1. Phoenix Contact

2. Entrelec

3. Weidmuller

4. Allen Bradley

B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

2.03 SIGNAL ISOLATORS, BOOSTERS, CONVERTERS:

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:

1. Phoenix Contact

2. Acromag Inc.

3. Moore Industries

B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

1. Type:

a. Externally powered solid state electronic type. Loop powered devices are not acceptable.

2. Functional/Performance:

a. Accuracy - 0.15 percent.
b. Inputs - Current, voltage, frequency, temperature, or resistance as required.
c. Outputs - Current or voltage as required.
d. Isolation - There shall be complete isolation between input circuitry, output circuitry, and the power supply.
e. Adjustments - Zero and span adjustment shall be provided.
f. Protection - Provide RFI protection.
g. 24 Volt DC power input.

3. Physical:

a. Mounting - Suitable for DIN Rail mounting in an enclosure or instrument rack. Options/Accessories Required:

(i) Mounting rack or general purpose enclosure as required.

2.04 RELAYS AND TIMERS:

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:

1. Square D

2. IDEC

3. Potter-Broomfield

4. Allen-Bradley

B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

C. Type:

1. Relays shall be type of shown in the project plans. The relay shall be equipped with an indicating light to indicate when its coil is energized.

2. Units shall be of the general purpose plug-in type.

3. Timing relays shall be Square D JCK-70 or equal.

4. Alternating relays shall be TimeMark Corporation Model 441 or equal.

D. Functional/Performance:

1. Coil voltage shall match supply voltage.

2. Contact arrangement/function shall be as required to meet the specified control function.

3. Mechanical life expectancy shall be in excess of 10,000,000 cycles.

4. Duty cycle shall be rated for continuous operation.

5. Units shall be provided with integral indicating light to indicate if relay is energized.

6. Solid state time delays shall be provided with polarity protection (DC units) and transient protection.

7. Time delay units shall be adjustable and available in ranges from .1 second to 4.5 hours.

8. Plug-in general purpose relay.

9. Blade connector type.

10. Contact material: Silver cadmium oxide.

11. Relay sockets are DIN rail mounted.

12. Internal neon or LED indicator is lit when coil is energized.

13. Clear polycarbonate dust cover with clip fastener.

14. Operating temperature: -20 to +150 °F.

15. UL listed or recognized.

16. Alternator relay shall have the capability to defeat non-operational pumps.

E. Ratings:

1. For 120VAC service provide contacts rated 10 amps at 120VAC, for 24VDC service provide contacts rated 5 amps at 28VDC, for electronic (milliamp/ millivolt) switching applicator provide gold plated contacts rated for electronic service.

2. Relays shall be provided with dust and moisture resistant covers.

F. Physical:

1. DIN Rail mounting base

2. Screw Terminals

G. Options/Accessories Required:

1. Provide mounting sockets with pressure type terminal blocks rated 300 volt and 10 amps.

2. Provide mounting rails/holders as required.

2.05 ANALOG SIGNAL SURGE PROTECTORS (SPDS):

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:

1. AGM Electronics

2. Acromag Inc.

3. Moore Industries

B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

2.06 DIGITAL INDICATORS:

A. Digital indicators shall be NEWPORT Electronics Model 202A-P, ma process receiver, or Precision Digital Model PD 765-6RO.

2.07 POWER SUPPLIES:

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:

1. IDEC Model # PS5R-VD24

B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

C. Design and fabrication:

1. Converts 120 VAC input to DC power at required voltage.

2. Sized as required by the load. Minimum 2.4 A output.

3. AC input: 120 VAC +10 percent -13 percent; 47 to 63 HZ.

4. Provision for output fail alarm contact.

5. All Power Supplies shall be redundant pairs.

2.08 ETHERNET SURGE PROTECTOR:

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:

1. Transector ALPU PTP M 1101-959

2.09 SURGE PROTECTOR:

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:

1. Phoenix Contact Model # 2856702

2.10 UNITERRUPTABLE POWER SUPPLY (UPS):

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:

1. APC Smart Model SRT1500RMXLA

B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

C. Design and fabrication:

1. 1 2 0 V A C , 1500 VA

2.11 RADIO:

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:

1. Cambium Networks Integrated High Gain 5 GHz PMP-450i Subscriber Part # C050045C002C
2. No Equals.

C. Design and fabrication:

1.	Power Supply:	10-30VDC
2.	Frequency:	5.8 GHz
3.	Operational Temperature Range:	-40°C to +70°C
4.	Transmit Power:	+28 dBm

D. Provide with the following:

1. Cambium Tilt Bracket Assembly, Part # N000045L002A

2.12 CELLULAR ROUTER:

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:

1. Cisco System, Model IR1101-K9
2. Approved owner equal.

B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

C. Design and fabrication:

1. Power Supply: 24 or 48 VDC, 12 Watts
2. Ethernet Data Rate: 10/100/1000 Mbps
3. Operational Temperature Range: -40°C to +60°C
4. LTE Bands: 700 MHz (Band 13), 1700/2100 MHz (Band 4 AWS)
5. Interfaces: 4 x 10/100 BASE-T RJ45 ports, 2 TNC cellular antenna conn., WAN 1 Combo RJ45 and GE SFP port

D. Provide with the following:

1. Software:
    a. Cisco IOS Advanced IP Services
    b. Generic routing encapsulation (GRE) and multipoint GRE (MGRE)
    c. IEEE 802.1, IEEE 802.1Q VLANs, IEEE 82.3, SSH, SNMPv3, syslog, IGMP v3 Snooping, Command Line Interface
    d. Layer 2 Tunneling Protocol (L2TP)
    e. Layer 2 tunneling Protocol Version 3 (L2TPv3)
    f. Open Shortest Path First (OSPF)
    g. Enhanced Interior Gateway Routing Protocol (EIGRP)
    h. Virtual Route Forwarding (VRF) Lite
    i. 802.1x
2. Options:
    a. Extended service agreement with Next Business Day response. Full access to vendor device images, technical support and warranty.
    b. DIN rail mounting kit – Cisco part # IR1101-DINRAIL

2.12 MIDSPAN POWER INJECTOR:

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:

3. Moxa Power Injector – Part #INJ-24A-T
4. Approved owner equal.

B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

C. Design and fabrication:

1. Power Supply: 24 or 48 VDC
2. Ethernet Interface:
   a. One 10/100/1000 Base-T Port, RJ45
   b. One PoE 10/100/1000 Base-T Port, RJ45
3. Operational Temperature Range: -40°F to 167°F

2.12 INDUSTRIAL SCADA ETHERNET SWITCH:

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:

5. Cisco System, Model IE-2000-8TC-G-B
6. Approved owner equal.

B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

C. Design and fabrication:

1. Power Supply: 9-60 VDC,
2. Ethernet Data Rate: 10/100 Mbps
3. Operational Temperature Range: -40°C to +60°C
4. Copper Ports: 8 x 10/100 BASE-T ports minimum
5. RJ45 Ports: 8 Fast Ethernet
6. SFP Ports: 2 Gigabit Ethernet
7. Industrial Rated IEC/EN 61000-6-2
8. DIN Rail mounted

D. Provide with the following:

3. Software:
   a. Firmware Type: LAN Base
   b. IPv4 static routing, Port-Security, 802.1x, QoS, IEEE 1588 PTPv2, SNMP
   c. IEEE 802.1, IEEE 802.1Q VLANs, IEEE 82.3, SSH, SNMPv3, syslog, IGMP v3 Snooping, Command Line Interface
4. Options:
   a. Extend service agreement to 1 year with Next Business Day response.
   b. Provide Expansion Modules and SFP transceivers as required to meet connectivity requirement.
      i. Fiber connectivity – Single Mode (SM) SFP Transceiver
         1. Cisco part # GLC-LH-SM-RGD=
   c. Full access to vendor device images, technical support and warranty.
   d. With Cisco SMARTnet extended service agreement register to SAWS
      i. Part # CON-SNT-IE2K8TCG

2.13 NAMEPLATES:

A. Furnish nameplates for each device as indicated in Drawings. Nameplates shall be engraved, laminated impact acrylic, matte finish, black lettering on a white background, not less than 1/16-in thick by 1/2-in by 1-1/2-in, Rowmark 322402. Nameplates shall be attached to the backplate with double faced adhesive strips, TESA TUFF TAPE 4970, .009 X ½". Prior to installing the nameplates, the metal surface shall be thoroughly cleaned with 70% alcohol until all residues has been removed. Epoxy adhesive or foam tape is not acceptable.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. All equipment specified herein shall be factory installed, field adjusted, tested and cleaned as an integral part of equipment specified elsewhere in these Specifications.

END OF SECTION

SECTION 17328

SCADA PANEL

PART 1 - GENERAL

1.01 SCOPE OF WORK:

A. Design, furnish and install fully functional SCADA panel to manually or automatically operate the pump station as specified in the detailed requirements of this Section, and logic and schematics as shown on the Electrical and Instrumentation Drawings.

B. SCADA panel as specified in Electrical Equipment Division or Mechanical Equipment Divisions, except as specifically stated herein shall not be submitted under this Section.

C. Provide the following SCP panel as depicted in the Drawings and as specified herein.

1.02 RELATED WORK:

A. Division 16

B. Section 17300 Instrumentation General Provisions

C. Section 17302 Testing

D. Section 17305 Application Services

E. Section 17310 Field Instruments

F. Section 17327 Panel Mounted Equipment

G. Section 17400 Control Loop Descriptions

H. Section 17405 Input/Output List

I. Section 17410 Field Instrument List

J. Section 17500 Programmable Logic Controller (PLC)

1.03 SUBMITTALS:

A. Submittal Process:

1. Submittals shall be made in accordance with the requirements of Section 01300, Section 17300 and as specified herein.

2. Submittals require information on related equipment to be furnished under this Specification, and described in the related Sections listed in the Related Work paragraph above. Incomplete submittals not containing the required information on the related equipment will be returned un-reviewed.

B. Submittal Content:

1. The original equipment manufacturer shall create all equipment shop drawings, including

all wiring diagrams, in the manufacturer's Engineering department. All equipment shop drawings shall bear the original equipment manufacturer logo, drawing file numbers, and shall be maintained on file in the original equipment manufacturers archive file system. Photocopies of the Engineer's ladder schematics are unacceptable as shop drawings.

C. Required Submittals:

1. Copies of previously Approved Related Work submittals

2. Documentation confirming that the Panel Assembly Facility is a UL-508 certified panel shop

3. Facsimile of the UL label that is to be applied to the completed panels

4. Shop Drawings:

   a. Shop Drawings shall include the following:

      1) Drawings shall be to scale and shall show the location of panel mounted devices, including doors, louvers, and sub panels
      2) Equipment outline drawings showing elevation, plan and interior views, front panel arrangement, dimensions, weight, shipping splits, conduit entrances and anchor bolt pattern. Indicate all options, special features, ratings and deviations from this Section's requirements.
      3) The first sheet of each Panel Drawing Packet shall contain a Bill of Materials for that panel. The Bill of Materials shall list all devices mounted within the panel, and shall include the tag number, description, manufacturer, and model number of each item.
      4) Following the Bill of Material shall be a listing, uniquely identifying each component of the Panel, and a description of the item used, i.e. devices by their assigned tag numbers, nameplate inscriptions, service legend, and annunciator inscriptions.
      5) Power and control schematics including external connections. Show wire and terminal numbers and color-coding.

   b. Interconnecting Wiring Diagrams:

      1) Provide interconnecting wiring diagrams showing electrical connections between equipment, consoles, panels, terminal junction boxes, and field mounted components.
      2) Diagrams shall show component and panel terminal board identification numbers, and external wire and cable numbers.
      3) Circuit names corresponding to the Circuit and Raceway Schedule shall be shown. The diagram shall include intermediate terminations between field elements and panels (e.g., terminal junction boxes, pull boxes, etc.).

5. Factory Tests:

   a. Submittals shall be made for factory tests as specified herein. Owner/Engineer approval of required factory tests is required prior to shipment of the equipment.

6. Field Tests:

a. Submittals shall be made for field tests as specified herein

7. Operation and Maintenance Manuals:

a. Operation and maintenance manuals shall include the following information:

1) Manufacturer's contact address and telephone number for parts and service
2) Instruction books and/or leaflets
3) Recommended renewal parts list
4) Record Documents for the information required by the Submittals paragraph above

D. Operation and Maintenance Manuals:

1. Operation and maintenance manuals shall include the following information:

a. Manufacturer's contact address and telephone number for parts and service
b. Instruction books and/or leaflets
c. Recommended renewal parts list
d. Record Documents for the information required by the Submittals paragraph above

1.04 REFERENCE CODES AND STANDARDS:

A. Instrumentation equipment, materials and installation shall comply with the National Electrical Code (NEC and with the latest edition of the following codes and standards:

1. National Electrical Safety Code (NESC)

2. Occupational Safety and Health Administration (OSHA)

3. NEMA ICS 1-101 Diagrams, Designations and Symbols

4. ANSI/ISA-5.06.01-2007 - Functional Requirements Documentation for Control Software Applications

5. ISA-TR20.00.01-2001 - Specification Forms for Process Measurement and Control Instruments Part 1: General Considerations Updated with 27 New Specification Forms in 2004-2005

6. ISA-5.4-1991 Instrument Loop Diagrams

7. ISA-5.5-1985 Graphic Symbols for Process Displays

8. ISA-5.1-1984 (R1992) Instrumentation Symbols and Identification

9. ISA-5.3-1983 Graphic Symbols for Distributed Control/Shared Display Instrumentation, Logic, and Computer Systems

10. ISA-20-1981 Specification Forms for Process Measurement and Control Instruments, Primary Elements, and Control Valves

11. ISA-5.2-1976 (R1992) Binary Logic Diagrams for Process Operations
12. NEMA ICS 6 Enclosures for Industrial Controls and Systems
13. National Fire Protection Association (NFPA)
14. National Electrical Manufacturers Association (NEMA)
15. American National Standards Institute (ANSI)
16. Insulated Cable Engineers Association (ICEA)
17. International Society of Automation (ISA)
18. Underwriters Laboratories (UL)
19. UL 508, the Standard of Safety for Industrial Control Equipment
20. UL 508A, the Standard of Safety for Industrial Control Panels
21. UL 50, the Standard of Safety for Enclosures for Electrical Equipment
22. NFPA 79, Electrical Standard for Industrial Machinery
23. Factory Mutual (FM)
24. NFPA 70 National Electrical Code (NEC)
25. NFPA 70E Standard for Electrical Safety in the Workplace
26. ANSI C37.90.2 Standard Withstand Capability of Relay Systems to Radiated Electromagnetic Interference From Transceivers
27. NEMA ICS 4 Terminal Blocks for Industrial Use
28. NEMA LS1 Low Voltage Surge Protection Devices
29. UL 1283 Standard for Safety-Electromagnetic Interference Filters
30. UL 1449 Third Edition Surge Protective Devices
31. City of San Antonio, Texas Electrical Code
32. All equipment and installations shall conform to applicable Federal, State, and local codes

1.05 QUALITY ASSURANCE:

A. The manufacturer of this equipment shall have produced similar equipment for a minimum period of five (5) years. When requested by the Owner/Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement

B. The control panels shall be assembled in a UL-certified panel shop, experienced in the

assembled of control panels for wastewater and water treatment systems. A submittal of the documentation, that certifies the panel fabrication shop is a UL-certified shop, is required

C. Equipment components and devices shall be UL labeled wherever UL standards exist for such equipment. The completed control panel shall be UL Labeled in accordance with UL 508 and 508A and other applicable UL standards. The panel shall also be UL labeled for the environment in which it is to be placed. A UL label shall be affixed to the inside of the external door by the panel fabrication assembly. Submit a facsimile of the UL label in the submittal information

D. Equipment submitted shall fit within the space shown on the Drawings. Equipment which does not fit within the space is not acceptable

1.06 DELIVERY STORAGE AND HANDLING:

A. Equipment shall be handled and stored in accordance with manufacturer's instructions. Two (2) copies of these instructions shall be included with the equipment at time of shipment, and shall be made available to the Contractor and Owner/Engineer.

B. Shipping groups shall be designed to be shipped by truck, rail, or ship. Accessories shall be packaged and shipped separately.

C. Within (5) five days after shipment of all equipment, Manufacturer shall ship all software, supplied under this Section of the Specifications, by Registered Mail or Approved Courier, to the Owner’s Representative, with a copy of the Shipment Manifest

D. Visibly damaged panels shall be returned to the Manufacturer’s UL 508 facility, for examination and damaged equipment replaced at no expense to the Owner.

E. Equipment shall be installed in its permanent finished location shown on the Drawings within seven (7) calendar days of arriving onsite. If the equipment cannot be installed within seven (7) calendar days, the equipment shall not be delivered to the site, but stored offsite, at the Contractor’s expense, until such time that the site is ready for permanent installation of the equipment.

F. Where space heaters are provided in equipment, provide temporary electrical power and operate space heaters during storage, and after equipment is installed in permanent location, until equipment is placed in service.

1.07 WARRANTY:

A. The Manufacturer shall warrant the equipment to be free from defects in material and workmanship for two (2) years from date of final acceptance of the equipment. Within such period of warranty the Manufacturer shall promptly furnish all material and labor necessary to return the equipment to new operating condition. Any warranty work requiring shipping or transporting of the equipment shall be performed by the Manufacturer, at no expense to the Owner.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Subject to compliance with the Contract Documents, the following enclosure Manufacturers are acceptable:

1. Hoffman Enclosures

2. Rittal Enclosures

B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

2.02 RATINGS

A. Enclosure Ratings for Area Classifications:

1. Unless otherwise specified herein or shown on the Drawings, enclosures and associated installations shall have the following ratings:

2. Provide white enamel painted, NEMA 4X 316 Stainless Steel enclosures for outdoor, wet locations In addition NEMA 4X Aluminum enclosures will be allowed on an individual basis, but only where specifically designated herein or specifically shown on the Drawings.

B. The complete control panel assembly shall be UL certified or carry a UL listing for "Industrial Control Panels".

C. The SCADA panel shall meet all applicable requirements of the National Electrical Code.

D. For additional ratings and construction notes, refer to the Drawings.

E. The service voltage shall be as specified and as shown on the Drawings. The overall short circuit withstand and interrupting rating of the equipment and devices shall be equal to or greater than the overall short circuit withstand and interrupting rating of the feeder device immediately upstream of the Control Panel, but not less than 10,000 amperes at 120 volts single phase.

F. The Manufacturer shall produce and install on each panel, an Arc Flash Warning Label listing the various Flash Hazard Protection Boundaries, calculated from NFPA 70E, Annexes, as listed below:

1. Flash Hazard Protection Boundary

2. Limited Approach Boundary

3. Restricted Boundary

4. Restricted Boundary

5. Incident Energy Level

6. Required Personal Protective Equipment Class

7. Type of Fire Rated Clothing

G. Provide an Arc Flash Warning Label, printed in color and affixed to the front of each panel provided.

1. Shown below is a typical label. Size of each label shall be not less than 8 inches wide and 6 inches tall.

2.03 CONSTRUCTION:

A. General:

1. Refer to the Drawings for: schematics, actual layout and location of equipment and components; current ratings of devices, bus bars, components; protective relays, voltage ratings of devices, components and assemblies; and other required details.

B. Enclosures:

1. Free Standing:

a. Enclosures shall be of factory white enamel painted 316 stainless steel, rear and side panels, with lifting eyes, without knockouts or holes. Enclosures shall have fully sized rear and side panels. Panels shall have factory cutouts where required for environmental ducts. Enclosures shall not be less than 12 gauge metal. All enclosures shall have continuous hinged doors with handle latch, 3-point. All enclosures shall have bonding provisions on door. Enclosures shall be NEMA 12 rated if located in doors. Outdoor areas require a NEMA 4X 316 Stainless Steel rating.

3. Each enclosure less than 4 ft. wide shall be shall have one overhead interior LED light fixture, with Off/On switch, powered from a dedicated non UPS circuit. Each enclosure greater than 4 ft. wide shall have one overhead florescent light for every 4 ft. of length, or every fraction thereof.

4. Each enclosure shall have one, UPS powered, 150 watt receptacle.

5. Each enclosure shall have, factory installed, full sized removable back and side panels, on which control components shall be mounted. Back panel shall be secured to the enclosure with collar studs for wall mounted enclosures, and 316 SS hardware for free standing enclosures.

6. The enclosure outer door shall have a rear mounted pocket in the lower portion, which shall containing laminated copies of the panel schematics and wiring.

7. Electrical tables shall be laminated and adhered to the inside of the door.

8. All enclosures shall be lockable, and keyed alike.

9. Level and pressure process indicators shall be securely mounted on the exterior door. All controls and indicators shall be 30mm, clearly labeled to indicate function and shall be NEMA 12 rated. Auxiliary contacts shall be provided for remote run indication and indication of each status and alarm condition. Additional controls shall be provided as specified herein and as required by the detailed mechanical and electrical equipment

requirements.

C. Environmental Controls:

1. Enclosure Condensate Heaters:

a. A self-contained enclosure condensation heater with thermostat and fan shall be mounted inside the control panel, if panel is mounted outdoors or in a non-air-conditioned spaced.

1) Enclosure heaters shall be energized from 120 volt, single-phase power supply and sized to prevent condensation within the enclosure.
2) Locate enclosure heaters to avoid overheating electronic hardware or producing large temperature fluctuations on the hardware.
3) Enclosure heaters shall have an internal fan for heat distribution and shall be controlled with adjustable thermostats. The thermostat shall have an adjustment range of 40 degrees Fahrenheit to 90 degrees Fahrenheit. Provide a circuit breaker or fused disconnect switch within the enclosure.
4) Enclosure heaters shall be Hoffman type DAH.

b. Strip heaters may be provided if they are 240 volt rated, powered at 120 volts AC and do not have a surface temperature higher than 60°C. Strip heaters and thermostats shall be as manufactured by Chromalox.

1) Strip heaters shall be Chromalox, Type OT, 1.5-in wide, 240 Volts, single phase, 150 watts, energized at 120 volts, with rust resisting iron sheath, Catalog No. OT-715, Product Code No. 129314. Provide sufficient wattage in heaters to prevent condensation should the interior temperature of the enclosure drop below the dew point.
2) A control thermostat mounted inside the control Panel shall be Chromalox, Type WR, single stage, Catalog No. WR-80, Product Code No.263177.
3) The strip heater terminals shall be guarded by a protective terminal cover.
4) High temperature connecting lead wire shall be used between the thermostat and the heater terminals. Wire shall be No. 12 AWG stranded nickel-plated copper with Teflon glass insulation and shall be the product of Chromalox, Catalog No. 6-CFI-12, and Product Code No. 263783.

2. NEMA 4X Enclosure Air Conditioner:

a. NEMA 4X enclosures containing electronic devices or electrical equipment shall have air conditioners that will maintain the internal temperature at or below 85F at an ambient temperature of 105F without violating the NEMA 4X rating of the enclosure.
b. The panel builder shall provide panel internal heat rise calculations to show that the panel internal temperatures will be maintained below 85F at an ambient temperature of 105F.

1) For enclosures mounted indoors in non-air-conditioned spaces, include an ambient air temperature of 40 degree C and a humidity of 100% non-condensing
2) For enclosures mounted in direct sunlight add the appropriate solar heat gain component to the calculation, and raise the ambient temperature to 60 degrees C.
3) The calculation shall show all the internal and external heat gain loads, the expected internal temperature rise in degrees C above the specified ambient without

the air conditioner. Provide a calculation showing the expected temperature rise in degrees C above the specified ambient with the air conditioner running.

c. The air conditioner shall have the following features:

1) Use CFC-free R134a refrigerant
2) Have fully gasketed flanges on all four mounting edges for a watertight seal that maintains NEMA 4X rating of the panel.
3) Thermostatic low temperature control to provide energy efficient operation and prevents over-cooling.
4) EMI/RFI suppressor to minimize transient spikes during compressor on/off cycling.
5) Separated blower-driven evaporator and condenser air systems for closed loop cooling.
6) UL listed
7) Stainless steel enclosure
8) Internal corrosion resistant coating and/or galvanized steel components.
9) Low ambient kit
10) Short cycle protector
11) Provide an air conditioner manufactured by McLean.

2.04 PANEL EQUIPMENT:

A. Equipment Requirements:

1. The requirements for equipment, controls, meters, converters, etc, for the SCADA Panel, shall be as shown on the Drawings, panel schematics, and the functions specified in the Loop Descriptions.

2. The PLC shall be as specified in Section 17500 Programmable Logic Controller System.

3. All other equipment, controls, meters, converters that are designed as a part of the control panel, shall be as specified in Section 17327 Panel Mounted Equipment, Related Work Sections specified herein, as shown on the Drawings, panel schematics, and the functions specified in the Loop Descriptions.

4. Provide a main circuit protective device, DIN rail mounted, to protect the panel equipment.
5. Provide and install a 316 stainless steel-folding shelf and located on the control panel internal swing panel door. Folding shelf shall be catalog number ACSHELF1818SS as manufactured by Hoffman Enclosures.
6. Terminal blocks shall be single stack only. Cooper Bussman DP series or equivalent.
7. Wiring troughs shall be manufactured by Panduit or equivalent.

2.05 EQUIPMENT INSTALLATION:

A. Equipment Mounting:

1. The location of the installed equipment shall be as shown on the Panel Layouts on the Drawings.

2. Each piece of equipment shall be securely mounted to the backplate or side plate in accordance with the manufacturer's installation instructions. All mounting hardware shall

be from the front of the backplate or side plate with threaded screws. Attaching hardware shall not be installed from the rear of the backplate or side plate. Removal of any piece of equipment shall not require the removal or loosening of any other piece of equipment.

3. Operator interface equipment installed on the door shall be arranged as shown on the Drawings in accordance with the manufacturer's installation instructions. No penetrations of the door shall be made except for equipment mounting. Provide adequate clearance between pieces of equipment and door latching mechanisms.

B. Nameplates:

1. Furnish nameplates for each device as indicated in Drawings. Nameplates shall be engraved, laminated impact acrylic, matte finish, black lettering on a white background, not less than 1/16-in thick by 1/2-in by 1-1/2-in, Rowmark 322402. Nameplates shall be attached to the backplate with double faced adhesive strips, TESA TUFF TAPE 4970, .009 X ½". Prior to installing the nameplates, the metal surface shall be thoroughly cleaned with 70% alcohol until all residues has been removed. Epoxy adhesive or foam tape is not acceptable.

C. Wiring Trough and Terminal Block Installation:

1. Space between wiring troughs and equipment shall be such that space for terminal blocks is provided for termination of each conductor or group of conductors before connection to the equipment. Removal of equipment for service shall not leave any exposed conductors hanging unconnected.

2. Install the wiring troughs such that one may be removed without interference from the other. Troughs shall be installed such that trough covers may be removed without cover interference.

3. Install terminal blocks on DIN rail with adequate space for access to the terminal with clear view of the wire identification label. All incoming or outgoing wiring shall enter or leave the panel on terminal blocks. Terminal blocks or wiring troughs shall not be installed on the doors. Provide terminal blocks on side plates/backplate for all door mounted equipment.

4. In no case shall internal and external wiring share a wiring trough.

5. Provide 600 volt rated terminal blocks for any conductor carrying any voltage over 120 volts to ground.

6. Provide 600 volt rated strap screw terminal blocks for any power conductors carrying over 20 amps, at any voltage. Terminals shall be double sided and supplied with removable covers to prevent accidental contact with live circuits.

7. Power conductors carrying over 20 amps, at any voltage shall be terminated to strap-screw type terminal blocks with crimp type, pre-insulated, ring-tongue lugs. Lugs shall be of the appropriate size for the terminal block screws and for the number and size of the wires terminated. Do not terminate more than one conductor in any lug, and do not land more than two conductors under any strap-screw terminal point.

8. Terminals shall have permanent, legible identification, clearly visible with the protective cover removed. Each terminal block shall have 20 percent spare terminals, but not less than two spare terminals.

9. Do not land more than two conductors per terminal point. Use the manufacturer's provided bridge connectors to interconnect terminal blocks terminating common or ground conductors.

10. Twisted shielded pair or triad cables shall have each individual conductor and shield drain wire landed on individual terminal blocks. Use the manufacturer's provided bridge connectors to interconnect terminal blocks terminating the shield drain wire conductors.

11. Provide an AC ground bar bonded to the panel enclosure, if metal, with 20 percent spare terminals.

12. Provided ground terminal blocks for each twisted-shielded pair drain wire.

D. Internal Panel Wiring:

1. Power and control wiring shall be tinned stranded copper, minimum size No. 14 AWG, with 600 volt, 90 degree C, flame retardant, Type MTW thermoplastic insulation. Line side power wiring shall be sized for the full fault current rating or frame size of the connected device, and as shown on the Drawings.

2. Analog signal wires shall be 600 Volt Class, insulated stranded tinned copper, twisted shielded #16 AWG pair.

3. All interconnecting wires between panel mounted equipment and external equipment shall be terminated at numbered terminal blocks. Field wiring shall not be terminated directly on any panel-mounted device.

4. All wiring shall be tagged and coded with an identification number as shown on the Drawings. Coding shall be typed on a heat shrinkable tube applied to each end showing origination and destination of each wire. The marking shall be permanent, non-smearing, solvent-resistant type similar to Raychem TMS-SCE.

5. All wiring shall be enclosed in PVC wire trough with slotted side openings and removable cover. Plan wire routing such that no low twisted shielded pair cable conducting analog 4-20 mA signals or low voltage analog signals are routed in the same wire trough as conductors carrying discrete signals or power.

6. All control panel wiring shall use the following color code:

   a. Black: AC power at line voltage
   b. Red: switched AC power
   c. Orange: May be energized while the main disconnect is in the off position
   d. White: AC neutral
   e. Orange/white stripe or white/orange stripe: separate derived neutral
   f. Red/white stripe or white/red stripe: switched neutral
   g. Green or green w/ yellow tracer: ground/earth ground
   h. Blue: Ungrounded DC power
   i. Blue/white stripe or white/blue stripe: DC grounded common
   j. Purple: 480V AC 3 phase - phase A

k. Yellow: 480V AC 3 phase - phase B
l. Brown: 480V AC 3 Phase - phase C

E. Field Entrance Internal Wiring:

1. Field entrance internal wiring shall be neatly grouped by circuit and bound by plastic tie wraps. Circuit groups shall be supported so that circuit terminations are not stressed. In addition, low signal wiring (millivolt and milliamp) shall be bundle separately from the rest of the control wiring.

2. All field wiring shall be tagged and coded with an identification number. Coding shall be typed on a heat shrinkable tube applied to each end of the wire. The marking shall be a permanent, non-smearing, solvent-resistant type similar to Raychem TMS-SCE.

3. All conduit entering or leaving equipment shall be coordinated in advance with the panel installer, so that the conduit entrances to the enclosure are directly below the termination ara for immediate termination. Conduits shall not enter the top or side of the panel unless approved in writing by the Owner/Engineer.

F. PLC Inputs and Outputs:

1. All PLC Analog inputs and outputs shall be individually fused for each channel. All Discrete inputs and outputs shall be buffered with relays from the field connections. Discrete points shall be fused for each circuit group with no less than one fuse per card.

2.06 FACTORY TESTING:

A. The entire control panel shall be completely assembled, wired, and adjusted at the factory and shall be given the manufacturer's routine shop tests and any other additional operational test to insure the workability and reliable operation of the equipment.

B. Factory test equipment and test methods shall conform to the latest applicable requirements of ANSI, IEEE, UL, and NEMA standards.

C. The operational test shall include the proper connection of supply and control voltage and, as far as practical, a mockup of simulated control signals and control devices shall be fed into the boards to check for proper operation.

D. Factory test equipment and test methods shall conform to the latest applicable requirements of ANSI, IEEE, UL, and NEMA standards, and shall be subject to the Owner/Engineer's approval.

PART 3 - EXECUTION

3.01 INSTALLER'S QUALIFICATIONS:

A. Installer shall be specialized in installing this type of equipment with minimum 5 years documented experience. Experience documentation shall be submitted for approval prior to beginning work on this project.

3.02 EXAMINATION:

A. Examine installation area to assure there is enough clearance to install the equipment.

Housekeeping pads shall be included for the floor mounted panels as detailed on the Drawings.

B. Check concrete pads and base plates for uniformity and level surface.

C. Verify that the equipment is ready to install.

D. Verify field measurements are as instructed by manufacturer.

3.03 INSTALLATION:

A. The Contractor shall install all equipment per the manufacturer's recommendations and Contract Drawings.

B. Conduit hubs for use on raceway system pull and junction boxes shall be watertight, threaded aluminum, insulated throat, stainless steel grounding screw, as manufactured by T&B H150GRA Series.

C. Conduits entering a control Panel or box containing electrical equipment shall not enter the enclosure through the top.

D. Install required safety labels.

3.04 RACEWAY SEALING:

A. Where raceways enter junction boxes or control panels containing electrical or instrumentation equipment, all entrances shall be sealed with 3M 1000NS Watertight Sealant.

B. This requirement shall be strictly adhered to for all raceways in the conduit system.

3.05 FIELD QUALITY CONTROL:

A. Inspect installed equipment for anchoring, alignment, grounding and physical damage.

B. Check tightness of all accessible electrical connections. Minimum acceptable values are specified in manufacturer's instructions.

3.06 FIELD ADJUSTING:

A. Adjust all circuit breakers, switches, access doors, operating handles for free mechanical and electrical operation as described in manufacturer's instructions.

B. The breaker protective devices shall be set in the field by a qualified representative of the manufacturer, retained by the Contractor, in accordance with settings designated in a coordinated study of the system as required in Section 16411 Power System Study.

3.07 FIELD TESTING:

A. Perform all electrical field tests recommended by the manufacturer. Disconnect all connections to solid-state equipment prior to testing.

B. Test all control logic before energizing the equipment.

3.08 CLEANING:

A. Remove all rubbish and debris from inside and around the panel. Remove dirt, dust, or concrete spatter from the interior and exterior of the equipment using brushes, vacuum cleaner, or clean, lint free rags. Do not use compressed air.

3.09 EQUIPMENT PROTECTION AND RESTORATION:

A. Touch-up and restore damaged surfaces to factory finish, as approved by the manufacturer. If the damaged surface cannot be returned to factory specification, the surface shall be replaced.

3.10 MANUFACTURER'S CERTIFICATION:

A. A qualified factory-trained manufacturer's representative shall certify in writing that the equipment has been installed, adjusted, including all settings designated in the Power System Study, and tested in accordance with the manufacturer's recommendations.

B. The Contractor shall provide three (3) copies of the manufacturer's representative's certification.

3.11 TRAINING:

A. Provide manufacturer's services for training of plant personnel in operation and maintenance of the equipment provided under this Section.

B. The training for each type of equipment shall be for a period of not less than one (1) eight hour day.

C. The cost of training program to be conducted with Owner's personnel shall be included in the Contract Price. The training and instruction, insofar as practicable, shall be directly related to the system being supplied.

D. Provide detailed O&M manuals to supplement the training course. The manuals shall include specific details of equipment supplied and operations specific to the project.

E. The training session shall be conducted by a manufacturer's qualified representative. Training program shall include instructions on the assembly, motor starters, protective devices, metering, and other major components.

F. The Owner reserves the right to videotape the training sessions for the Owner's use.

END OF SECTION

SECTION 17400

CONTROL LOOP DESCRIPTIONS

PART 1 - GENERAL

1.01 SCOPE OF WORK:

A. This section describes proposed equipment and system components and their intended operation via control loop descriptions which will be used for the programming integration into the SAWS SCADA System.

1.02 RELATED WORK:

A. Division 16, Electrical

B. Division 17, Instrumentation

1.03 ACRONYMS:

A. Comp – Computer

B. HMI – Human Machine Interface at SAWS Production Control Room

C. LP- Lift Pump

D. MCC – Motor Control Center

E. MG – Million Gallon

F. PLC – Programmable Logic Controller

G. RTD – Resistance Temperature Detectors

H. SCADA – Supervisory Control and Data Acquisition

I. PCP – Pump control panel

1.04 TERMS AND DEFINITIONS:

A. SCADA Panel – The panel located on-site at the Specht Road Lift Station.

B. Local Operation – Describes the manual operation of a device or piece of equipment at the Facility which includes SCP, MCC, and local equipment panels.

C. Remote Operation – Describes the operation of a device or piece of equipment from the SAWS Control Room.

1.05 GENERAL DESCRIPTION:

A. The equipment that controls the operating strategy of the Specht Road Lift Station includes:

1. Four (4) Lift Pumps.

2. One (1) Wet Well Submersible Level Transducer.

3. One (1) Pressure Transmitter for Pump Discharge Header Pressure

4. Proposed PLC, Power Supply and Communications

5. One (1) Proposed Standby Diesel Generator for the Plant Electrical System

6. Backup secondary float controls.

PART 2 - PRODUCTS

2.01 WET WELL LEVEL INDICATING TRANSMITTER AND WET WELL LEVEL FLOATS:

One (1) submersible level transmitter and eight (4) level floats will be installed at the proposed lift station wet well.

Tag No.: LE-102, LS-103, LS-103A, LS-104A, LS-104B, LS-104C, LS-104D and LS-104E.

Local

- The operator can read the level transmitter from SCADA Panel.
- Wet well transmitter will start and stop lift pumps thru level controller (HydroRanger 200) when Level Control Selector Switch is in Primary or Primary/Secondary position.
- Wet well floats LS-103A thru LS-103E will start and stop lift pumps when Level Control Selector Switch is in Secondary or Primary/Secondary position.
- When Level Control Selector Switch is in Primary/Secondary position, and Wet Well float LS-103A is activated (assumes level transmitter/level controller is inactive), control of lift pump operation defaults to Secondary pump control
- Wet well float LS-104 indicates low level in wet well only.

Remote Manual

- None.

Remote Automatic

- None.

SCADA Interface

- The PLC sends a signal to SAWS indicating the level in the wet well from the level controller.
- The PLC sends a signal to SAWS indicating the low level or high level in the wet well from the floats.

2.02 LIFT PUMPS:

A total of 2 constant-speed lift pumps will be located at the lift station.

Tag Nos.: LP-1, LP-2

The pumps will operate based on the following criteria:

1) When the Level Control Selector Switch is in the Primary position, the lift pumps will be started and stopped by the level controller.

2) The level setpoints from the level controller are specified as:

High Level Alarm	Feet
Start Lead Pump	Feet
Start Lag Pump	Feet
Low Level Alarm	Feet

3) As the wet well rises in level, the lead pump is energized at the start lead level setpoint. If the level continues to rise, the lag pumps is started based on their level setpoints. As level drops to the lag pump off level setpoint and the lag pump stops. If the level continues to decrease will stop the lead pump. The level controller will alternate pump sequence automatically.

4) When the Level Control Selector Switch is in the Primary/Secondary position, the lift pumps will be started and stopped by the level controller. In the event the level controller fails, evidenced by the activation of the high alarm float, control of the lift pump operation shall default to backup float controls (Secondary). Pump sequence of operation will be controlled by a 2 pump alternator relay.

5) When the Level Control Selector Switch is in the Secondary position, the lift pumps will be started and stopped by the backup floats.

Pump Operation Sequencing Strategy:

1) Each Lift Pump can be started by one of the following methods:

   a. Manually from the Pump Control Panel:

      i. Normal/Emergency Switch on Pump Control Panel in Emer position. Pump will run continuously by energizing bypass starter.
      ii. Normal/Emergency Switch on Pump Control Panel in Normal position. Hand/Off/Auto Switch on Pump Control Panel in Hand position. Start/Stop switch in Start position. Pump will start via RVSS starter.

   a. Automatically from the Pump Control Panel:

      i. Normal/Emergency Switch on Pump Control Panel in Normal position. Hand/Off/Auto Switch on Pump Control Panel in Auto position. Local/Remote switch in Local position.

2) Upon startup, a Lift Pump remains in operation until one of the following occurs:

a. Automatically shut off from Level Controller.

b. Automatically shut off by low level pump shutoff float.

c. Automatically shut off due to the activation of:

i. Overload from bypass starter.

ii. Seal fail/Overtemperature detection.

d. Manually shut off by Hand/Off/Auto Switch.

Local

The Lift Pumps can be turned on/off in the field at the Pump Control Panel.

- Pump On/Off Status can be seen on the Pump Control Panel.

Remote

None.

SCADA Interface

The PLC sends a signal to SAWS indicating the following for each Lift Pump:

- On/Off status
- Hand/Off/Auto Switch position
- Normal/Emergency Switch position.
- Level Control Selector Switch position.
- Seal Leak/Overtemperature

The PLC monitors the status of the Lift Pumps and warns the operator with an alarm:

2.08 PRESSURE TRANSMITTERS: SYSTEM PRESSURE

Tag No.: PIT-601

Local (Manual)

- None. (The operator can read the pressure transmitter from SCADA Panel.)

Remote Manual

- None.

Remote Automatic

- None.

SCADA Interface

- The PLC sends a signal to the control room indicating the pressure at the installed

location.

2.10 SCADA PANEL INTERNAL TEMPERATURE MONITORS:

SCADA Panel uses an internal temperature sensor/transmitter (RTD) to monitor the temperature of the SCADA Panel. The temperature can be read by SAWS operators and will be displayed in °F. The temperature transmitter is only monitored by the SCADA system.

Tag Nos.: SPT-1

Local (Manual)

- None.

Remote Manual

- None.

Remote Automatic

- None.

SCADA Interface

- The PLC monitors the data using the temperature indicators and transmits a signal to SAWS. The operators can read the temperature in degrees Fahrenheit.
- The PLC monitors the status of the temperature transmitters and alerts the SAWS operator with a high temperature alarm.

2.11 PLC, POWER SUPPLY AND COMMUNICATIONS:

The SCADA system monitors additional parameters related to the Power Supply and SCP Panel doors.

Tag Nos.: Door #1

Local

- None.

Remote Manual

- None.

Remote Automatic

- None.

SCADA Interface

- The PLC monitors the status of the PLC and alerts the SAWS operator with a power failure alarm and that the UPS system is running.
- The PLC monitors the status of the SCP panel door switches and reports to the SAWS operator if a door is open if a switch is closed.

2.12 STANDBY DIESEL GENERATOR :

This generator will be installed to provide back-up power for the site.

Tag Nos.: GEN-1

Local

- Operators can locally see generator status at the generator Local Control Panel supplied by the manufacturer.
- Generator is started/stopped automatically by the ATS.
- The generator can by started/stopped locally from the ATS.

Remote Manual

- None.

Remote Automatic

- None

SCADA Interface

- The PLC monitors the generator status and sends a signal back to the SAWS Production
- Control Room indicating the individual the following:
  - Generator Run Status
  - Generator Trouble
  - Generator Low Fuel

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 17405

INPUT/OUTPUT LIST

PART 1 - GENERAL

1.01 SCOPE:

A. This Section includes the Input/Output List.

1.02 RELATED SECTIONS:

A. Section 17300 Instrumentation General Provisions including coordination meeting required between various parties involved with controls programming.

B. Section 17400 Control Loop Descriptions

1.03 SUBMITTALS:

A. Refer to Section 17305 Applications Services and Section 17300 Instrumentation General Provisions.

1.04 SYSTEM DESCRIPTION:

A. The Input/Output List provides the minimum physical signal requirements of the control loops represented in the Contract Documents. Additional software integrated signals as required to fully implement the strategies as described in these specifications shall be included.

B. The Input/Output List is not intended to be an inclusive listing of all elements and appurtenances required to execute loop functions, but is rather intended to supplement and complement the drawings and other specification sections. The Input/Output List shall not be considered equal to a bill of materials.

C. Provide instrumentation hardware and software as necessary to perform control functions specified herein and as shown on drawings.

1.05 INPUT OUTPUT LISTING:

A. The Input/Output List follows in Appendix A.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 INSTALLATION:

A. All inputs and outputs listed shall be programmed in the system as specified herein and shall be installed, field adjusted and tested as an integral part of equipment specified elsewhere in these Specifications.

END OF SECTION

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SPECIFICATION 17405
APPENDIX A

I/O LIST						
Booster Pump Status/Control						
Item. No.	P&ID	Parameter	Digital Input	Digital Output	Analog Input	Analog Output
1		UPS FAIL	X			
2		GENERATOR FAIL	X			
3		LEVEL ALARM LOW	X			
4		LEVEL ALARM HIGH	X			
5		CONTROL POWER FAIL	X			
6		UTILITY POWER FAIL	X			
7		GENERATOR ON	X			
8		TRANSFER FAIL	X			
9		LEVEL CONTROL IN PRIMARY	X			
10		LEVEL CONTROL IN SECONDARY	X			
11		LEVEL CONTROL IN PRIMARY/SECONDARY	X			
12		LIFT PUMP #1 IN HAND	X			
13		LIFT PUMP #1 IN AUTO	X			
14		LIFT PUMP #1 STATUS	X			
15		LIFT PUMP #1 SEAL LEAK	X			
16		LIFT PUMP #1 OVERTEMPERATURE	X			
17		LIFT PUMP #1 OVERLOAD	X			
18		LIFT PUMP #1 PHASE FAIL	X			
19		LIFT PUMP #2 IN HAND	X			
20		LIFT PUMP #2 IN AUTO	X			
21		LIFT PUMP #2 STATUS	X			
22		LIFT PUMP #2 SEAL LEAK	X			
23		LIFT PUMP #2 OVERTEMPERATURE	X			
24		LIFT PUMP #2 OVERLOAD	X			
25		LIFT PUMP #2 PHASE FAIL	X			
Item. No.	P&ID	Parameter	Digital Input	Digital Output	Analog Input	Analog Output
26		WET WELL LEVEL			X	
27		PUMP DISCHARGE PRESSURE			X	
28		SCADA PANEL TEMPERATURE SENSOR			X	
44		OBSTRUCTION LIGHT FAIL	X			

SECTION 17410

FIELD INSTRUMENT LIST

PART 1 - GENERAL

1.01 SCOPE:

A. This Section includes a summary of the Field Instrument List.

1.02 RELATED SECTIONS:

A. Section 17300 Instrumentation General Provisions including coordination meeting required between various parties involved with controls programming.

B. Section 17400 Control Loop Descriptions

1.03 SUBMITTALS:

A. Refer to Section 17305 Applications Services and Section 17300 Instrumentation General Provisions.

1.04 SYSTEM DESCRIPTION:

A. The Field Instrument List provides a summary of the major process instrumentation requirements as utilized within the control loops represented in the Contract Documents. Additional instruments shall be provided as required to fully implement the strategies as described in these specifications and as recommended by the process and mechanical equipment division suppliers.

B. The Field Instrument List is not intended to be an inclusive listing of all elements and appurtenances required to execute loop functions, but is rather intended to supplement and complement the drawings and other specification sections. The Field Instrument List shall not be considered equal to a bill of materials.

C. Provide instrumentation hardware and software as necessary to perform control functions specified herein and as shown on drawings.

1.05 FIELD INSTRUMENT LIST:

A. The Field Instrument List follows in Appendix A.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 INSTALLATION:

A. All field instruments listed shall be supplied as specified herein and shall be installed, field adjusted and tested as an integral part of overall control systems specified elsewhere in these Specifications.

END OF SECTION

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SPECIFICATION 17410
APPENDIX A

FIELD INSTRUMENT LIST						
Item No.	**P&ID**	**Instrument Tag**	**Description**	**Instrument Type**	**Instrument Range or Setpoint**	**Comments**
1		PIT-601	Lift Station Discharge Pressure	Pressure Transmitter	-14.7 – 150 psi	
2		LE-102	Wet Well Level	Pressure Transducer	25 psi	
3		TI-100	SCADA Panel Temperature Sensor	Temperature Sensor	-40 – 150 F	

SECTION 17500

SCADA PANEL EQUIPMENT

PART 1 - GENERAL

1.01 SCOPE OF WORK:

A. This Section of the Specifications describes the requirements for a Programmable Logic Controller (PLC) to be furnished under other Sections of the Specifications as listed in the Related Work paragraph of this Section.

B. All equipment described herein shall be submitted and furnished as an integral part of equipment specified elsewhere in these Specifications.

1.02 RELATED WORK:

A. Section 16010 Basic Electrical Requirements

B. Section 17300 Instrumentation General Provisions

C. Section 17302 Process Instrumentation and Control System Testing

D. Section 17305 Application Services

E. Section 17310 Field Instruments

F. Section 17327 Panel Mounted Equipment

G. Section 17400 Control Loop Descriptions

H. Section 17405 Input/Output List

I. Section 17410 Field Instrument List

1.03 SUBMITTALS:

A. Submittals for equipment specified herein shall be made as a part of equipment furnished under other Sections. Individual submittals for equipment specified herein will not be accepted and will be returned un-reviewed.

B. Shop Drawings:

1. Bill of Materials

2. Catalog Cuts

3. Component Data Sheets

4. Panel Construction Drawings, including wiring and component layout

5. List of Labels and Tags

C. Submit control loop drawings complete with rack, card slot and point configuration.

D. Submit catalog data sheets for all software licenses provided under this Specification Section.

E. Operation and Maintenance Manuals:

1. Operation and Maintenance manuals shall include the following information:

a. Manufacturer's contact address and telephone number for parts and service.
b. Instruction books and/or leaflets
c. Recommended renewal parts list
d. Record Documents for the information required by the Submittals above.
e. Copy of the software license data including serial numbers, license key, etc.
f. Complete set of as-built control loop and wiring drawings in "11x17" format.

1.04 REFERENCE CODES AND STANDARDS:

A. PLC equipment, materials and installation shall comply with the National Electrical Code (NEC and with the latest edition of the following codes and standards:

1. National Electrical Safety Code (NESC)

2. Occupational Safety and Health Administration (OSHA)

3. NEMA ICS 1-101 Diagrams, Designations and Symbols

4. ANSI/ISA-5.06.01-2007 - Functional Requirements Documentation for Control Software Applications.

5. ISA-TR20.00.01-2001 - Specification Forms for Process Measurement and Control Instruments Part 1: General Considerations Updated with 27 New Specification Forms in 2004-2005.

6. ISA-5.4-1991 Instrument Loop Diagrams.

7. ISA-5.5-1985 Graphic Symbols for Process Displays.

8. ISA-5.1-1984 (R1992) Instrumentation Symbols and Identification.

9. ISA-5.3-1983 Graphic Symbols for Distributed Control/Shared Display Instrumentation, Logic, and Computer Systems.

10. ISA-20-1981 Specification Forms for Process Measurement and Control Instruments, Primary Elements, and Control Valves.

11. ISA-5.2-1976 (R1992) Binary Logic Diagrams for Process Operations.

12. NEMA ICS 6 Enclosures for Industrial Controls and Systems

13. National Fire Protection Association (NFPA)

14. National Electrical Manufacturers Association (NEMA)

15. American National Standards Institute (ANSI)

16. Insulated Cable Engineers Association (ICEA)

17. International Society of Automation (ISA)

18. Underwriters Laboratories (UL)

19. UL 508, the Standard of Safety for Industrial Control Equipment

20. UL 508A, the Standard of Safety for Industrial Control Panels

21. UL 50, the Standard of Safety for Enclosures for Electrical Equipment.

22. NFPA 79, Electrical Standard for Industrial Machinery

23. Factory Mutual (FM)

24. NFPA 70 National Electrical Code (NEC)

25. NFPA 70E Standard for Electrical Safety in the Workplace

26. ANSI C37.90.2 Standard Withstand Capability of Relay Systems to Radiated Electromagnetic Interference From Transceivers.

27. NEMA ICS 4 Terminal Blocks for Industrial Use.

28. NEMA LS1 Low Voltage Surge Protection Devices.

29. UL 1283 Standard for Safety-Electromagnetic Interference Filters.

30. UL 1449 Third Edition Surge Protective Devices

31. Texas Electrical Code

32. All equipment and installations shall conform to applicable Federal, State, and local codes.

B. All equipment shall comply with the requirements of the National Electric Code and Underwriters Laboratories (UL) where applicable.

C. Each specified device shall also conform to the standards and codes listed in the individual device paragraphs.

1.05 QUALITY ASSURANCE:

A. The manufacturer of this equipment shall have produced similar equipment for a minimum period of five (5) years. When requested by the OWNER/ENGINEER, an acceptable list of

installations with similar equipment shall be provided demonstrating compliance with this requirement.

B. Requirements of the CONTRACTOR:

1. Have a local office within one hundred (100) miles of the City of San Antonio or have technicians available on-site within 4 hours of emergency notification.

2. Be able to provide resumes, project experience history and references for all employees that will be qualified to work on the SCADA system.

3. Have a local full time staff of employees that have developed and commissioned a minimum of three new Allen Bradley based systems within the past twelve months. Must have a minimum five years' experience designing, installing and commissioning SCADA systems.

4. Have a minimum of three full time employees qualified to perform the SCADA system configuration work.

5. All proposals submitted to the San Antonio Water System must be accompanied by documentation supporting the qualifications of the CONTRACTOR as detailed above. The San Antonio Water System reserves the right to reject any proposal if the above qualifications are not met.

C. Equipment submitted shall fit within the space or location shown on the Drawings. Equipment which does not fit within the space or location is not acceptable.

D. For the equipment specified herein, the manufacturer shall be ISO 9001 2000 certified.

1.06 WARRANTY:

A. The Manufacturer shall warrant the equipment to be free from defects in material and workmanship for 2 years from date of acceptance of the equipment containing the items specified in this Section. Within such period of warranty the Manufacturer shall promptly furnish all material and labor necessary to return the equipment to new operating condition. Any warranty work requiring shipping or transporting of the equipment shall be performed by the CONTRACTOR at no expense to the OWNER.

PART 2 - PRODUCTS

2.01 PROGRAMMABLE LOGIC CONTROLLER (PLC) SYSTEM:

A. The PLC shall be a complete system that includes but is not limited to the following:

1. PLC processor
2. PLC modules, chassis, and power supply
3. All connection cables
4. Connection bases
5. 25% spare capacity on all I/O modules

B. Approved Products – NO SUBSTITUTIONS:

DESCRIPTION	MANUFACTURER	PART NUMBER
Power Supply Module	Allen Bradley	Embedded
PLC	Allen Bradley	5069-L320ER & 5069-RTB64-SCREW (CompactLogix 5380, up to 16 I/O Modules)
16 Channel Digital Input Module	Allen Bradley	5069-IB16 & 5069-RTB18-SCREW
16 Channel Digital Output Module	Allen Bradley	5069-OB16 & 5069-RTB18-SCREW (DC source output, max 16 channel) or 5069-OW16 & 5069-RTB18-SCREW (Relay output, max 16 channel)
8 Channel Analog Input Module	Allen Bradley	5069-IF8 & 5069-RTB18-SCREW (voltage or current, max 8 channel)
8 Channel Analog Output Module	Allen Bradley	5069-OF8 & 5069-RTB18-SCREW (voltage or current, max 8 channel)
Network Interface Controller	Allen Bradley	5069-AENTR & 5069-RTB5-SCREW (can only be used as remote I/O adapter)
End Cap Terminator	Allen Bradley	5069-ECR

C. Communications:

Allen Bradley:
Communication shall be IP/Ethernet Protocol.

D. Programming – Local PLC:

1. The PLC shall use the latest version of STUDIO 5000 Full Edition ENE Configuration software for programming the CPU. Contractor to provide cable needed for

communications. (Allen Bradley). The PLC shall use the latest version of Studio 5000 Full.

2. PLC Programming shall be performed by Process Control Systems Integrator (PCSI).

3. SAWS will provide support with the programming.

2.02 120 VAC UNINTERRUPTIBLE POWER SUPPLY (UPS)

A. Provide power conditioning during normal power operation.

1. Lightning and surge protection: Tested to ANSI/IEEE C62.41 Category A.
2. RF noise isolation: EMI/RFI suppression.
3. On-Line input range: 100-142 Vac, output 112-128 Vac.

B. Upon loss of feeder power to UPS, maintain power to the load for a minimum of 2 hours with 4 msec transfer time. Contractor to submit load calculation of proposed components and indicate the size of UPS needed for a 2 hour run time.

C. Ratings:

1. Volt – Ampere Capacity: Shall be sized to run all devices in SCADA panel for 2 hours.
2. Nominal Input Voltage: 120 Vac.
3. On-Battery Output Voltage: 120 Vac +/- 10%.
4. On-Battery Frequency: 60 Hz. Stepped sine wave.
5. Ambient Operating Temperature: 0-40 degrees C.

D. Battery shall be a sealed maintenance-free lead acid type with 3-year minimum life.

F. UL Compliance: UPS shall conform to UL Standards and have an applied UL listing.

G. Manufacturer: APC Smart Model SRT1500RMXLA.

2.03 DC POWER SUPPLY:

A. 24 Vdc Control Power shall be provided by a single-output DC Power Supply.

B. Ratings:

1. Input Voltage: 120 Vac, + 10% voltage adjustment.
2. Output Voltage: 24 Vdc single output.
3. Output Current: 1.3 amperes, overload protected.
4. Ambient Operating Temperature: -10-60 degrees C.

C. UL Compliance: Power Supply shall conform to UL Standards and have an applied UL listing.

D. Manufacturer: IDEC, Model PS5R-SC24.

2.04 ADDITIONAL SPARE PARTS:

A. Provide the following spare parts for the PLC in the quantities specified:

1. One-half dozen replacement fuses, all types and sizes

B. Spare parts shall be boxed or packaged for long term storage. Identify each item with manufacturer's name, description and part number on the exterior of the package.

PART 3 - EXECUTION

3.01 INSTALLATION

A. All equipment specified herein shall be factory installed, programmed, field adjusted, tested and cleaned as an integral part of equipment specified elsewhere in these Specifications.

END OF SECTION

SECTION 17600

ANTENNA TOWER

PART 1 - GENERAL

1.01 PURPOSE:

A. This specification covers the requirements for the design and construction of an antenna tower to be used for this project's radio communication system. Contractor shall provide all structural design as well as installation of the tower and the foundation.

1.02 SUBMITTALS:

A. Shop Drawings:

1. Tower description including materials of construction and foundation details.
2. Plans sealed by Engineer.

1.03 SPECIAL REQUIREMENTS:

A. The plans for the tower and foundation must be prepared and sealed by a structural engineer licensed to do work in the State of Texas. These shall be submitted to Owner before construction starts.

B. Geotechnical Engineering Studies included in the contract documents shall be used for tower foundation design. Contractor is responsible for the cost of more detailed studies, if needed, for the design of the tower and foundation.

C. Tower design and construction shall meet standards contained in the latest revisions of ANSI/TIA/EIA-222.

D. Grounding system shall be designed and installed by the Contractor.

E. Contractor is responsible for performing a TOWAIR Determination and filing the FAA notification.

F. Contractor is responsible for FCC registration.

G. Contractor is responsible for providing all marker lighting, if required, by the FAA.

H. Contractor shall be responsible for obtaining all required construction and/or installation permits including the San Antonio Building Inspection Department.

I. Contractor shall be responsible for adhering to OSHA requirements and guidelines for the duration of the installation and must submit a safety plan for review by Owner safety department prior to construction. The work areas must be properly marked to prevent OWNER personnel and outside parties from potential hazards.

J. Contractor must comply with ALL applicable code (building, electrical, etc.) requirements.

K. The equipment manufacturer or vendor shall provide a two (2) year warranty for all parts associated with the equipment defined by this Specification and the labor associated with repair and/or replacement of the parts. The warranty must be submitted during the shop drawing phase. Approval of the shop drawings will be contingent on the receipt of the warranty. If any part of the equipment should fail during the warranty period, it shall be replaced and restored to

an operative level at no expense to the Owner. This warranty shall also cover any and all parts that show signs of corrosion during the warranty period. The warranty shall commence at final acceptance of the facility.

PART 2 - PRODUCTS

2.01 ANTENNA TOWER

A. The tower must be self-supporting monopole type including a DBI Sala Lad-Saf fall-safety system, step bolts, and waveguide ladder.

B. Tower height shall allow for a maximum equipment mounting height of 60 feet.

C. The towers must be designed to support the equipment load as listed in Section 17515-2.03 plus 50% additional load capacity.

D. Contractor must provide and install all mounting hardware for equipment installed on the tower.

E. Contractor to install all radio communication equipment on the tower. Refer to Section 17515.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. The tower must be installed by a Contractor with a minimum of one (1) employee that is ComTrain certified in Basic Tower Construction, and a minimum of four (4) employees that are ComTrain certified in Tower Climbing. Contractor shall submit proof of certification to Owner, prior to commencement of work.

B. Contractor will provide a final tower inspection and provide to Owner a written report sealed by a professional engineer licensed in the State of Texas verifying the tower was installed per approved design drawings. Should it be determined that flaws exist in the installation, a punch-list will be developed for the Contractor to resolve and the tower again must be re-inspected at the Contractor's cost.

C. Contractor shall adhere to all tower manufacturer construction recommendations and make available to the Owner the manufacturer recommendations at both pre-and post-installation for approval.

D. Contractor shall supply three (3) hard copies and electronic as-built documentation at completion of project to include: as-built plans, the details of the warranty on the tower, grounding system information, photos of construction milestones, copy of any permits received, any FCC registration records, and other requirements per Section 01300.

END OF SECTION

Project Vestal Tank

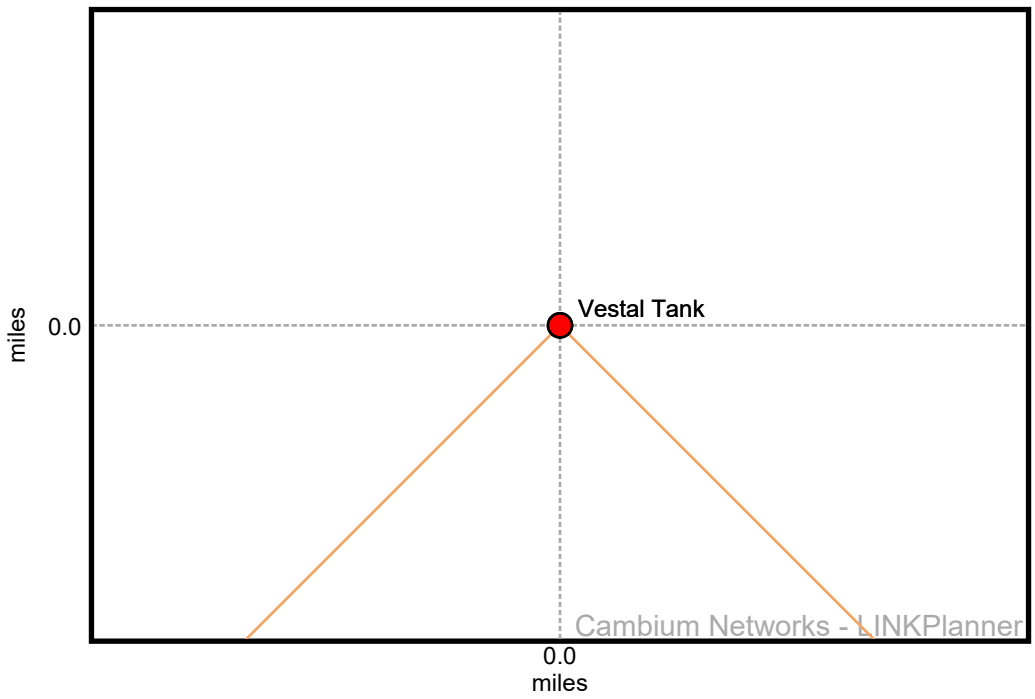
LINKPlanner PMP Installation Report

18 May 2023

Chris Ballinger
Organization: Twin Eagle Solutions
Phone: 713-494-6055
Email: chris.b@twineaglesolutions.com

Cambium Networks™

center = 29.34693N 098.50462W



Cambium Networks™

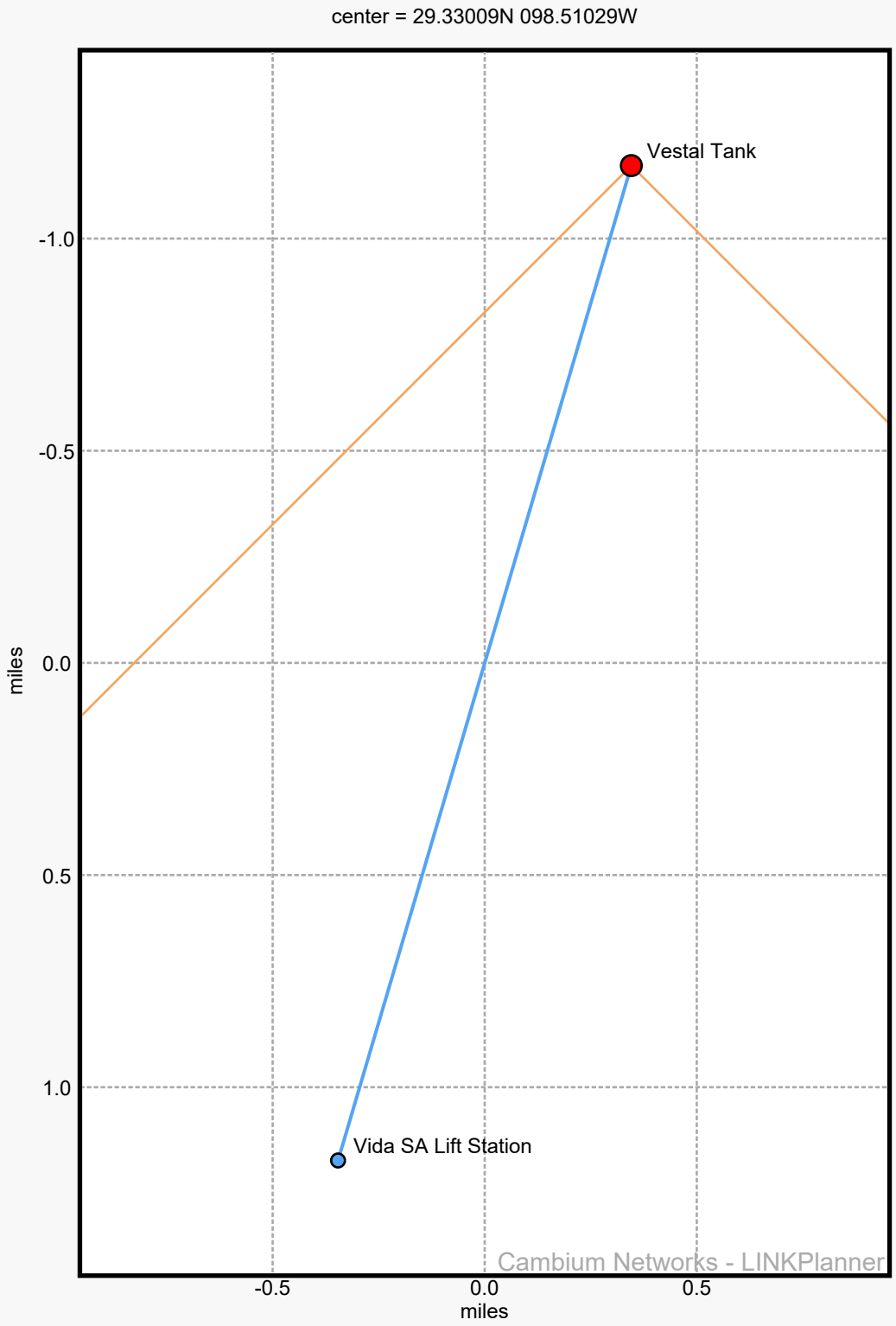
Table of Contents

1. Project Summary

Project: Vestal Tank

General Information
Customer Name
Company Name
Address
Phone
Cell Phone
Email

Network Map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Vestal Tank
Vida SA Lift Station
-1.0
-0.5
0.0
0.5
1.0
miles
-0.5
0.0
0.5
miles
Cambium Networks - LINKPlanner

Access Point Name	Product	Antenna Azimuth	Beamwidth	Band	Max Range	Connected Subscribers	Total Predicted Throughput
Vestal Tank : 1	PMP450i	180.0°	90.0°	4.9 GHz	10 miles	1	16.38 Mbps

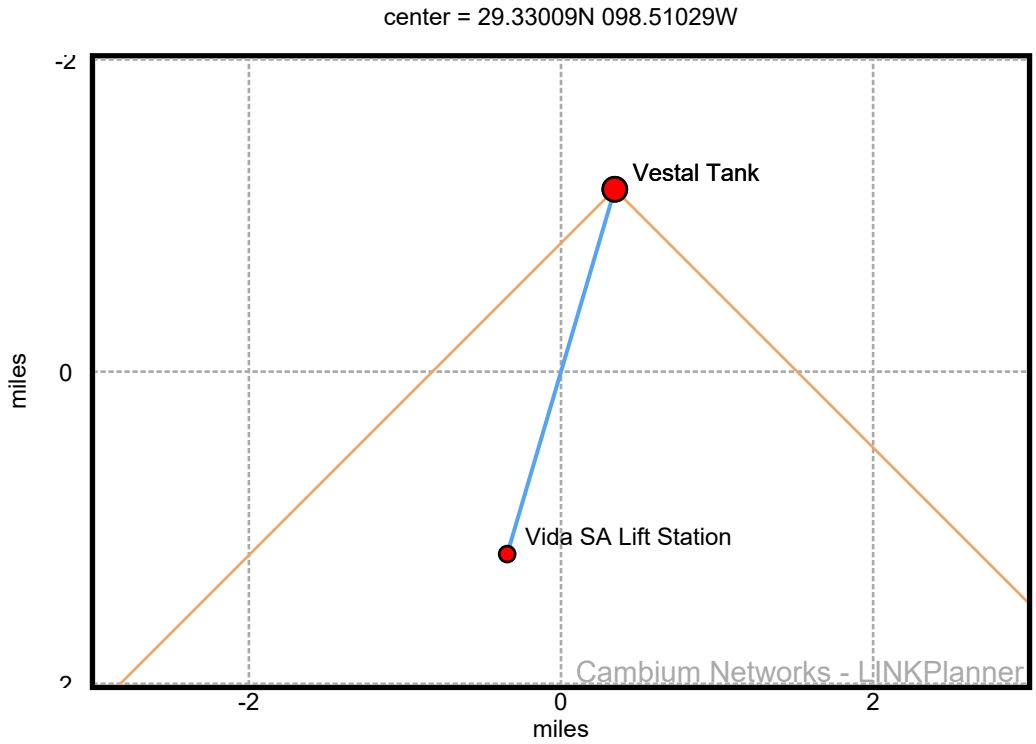
Bill of Materials : Switch Network		
Part Number	Qty	Description

Bill of Materials : PMP Network		
Part Number	Qty	Description
(no part number)	1	Unspecified Power Lead. (set the region in the Bill of Materials options)
01010419001	4	Coaxial Cable Grounding Kits for 1/4" and 3/8" Cable
C000065L007	1	LPU and Grounding Kit (1 kit per ODU)
C050045A006	1	5 GHz PMP 450i Integrated Access Point, 90 degree (FCC). Requires suffix "B" or newer
EW-E2PM45AP-WW	1	PMP450/450i Access Point Extended Warranty, 2 Additional Years
N000000L034	1	PoE, 30.5W, 56V, 5GbE DC Injector, Indoor, Energy Level 6 Supply, accepts C5 connector
WB3176	1	328 ft (100 m) Reel Outdoor Copper Clad CAT5E (Recommended for PTP)

Bill of Materials : Subscriber Modules		
Part Number	Qty	Description
(no part number)	1	Unspecified Power Lead. (set the region in the Bill of Materials options)
C000000L033	1	Gigabit Surge Suppressor (56V), 10/100/1000 BaseT
C050045C002	1	5 GHz PMP 450i SM, Integrated High Gain Antenna
EW-E2PM4ISM-WW	1	PMP450i Subscriber Module Extended Warranty, 2 Additional Years
N000000L034	1	PoE, 30.5W, 56V, 5GbE DC Injector, Indoor, Energy Level 6 Supply, accepts C5 connector
N000045L002	1	Tilt Bracket Assembly

2. Vestal Tank

Hub Summary	
Hub Name	Vestal Tank
Latitude	29.34693N
Longitude	098.50462W
Number of Access Points	1
Number of Connected Subscribers	1
Total Predicted DL Throughput	11.47 Mbps
Total Predicted UL Throughput	4.92 Mbps
Total Throughput	16.38 Mbps



Access Point Name	Product	Antenna Azimuth	Beamwidth	Band	Max Range	Connected Subscribers	Total Predicted Throughput
Vestal Tank : 1	PMP450i	180.0°	90.0°	4.9 GHz	10 miles	1	16.38 Mbps

Bill of Materials : PMP Network		
Part Number	Qty	Description
(no part number)	1	Unspecified Power Lead. (set the region in the Bill of Materials options)
01010419001	4	Coaxial Cable Grounding Kits for 1/4" and 3/8" Cable
C000065L007	1	LPU and Grounding Kit (1 kit per ODU)
C050045A006	1	5 GHz PMP 450i Integrated Access Point, 90 degree (FCC). Requires suffix "B" or newer
EW-E2PM45AP-WW	1	PMP450/450i Access Point Extended Warranty, 2 Additional Years
N000000L034	1	PoE, 30.5W, 56V, 5GbE DC Injector, Indoor, Energy Level 6 Supply, accepts C5 connector
WB3176	1	328 ft (100 m) Reel Outdoor Copper Clad CAT5E (Recommended for PTP). Total cable requirements are aggregated at the network level

3. Vestal Tank : 1

Summary	
AP Name	Vestal Tank : 1
Group Name	
Hub Name	Vestal Tank
Equipment Type	PMP450i (running Release 21.1)
Antenna Type	Cambium Networks 90° 4.9 - 6 GHz, 90/120 deg Sector Antenna
Modeled Beamwidth	90°
Antenna Azimuth	180.00° from True North 176.31° from Magnetic North
Antenna Tilt	0.0°
Connected Subscribers	1
Max Range	10 miles
RF Frequency Band	4.9 GHz (4940 to 4990 MHz)
RF Channel Bandwidth	5 MHz
Downlink Data	75 %
Contention Slots	3
Effective Contention Slots	3
0.01% Rain rate	51.06 mm/hr
Rain Attenuation	0.10 dB/km
Total Predicted DL Throughput	11.47 Mbps
Total Predicted UL Throughput	4.92 Mbps
Total Predicted Throughput	16.38 Mbps

Bill of Materials : AP		
Part Number	Qty	Description
(no part number)	1	Unspecified Power Lead. (set the region in the Bill of Materials options)
01010419001	4	Coaxial Cable Grounding Kits for 1/4" and 3/8" Cable
C000065L007	1	LPU and Grounding Kit (1 kit per ODU)
C050045A006	1	5 GHz PMP 450i Integrated Access Point, 90 degree (FCC). Requires suffix "B" or newer
EW-E2PM45AP-WW	1	PMP450/450i Access Point Extended Warranty, 2 Additional Years
N000000L034	1	PoE, 30.5W, 56V, 5GbE DC Injector, Indoor, Energy Level 6 Supply, accepts C5 connector
WB3176	1	328 ft (100 m) Reel Outdoor Copper Clad CAT5E (Recommended for PTP). Total cable requirements are aggregated at the parent level

Bill of Materials : Subscriber Modules		
Part Number	Qty	Description
(no part number)	1	Unspecified Power Lead. (set the region in the Bill of Materials options)
C000000L033	1	Gigabit Surge Suppressor (56V), 10/100/1000 BaseT
C050045C002	1	5 GHz PMP 450i SM, Integrated High Gain Antenna
EW-E2PM4ISM-WW	1	PMP450i Subscriber Module Extended Warranty, 2 Additional Years
N000000L034	1	PoE, 30.5W, 56V, 5GbE DC Injector, Indoor, Energy Level 6 Supply, accepts C5 connector
N000045L002	1	Tilt Bracket Assembly

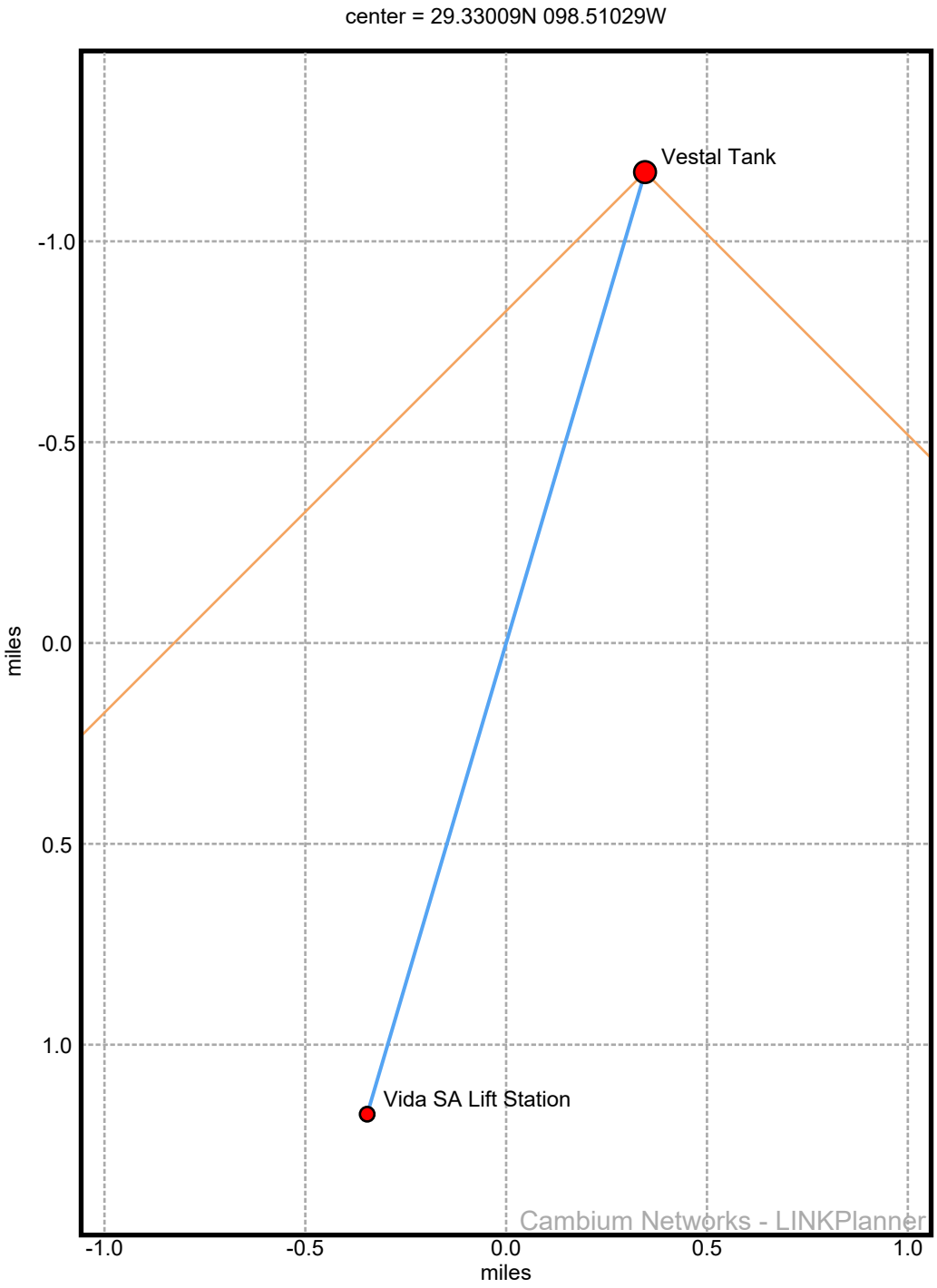
Physical Installation Notes for AP Vestal Tank : 1	
Latitude	29.34693N
Longitude	098.50462W
Platform Variant	4.9 GHz PMP-450i
Antenna Type	Cambium Networks 90° 4.9 - 6 GHz, 90/120 deg Sector Antenna
Antenna Beamwidth	90.0°
Antenna Gain	18.0 dBi
Antenna Height	162.0 feet AGL
Antenna Tilt Angle (mechanical)	0.0°
Antenna Azimuth	180.00° from True North 176.31° from Magnetic North
Magnetic Declination	3.69° E ±0.33° changing by 0.11° W per year

Radio Commissioning Notes for AP Vestal Tank : 1	
Device Setting	AP
Sync Input	AutoSync + Free Run
Region	North America
Country	United States
Latitude	29.34693N
Longitude	098.50462W
Height	49.4 m (162 ft)
Frequency Band	4.9 GHz (4940 to 4990 MHz)
Channel Bandwidth	5 MHz
Cyclic Prefix	1/16
Frame Period	2.5 ms
Color Code	0
MIMO Rate Adapt Algorithm	MIMO-A/B
DL Maximum Mod Mode	x8
UL Maximum Mod Mode	x8
Max Range	10 miles
Downlink Data	75 %
Contention Slots	3

Radio Commissioning Notes for AP Vestal Tank : 1 (continued)	
Broadcast Repeat Count	0
Transmit Power	22.0 dBm
External Gain	18.0 dBi
SM Receive Target Level	-56 dBm
SM Registration Limit	238

Mode	Total Mean Predicted Throughput (Mbps)	SMs per DL modulation			SMs per UL modulation		
		Quantity	Percent	Throughput (Mbps)	Quantity	Percent	Throughput (Mbps)
x8 (256QAM MIMO-B)	16.38	1	100.0	11.47	1	100.0	4.92
x7 (128QAM MIMO-B)	0.00	0	0.0	0.00	0	0.0	0.00
x6 (64QAM MIMO-B)	0.00	0	0.0	0.00	0	0.0	0.00
x5 (32QAM MIMO-B)	0.00	0	0.0	0.00	0	0.0	0.00
x4 (16QAM MIMO-B)	0.00	0	0.0	0.00	0	0.0	0.00
x3 (8QAM MIMO-B)	0.00	0	0.0	0.00	0	0.0	0.00
x2 (QPSK MIMO-B)	0.00	0	0.0	0.00	0	0.0	0.00
x4 (256QAM MIMO-A)	0.00	0	0.0	0.00	0	0.0	0.00
x3 (64QAM MIMO-A)	0.00	0	0.0	0.00	0	0.0	0.00
x2 (16QAM MIMO-A)	0.00	0	0.0	0.00	0	0.0	0.00
x1 (QPSK MIMO-A)	0.00	0	0.0	0.00	0	0.0	0.00
Total	16.38	1	100.0	11.47	1	100.0	4.92

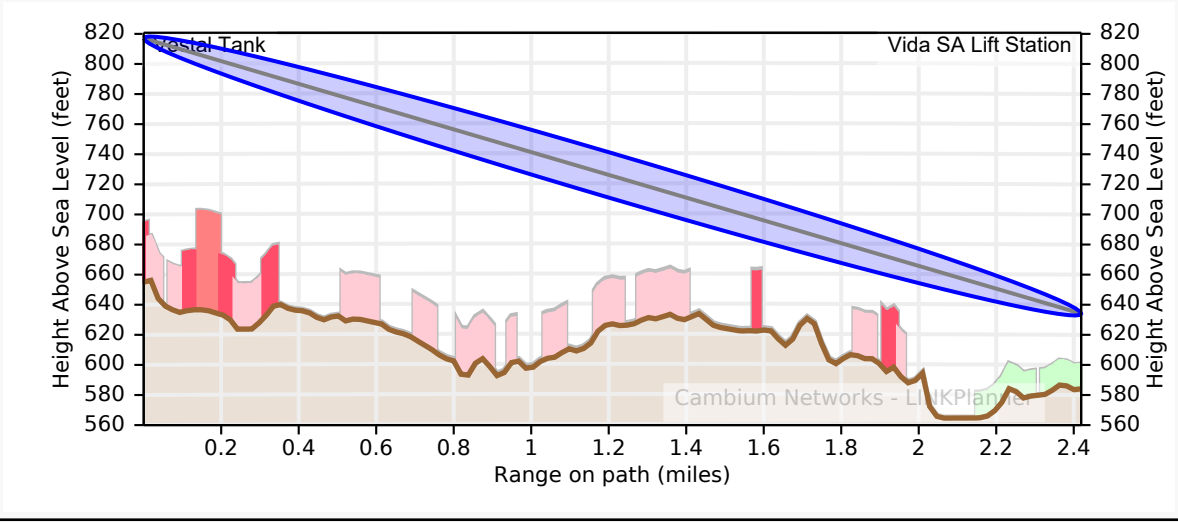
4. Vestal Tank : 1 - Access Point Map



5. Vestal Tank : 1 to Vida SA Lift Station

Summary	
AP Name	Vestal Tank : 1
Group Name	
Hub Name	Vestal Tank
SM Name	Vida SA Lift Station
Link Type	Line-of-Sight
AP Equipment Type	PMP450i (running Release 21.1)
SM Equipment Type	PMP450i (running Release 21.1)
Maximum Obstruction	0 feet
Link Distance	2.419 miles
Free Space Path Loss	118.17 dB
Excess Path Loss	0.00 dB
RF Frequency Band	4.9 GHz (4940 to 4990 MHz)
RF Channel Bandwidth	5 MHz
Downlink Data	75 %

Path Profile



Bill of Materials		
Part Number	Qty	Description
(no part number)	1	Unspecified Power Lead. (set the region in the Bill of Materials options)
C000000L033	1	Gigabit Surge Suppressor (56V), 10/100/1000 BaseT
C050045C002	1	5 GHz PMP 450i SM, Integrated High Gain Antenna
EW-E2PM4ISM-WW	1	PMP450i Subscriber Module Extended Warranty, 2 Additional Years

Bill of Materials (continued)		
Part Number	Qty	Description
N000000L034	1	PoE, 30.5W, 56V, 5GbE DC Injector, Indoor, Energy Level 6 Supply, accepts C5 connector
N000045L002	1	Tilt Bracket Assembly

Physical Installation Notes for SM Vida SA Lift Station	
Link Name	Vestal Tank : 1 to Vida SA Lift Station
Access Point	Vestal Tank : 1
Group Name	
Hub Name	Vestal Tank
Latitude	29.31324N
Longitude	098.51596W
Site Elevation	634 feet AMSL
Platform Variant	4.9 GHz PMP-450i
Antenna Type	Cambium Networks 10° High Gain Integrated
Antenna Beamwidth	10.0°
Antenna Gain	23.0 dBi
Antenna Height	50.0 feet AGL
Antenna Tilt Angle	0.8° (uptilt)
Antenna Azimuth	16.43° from True North 12.73° from Magnetic North
Magnetic Declination	3.70° E ±0.33° changing by 0.11° W per year

Radio Commissioning Notes for SM Vida SA Lift Station	
AP Output Power	22.0 dBm
AP Antenna Gain (towards SM)	15.9 dBi
Region	North America
Country	United States
Latitude	29.31324N
Longitude	098.51596W
Height	15.2 m (50 ft)
Number of Data Channels	1
Channel Bandwidth	5 MHz
Color Code	0
MIMO Rate Adapt Algorithm	Enabled
DL Maximum Mod Mode	x8
UL Maximum Mod Mode	x8
External Gain	23.0 dBi
Operational Transmit Power	23 dBm
Predicted Receive Power	-57 dBm ± 5 dB while aligning

Installation Instruction

Perform the following checks during the installation (Check the deployment guide and the User Guide.)

1. Check with a GPS that you are installing at the correct location.

2. Check carefully the direction to Access Point. Either use a corrected compass or use the GPS waypoint feature about 300 meters from the installation location.

3. When aligning antenna, it is important to find the centre of the main beam. This is done by adjusting the antenna and monitoring the receive level until the peak is found. Once the peak level is found, it should be checked against the prediced receive power to ensure that the antenna has not been aligned on a side lobe.

Performance to AP Vestal Tank : 1 *	
Predicted Receive Power	-56 dBm ± 5 dB while aligning
Min Mod Mode Required	x1 (QPSK MIMO-A)
Min Availability Required	99.0000 %
Max Usable Mode	x8 (256QAM MIMO-B)
Predicted Availability	100.0000 %

Performance to SM Vida SA Lift Station *	
Predicted Receive Power	-57 dBm ± 5 dB while aligning
Min Mod Mode Required	x1 (QPSK MIMO-A)
Min Availability Required	99.0000 %
Max Usable Mode	x8 (256QAM MIMO-B)
Predicted Availability	100.0000 %

* Multipath availability calculated using ITU-R P.530-17

Mode	Vestal Tank				Vida SA Lift Station			
	Max Data Rate for 1 SM (Mbps)	Fade Margin (dB)	Availability (%) *	Receive time in Mode (%)	Max Data Rate for 1 SM (Mbps)	Fade Margin (dB)	Availability (%) *	Receive time in Mode (%)
x8 (256QAM MIMO-B)	4.92	10.00	99.9994	99.9994	11.47	9.70	99.9994	99.9994
x7 (128QAM MIMO-B)	4.30	14.70	99.9995	0.0001	10.04	14.10	99.9995	0.0001
x6 (64QAM MIMO-B)	3.69	18.00	99.9995	0.0000	8.60	18.10	99.9995	0.0000
x5 (32QAM MIMO-B)	3.07	20.90	99.9995	0.0000	7.17	21.10	99.9995	0.0000
x4 (16QAM MIMO-B)	2.46	24.10	99.9995	0.0000	5.73	24.10	99.9995	0.0000
x3 (8QAM MIMO-B)	1.84	26.70	99.9995	0.0000	4.30	26.50	99.9995	0.0000

(continued)

Mode	Vestal Tank				Vida SA Lift Station			
	Max Data Rate for 1 SM (Mbps)	Fade Margin (dB)	Availability (%) *	Receive time in Mode (%)	Max Data Rate for 1 SM (Mbps)	Fade Margin (dB)	Availability (%) *	Receive time in Mode (%)
x2 (QPSK MIMO-B)	1.23	31.30	99.9995	0.0000	2.87	31.00	99.9995	0.0000
x4 (256QAM MIMO-A)	2.46	10.00	0.0005	0.0005	5.73	9.70	0.0005	0.0005
x3 (64QAM MIMO-A)	1.84	18.00	0.0005	0.0000	4.30	18.10	0.0005	0.0000
x2 (16QAM MIMO-A)	1.23	24.10	0.0005	0.0000	2.87	24.10	0.0005	0.0000
x1 (QPSK MIMO-A)	0.61	35.30	100.0000	0.0000	1.43	35.20	100.0000	0.0000

* Multipath availability calculated using ITU-R P.530-17

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SECTION 01450

TECHNICAL SPECIFICATIONS – LIFT STATION AND EQUIPMENT SLAB - SPECIAL INSPECTIONS AND QUALITY CONTROL

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Section Includes: Special Inspection as well as quality control requirements and procedures for products and workmanship and includes the following;

1. Sampling and testing of materials
2. Testing of equipment
3. Requirements for testing laboratories
4. Procedures and limitations of inspection

B. The Contractor shall hire an independent testing laboratory for inspections and material testing as specified further in this Section.

C. The project's geotechnical engineering firm is Professional Service Industries, Inc. of San Antonio, Texas, and shall be used for testing where indicated.

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM):

1. E 329 - Standard for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction.
2. E 543 - Standard Specification for Agencies Performing Nondestructive Testing

1.03 PRODUCTS AND WORKMANSHIP

A. When specified, products will be tested and inspected either at point of origin or at Work site.

1. Notify ENGINEER in writing well in advance, of when products will be ready for testing and inspection at point of origin.
2. Do not construe that satisfactory tests and inspections at point of origin is final acceptance of products. Satisfactory tests or inspections at point of origin do not preclude retesting or reinspection at Work site.

B. Do not ship products, which require testing, and inspection at point of origin prior to testing and inspection.

1.04 AUTHORITY AND DUTIES OF OWNER'S REPRESENTATIVE OR INSPECTOR

A. OWNER's Representative or Inspector employed or retained by OWNER or ENGINEER is authorized to inspect the Work.

B. Inspections may extend to entire or part of the Work and to preparation, fabrication, and manufacture of products for the Work.

C. Deficiencies or defects in the Work, which have been observed, will be called to CONTRACTOR's attention.

D. Inspector Will Not:

1. Alter or waive provisions of Contract Documents.
2. Inspect CONTRACTOR's means, methods, techniques, sequences, or procedures for construction.
3. Accept portions of the Work, issue instructions contrary to intent of Contract Documents, or act as foreman for CONTRACTOR. Supervise, control, or direct CONTRACTOR's safety precautions or programs; or inspect for safety conditions on Work site, or of persons thereon, whether CONTRACTOR's employees or others.

E. Inspector Will:

1. Conduct on-site observations of the Work in progress to assist ENGINEER in determining when the Work is, in general, proceeding in accordance with Contract Documents.
2. Report to ENGINEER whenever Inspector believes that Work is faulty, defective, does not conform to Contract Documents, or has been damaged; or whenever there is defective material or equipment; or whenever Inspector believes the Work should be uncovered for observation or requires special testing.

1.05 SAMPLING AND TESTING

A. General:

1. Prior to delivery and incorporation in the Work, submit listing of sources of materials, when specified in Sections where materials are specified.
2. When specified in Sections where products are specified,
   a. Submit sufficient quantities of representative samples of character and quality required of materials to be used in the Work for testing or examination.
   b. Test materials in accordance with standards of national technical organizations.

B. Sampling:

1. Furnish specimens of materials when requested.
2. Do not use materials, which are required to be tested until testing indicates satisfactory compliance with specified requirements.
3. Specimens of materials will be taken for testing whenever necessary to determine quality of material.
4. Assist ENGINEER in preparation of test specimens at site of Work, such as soil samples and concrete test cylinders.

C. Test Standards:

1. Perform sampling, specimen preparation, and testing of materials in accordance with specified standards, and when no standard is specified, in accordance with standard of nationally recognized technical organization.
2. Physical characteristics of materials not particularly specified shall conform to standards published by ASTM, where applicable.
3. Standards and publication references in Contract Documents shall be edition or revision in effect on date Project Bid Proposals are opened.

1.06 TESTING LABORATORY SERVICES

A. Qualification of Laboratory:

1. Meets "Recommended Requirements for Independent Laboratory Qualification", published by American Council of Independent Laboratories.
2. Meets requirements of ASTM E 329 and ASTM E 543.
3. Has authorization to operate in state in which Project is located.
4. Will submit copy of report of inspection of facilities made by Materials Reference Laboratory of National Bureau of Standards (NBS) during most recent tour of inspection, with memorandum of remedies of deficiencies reported by inspection.
5. Has testing equipment calibrated at reasonable intervals by devices of accuracy traceable to NBS or accepted values of natural physical constants.
6. Shall be insured against errors and omissions by a professional liability insurance policy having a limit of liability not less than $1,000,000.
7. Laboratory staff monitoring concrete work shall be ACI certified inspectors.

B. Laboratory Duties:

1. Cooperate with ENGINEER and CONTRACTOR.
2. Provide qualified personnel.
3. Notify ENGINEER and CONTRACTOR, in writing, of response time needed to schedule testing or inspections after receipt of notice.
4. Perform specified inspections, sampling and testing of materials and methods of construction in accordance with specified standards to ascertain compliance of materials with requirements of Contract Documents.
5. Promptly notify ENGINEER and CONTRACTOR of observed irregularities or deficiencies of construction.
6. Promptly submit written report of each test and inspection; one copy each to ENGINEER, OWNER, and CONTRACTOR. Each report shall include:
    a. Date issued.
    b. Project title and number.
    c. Testing laboratory name, address and telephone number.
    d. Name and signature of laboratory inspector.
    e. Date and time of sampling or inspection.
    f. Record of temperature and weather conditions.
    g. Date of test.
    h. Identification of product and Specification section.
    i. Location of sample or test in Project.
    j. Type of inspection or test.
    k. Results of tests and compliance with Contract Documents.
    l. Interpretation of test results, when requested by ENGINEER.

C. Limitations of Authority of Testing Laboratory: Laboratory is not authorized to:

1. Release, revoke, alter or enlarge on requirements of Contract Documents.
2. Approve or accept portion of Work.
3. Perform duties of CONTRACTOR.

1.07 CONTRACTOR'S RESPONSIBILITIES:

A. Hire an independent, qualified, testing laboratory; pay for testing; and any retesting necessary; unless specified otherwise.

B. Cooperate with laboratory personnel and provide access to construction and manufacturing operations.

C. Secure and deliver to laboratory adequate quantities of representative samples of materials proposed to be used and which require testing.

D. Provide to laboratory concrete mix design proposed to be used for concrete, and other materials mixes, which require control by testing laboratory.

E. Furnish copies of product test reports.

F. Furnish Incidental Labor and Facilities:

1. To provide access to construction to be tested.
2. To obtain and handle samples at Work site or at source of product to be tested.
3. To facilitate inspections and tests.
4. For safe storage of test samples.
5. For proper curing of concrete test samples on project site for the first 24 hours and also for subsequent field curing as required by ASTM Specifications C31.

G. Notify laboratory in advance of when observations, inspections and testing is needed for laboratory to schedule and perform in accordance with their notice of response time.
H. Provide current welder certifications for each welder to be employed.

I. Furnish fabrication and erection inspections of all welds in accordance with AWS D1.1, Chapter 6.

J. Prequalification of all welding procedures to be used in executing the work.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 EXCAVATION

A. A qualified representative of the project's geotechnical engineer shall provide the services specified in this section.

B. Review geotechnical parameters and assumptions used in the development of calculations and drawings for retention systems, including lateral design forces and surcharge effects.

C. Observe the excavation process, the exposed faces of the excavation and the installation of retention systems. Check for compliance with the Contract Documents and make alternative recommendations as may be required to suit field conditions.

D. Review required submittals as they pertain to geotechnical requirements.

E. Check the adequacy and accuracy of the Contractor's monitoring program, equipment, procedures and measurements related to movements of the excavated face and adjacent structures.

F. Check the adequacy of the Contractor's dewatering equipment and procedures.

G. Immediately report any unsafe conditions. Request additional shoring or bracing where judged to be necessary as the excavation progresses.

3.02 FILLING AND BACKFILLING

A. A qualified representative of the project's geotechnical engineer shall provide the services specified in this section.

B. The Contractor shall make available to the laboratory adequate samples and quantities of each fill and backfill material type from the proposed sources of supply not less than 14 days prior to the start of the work.

C. Laboratory shall analyze samples as required to provide a soil description and to determine compliance with quality requirements. Perform, at a minimum, the following tests:
   1. Test for plastic limit of soils and plasticity index of soils in accordance with ASTM D424.
   2. Test for moisture density relations of soil in accordance with ASTM D698.

D. Furnish a report for each individual test and state whether sample conforms to specified requirements or state reasons for non-compliance.

E. Inspect backfill material and placement for compliance with specified requirements.

F. Make in-place compaction tests for moisture content, moisture-density relationship and density of fill material after compaction to determine that foundation pads and backfill materials have been compacted to the specified density.

Provide one test for each 5000 square feet of area of each lift placed under foundation mats or slabs. Stagger test locations in each lift from those in the previous lift. Perform a minimum of three tests for each lift.

3.03 CONCRETE REINFORCING STEEL AND EMBEDDED METAL ASSEMBLIES

A. Inspect all concrete reinforcing steel prior to placing of concrete for compliance with the Contract Documents and approved shop drawings. All instances of noncompliance shall be immediately brought to the attention of the Contractor for correction. If uncorrected by the Contractor, they shall be listed in the report.

B. Observe and report on the following:
   1. Number and size of bars.
   2. Bending and lengths of bars.
   3. Splicing.
   4. Clearance to forms including chair heights.
   5. Clearance between bars or spacing.
   6. Rust, form oil, and other contamination.
   7. Grade of Steel.
   8. Securing, tying and chairing of bars.
   9. Excessive congestion of reinforcing steel.
   10. Installation of anchor bolts and placement of concrete around anchor bolts.
   11. Fabrication and installation of embedded metal assemblies, including visual inspection of all welds.
   12. Visually inspect deformed bar anchors on embedded assemblies for compliance with Contract Documents.

C. Provide a qualified, experienced inspector to inspect reinforcing steel. Inspector shall have a minimum of three years experience inspecting reinforcing steel in projects of similar size.

3.04 CONCRETE INSPECTION AND TESTING

A. Receive and evaluate all proposed concrete mix designs submitted by the Contractor. If the mix designs comply with the Drawings and Specifications, the laboratory shall submit a letter to the Engineer certifying compliance. Mix designs not complying with the Drawings and Specifications shall be returned by the Laboratory as unacceptable.

B. Secure composite samples of concrete at the jobsite in accordance with ASTM C172.

C. Mold and cure three specimens from each sample in accordance with ASTM C31. The test cylinders shall be stored in the field 24 hours and then carefully transported to the laboratory and cured in accordance with ASTM C31.

D. Test specimens in accordance with ASTM C39. Two specimens shall be tested at 28 days for acceptance and one shall be tested at seven days for information.

E. Make one strength test (three cylinders) for each 100 cubic yards or fraction thereof, of each mix design placed in one day.

F. Make one slump test for each set of cylinders following the procedural requirements of ASTM C143 and ASTM C172. Make additional slump tests whenever the consistency of the concrete appears to vary. Slump tests corresponding to samples from which strength tests are made shall be reported with the strength test results. Other slump tests need not be reported.

G. Determine total air content of air entrained normal-weight concrete sample for each strength test in accordance with ASTM C231.

H. Determine air content and unit weight of lightweight concrete sample for each strength test in accordance with ASTM C173 and ASTM C567.

I. Monitor the addition of water at the jobsite and the length of time the concrete is allowed to remain in the truck before

placement. Report any significant deviation from the approved mix design to the Engineer, the Contractor, and the concrete supplier.

J. Observe the placing of all concrete, except non structural slabs-on-grade and sitework. Observe and report on placing method, consolidation, cold joints, length of drop and displacement of reinforcing. Report deficiencies to the Contractor immediately for corrective action. Inspections may be reduced to a periodic basis when all procedures have been deemed satisfactory by the laboratory.

K. The testing laboratory shall certify each delivery ticket indicating class of concrete delivered (or placed), amount of water added and the time at which the cement and aggregate was dispensed into the truck, and the time at which concrete was discharged from the truck.

L. Evaluation and Acceptance:

1. The strength level of the concrete will be considered satisfactory if the averages of all sets of three consecutive strength test results are equal to or exceed the specified strength and no individual test result (average of two cylinders) is below the specified strength by more than 500 psi.

2. Completed concrete work will be accepted when the requirements of "Specifications for Structural Concrete for Buildings," ACI 301, Chapter 18 have been met

M. Comply with ACI 311, "Guide For Concrete Inspection" and "ACI Manual of Concrete Inspection" (SP-2).

N. Inspect the application of curing compound and monitor all curing conditions to assure compliance with Specification requirements. Report curing deficiencies to the Contractor immediately and submit a report to the Engineer.

3.05 MEASUREMENT AND PAYMENT

A. Payment for all work and services provided for under this item shall be included in the lump sum price as listed in the Bid Proposal.

END OF SECTION