Colliers
Engineering
& Design

Supplemental Specifications for Vida San Antonio Lift Station

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Vida San Antonio Lift Station.

Bexar County, Texas

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SUPPLEMENTAL SPECIFICATIONS

SUPLEMENTAL SPECIFICATIONS

LIFT STATION SPECIFICATIONS

Item No. 100 Mobilization
Item No. 101 Preparing Right-of-Way
Item No. 103 Revegetation
Item No. 200 Flexible Base
Item No. 299 Flowable Fill
Item No. 300 Concrete (Natural Aggregate)
Item No. 301 Reinforcing Steel
Item No. 307 Concrete Structures
Item No. 550 Trench Excavation Safety Protection
Item No. 804 Excavation Trenching and Backfill
Item No. 824 Water Service Supply Lines New Services
Item No. 833 Meter and Meter Box Installation
Item No. 836 Grey Iron and Ductile-Iron Fittings
Item No. 839 Anchorage Thrust Blocking and Joint Restraint
Item No. 845 Gate, Fencing and Property Marker Details
Item No. 847 Disinfection
Item No. 848 Sanitary Sewer
Item No. 849 Sanitary Sewer Testing
Item No. 852 Sanitary Sewer Manholes
Item No. 866 Sanitary Sewer Main Television Inspection
Item No. 868 Sanitary Sewer System Cleaning
Item No. 1110 Progress Schedule
Item No. 1112 Project Record Documents
Item No. 1114 Pre and Post Construction Video
Item No. 01340 Submittals
Item No. 02513 Bituminous Concrete Drives
Item No. 02657 Fiberglass Reinforced Polyester (FRP) Wet Well
Item No. 02701 Valves
Item No. 02703 Sanitary Force Main
Item No. 05500 Miscellaneous Metal Work
Item No. 09900 Painting
Item No. 15162 Wet Pit Submersible Pumps for Wastewater
Item No. 15163 Odor Control and Aeration System Equipment

ELECTRICAL SPECIFICATIONS

DIVISION 16 – ELECTRICAL

16015 General Electrical Requirements
16050 Basic Electrical Materials and Methods
16060 Grounding and Bonding
16075 Electrical Identification
16120 Conductors and Cables

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. 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.

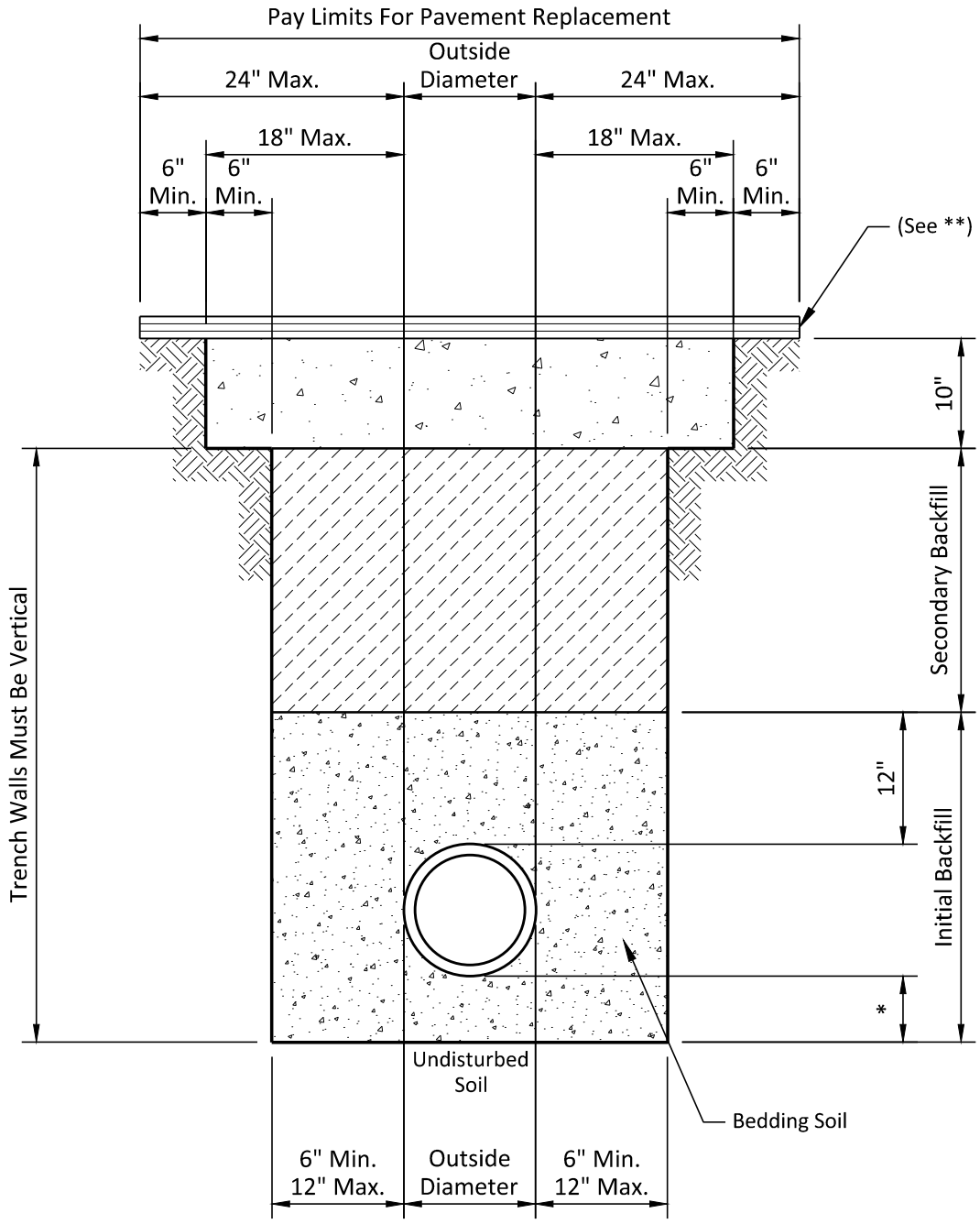
h. These tests shall be performed by a nationally-accredited, independent testing laboratory.

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.

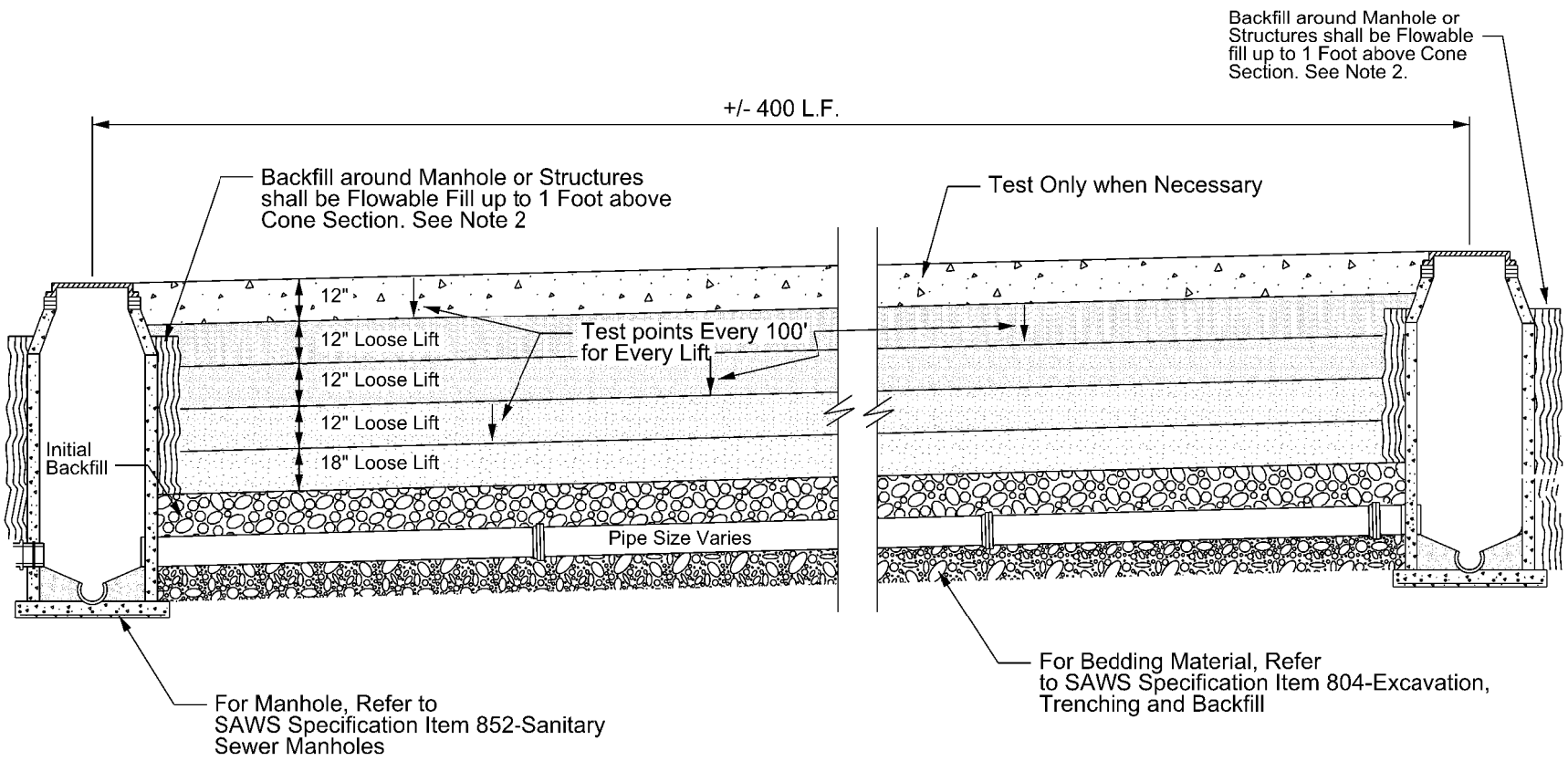
* Sewer Gravel 6" Min. or ⅛ O.D. of the Pipe, whichever is greater.
** Minimum 2" HMAC Type "D" for Trench Repair in Local/Residential Streets.
** Minimum 3" HMAC Type "C" for Trench Repair in Collector/Arterial Streets.

- 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

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:

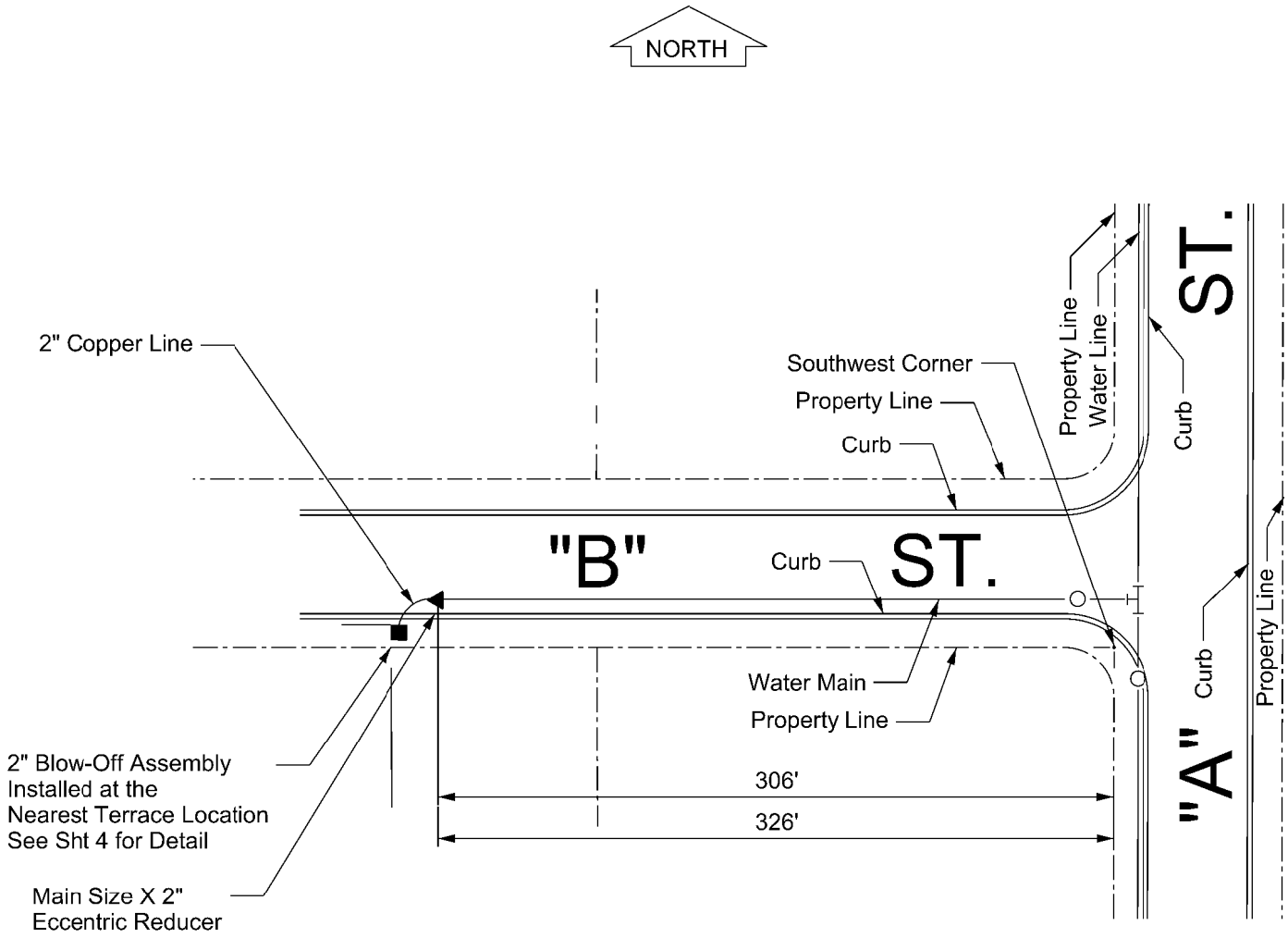
1. New Short Service will be measured by the unit of the various types and sizes of each new service line installed.
2. New Long Service will be measured by the unit of the various types and sizes of each new service line installed.
3. New Un-metered Short Service will be measured by the unit of the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

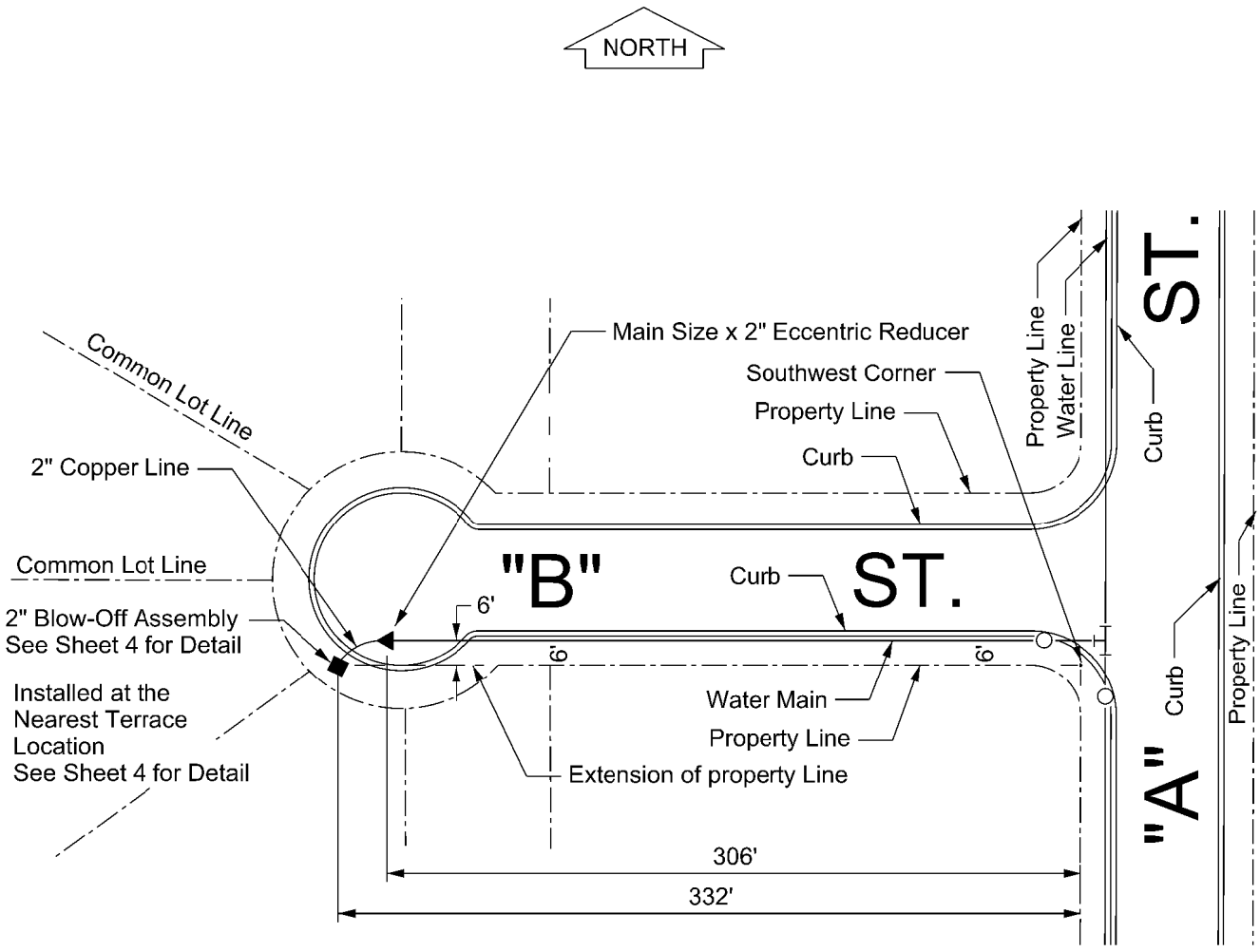
-End of Specification-



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

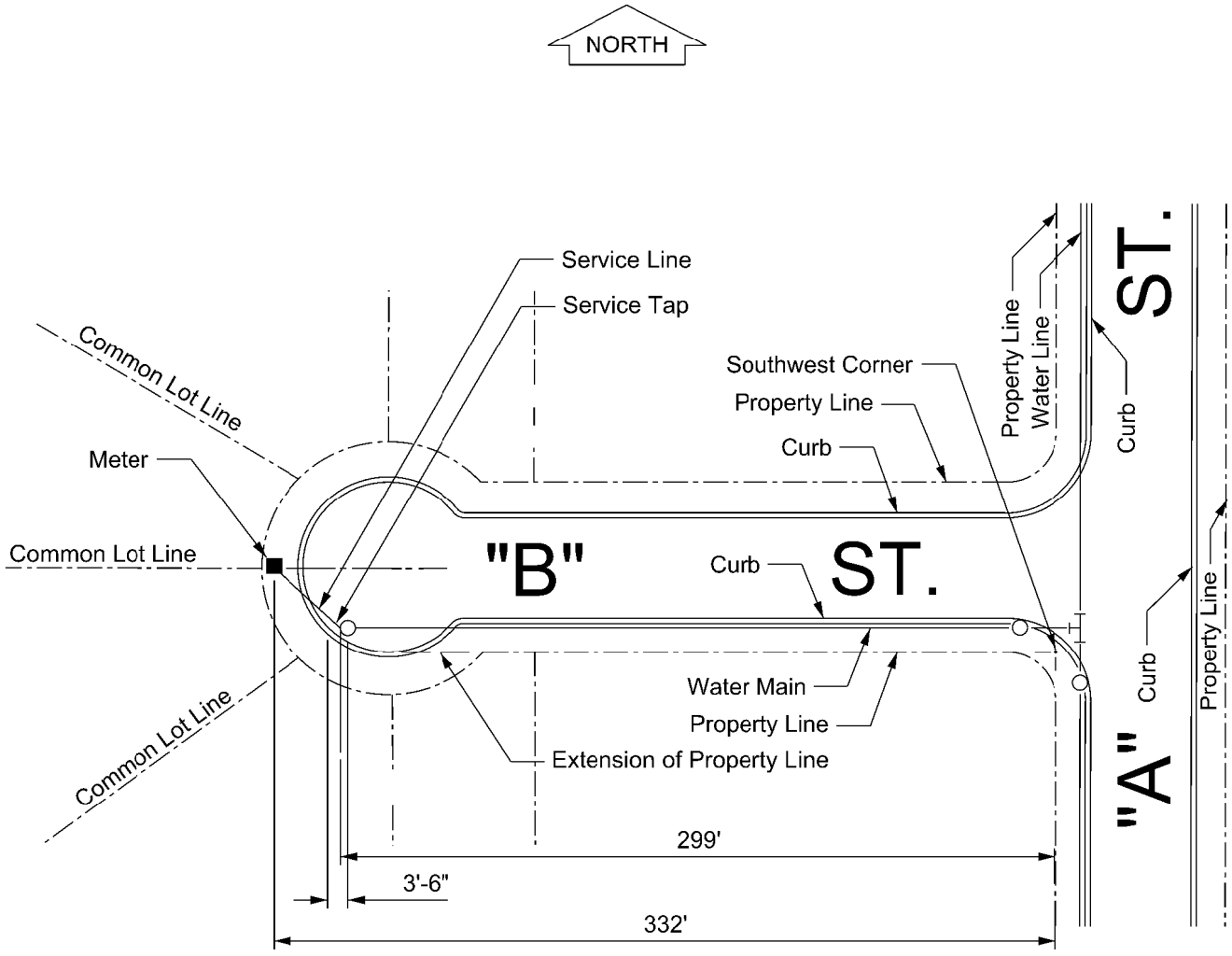
PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	TYPICAL BLOW-OFF ARRANGEMENT ON DEAD END MAINS	APPROVED MARCH 2008	REVISED AUG 2019
		DD-824-04	SHEET 1 OF 4



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.

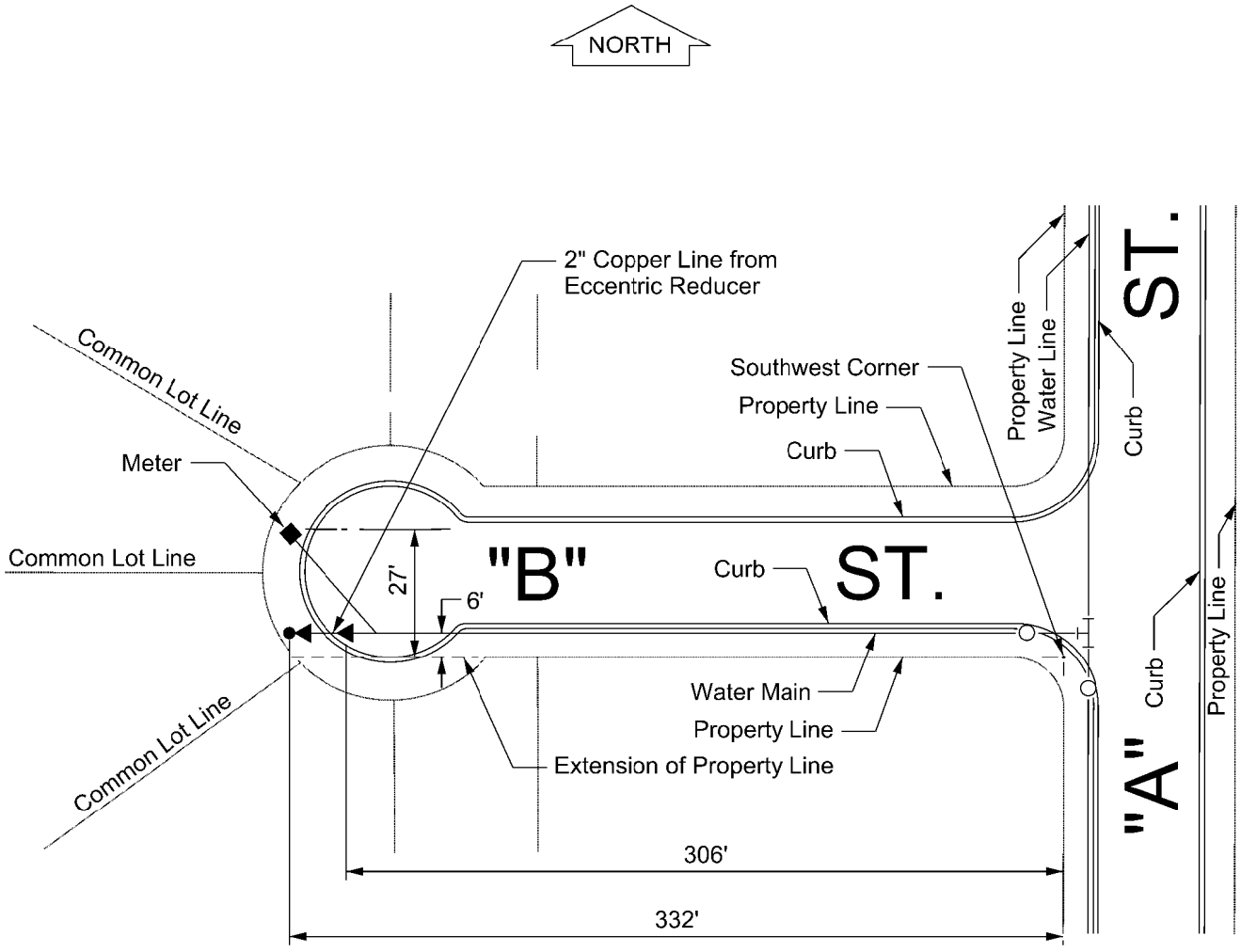
PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	TYPICAL BLOW-OFF ARRANGEMENT IN CUL-DE-SAC	APPROVED MARCH 2008	REVISED AUG 2019
		DD-824-04	SHEET 2 OF 4



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.

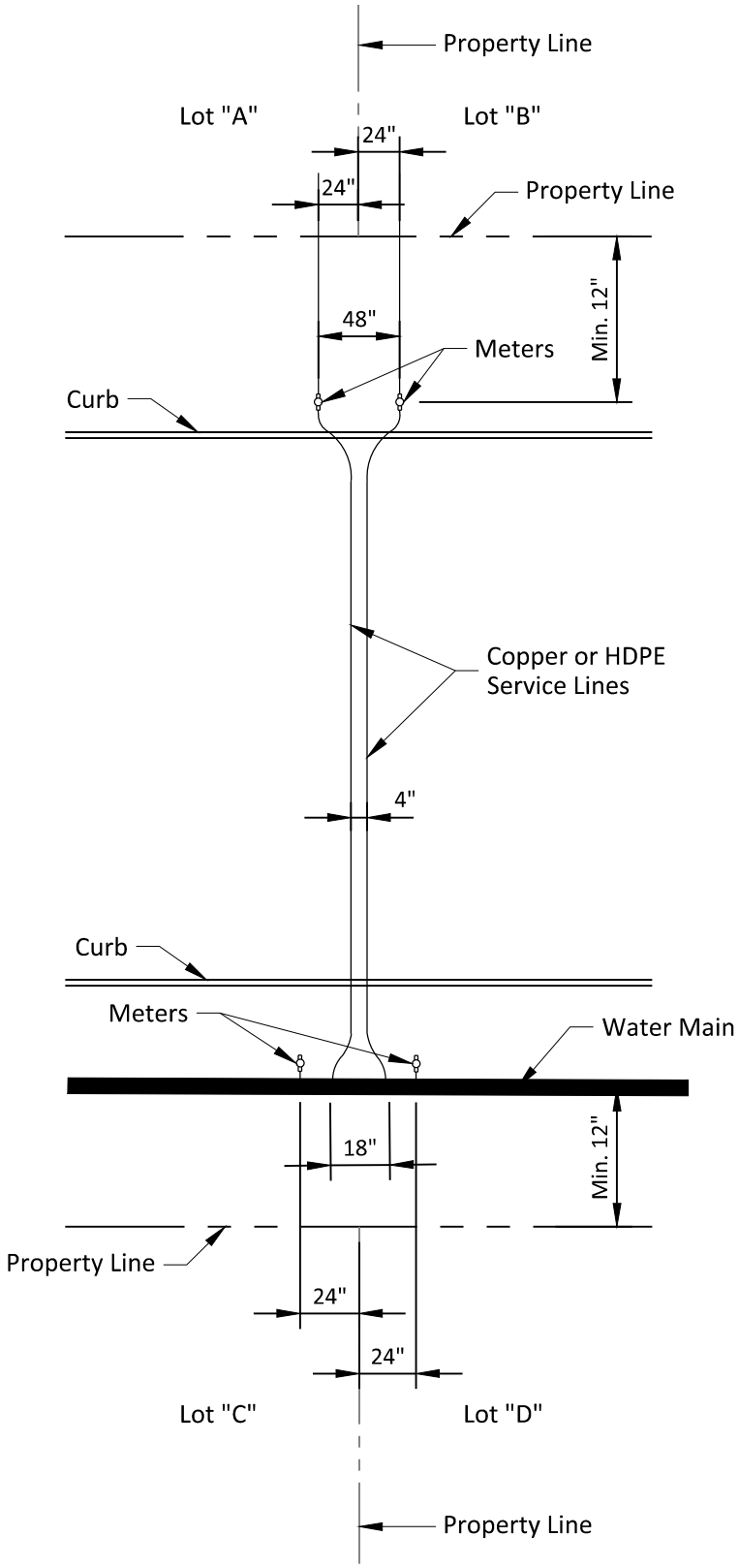
PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	TYPICAL SERVICE ARRANGEMENT IN CUL-DE-SAC	APPROVED MARCH 2008	REVISED AUG 2019
		DD-824-04	SHEET 3 OF 4



EXAMPLE BLOW-OFF MEASUREMENT:

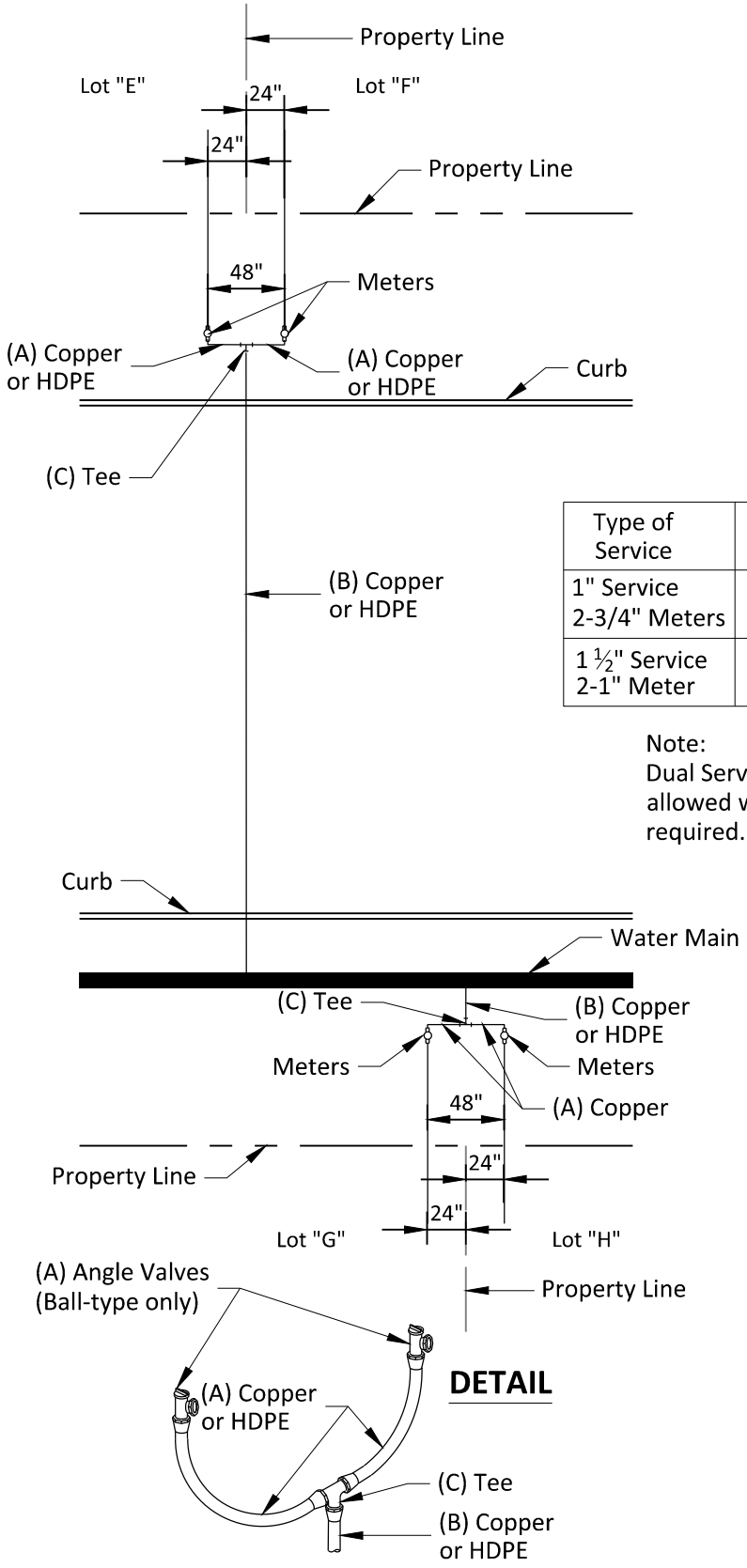
- From the Southwest Corner of "A" St. and "B" St. West 306' and North 6' to End of Eccentric Reducer and West 332' and North 6' Blow-Off Assembly.

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



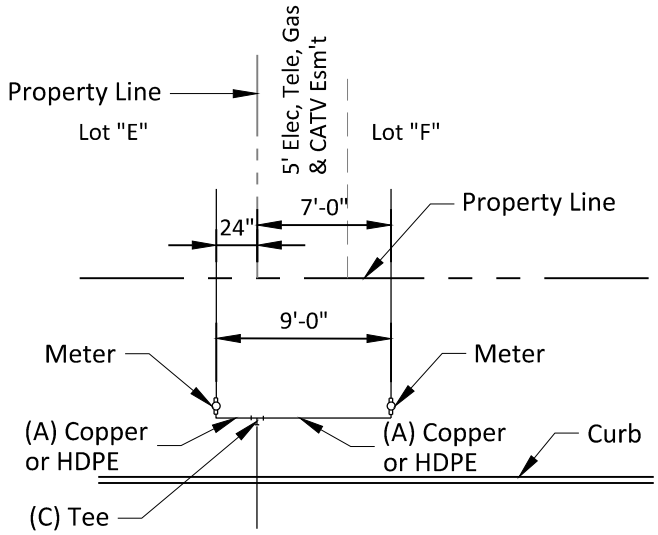
DETAIL

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"

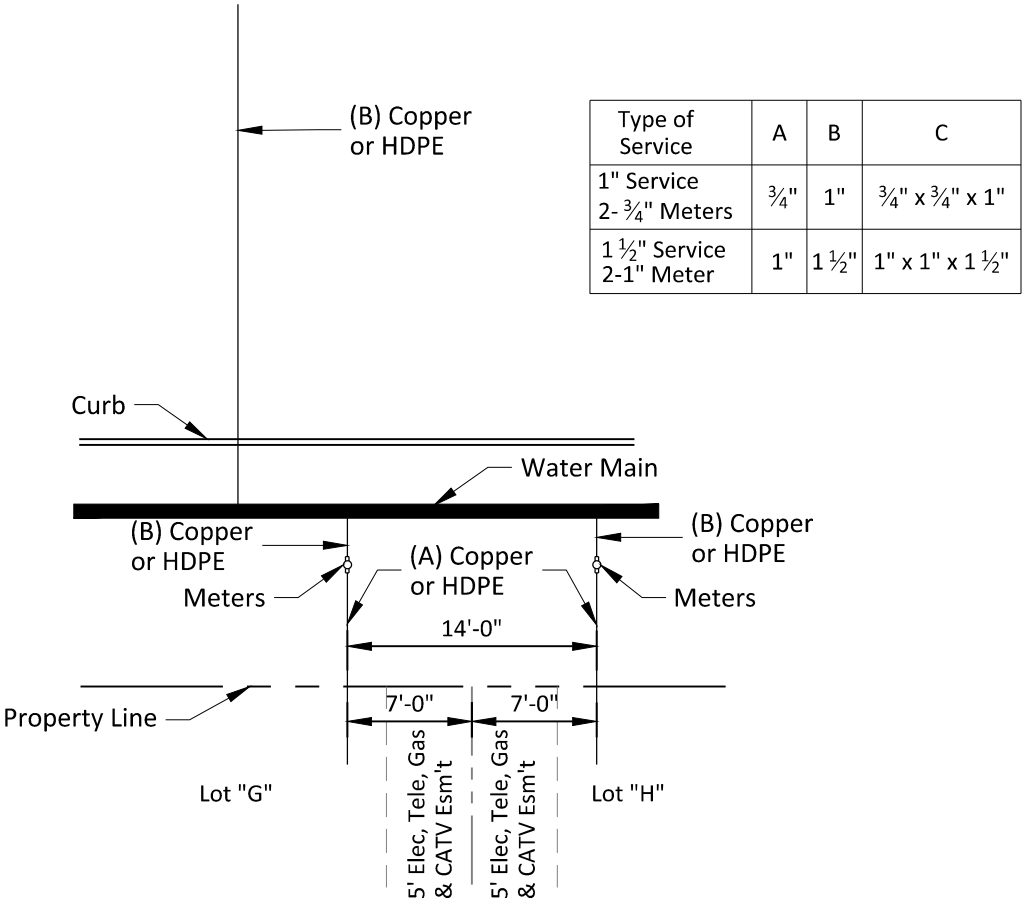
Note:
Dual Services not allowed when PRVs are required.

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



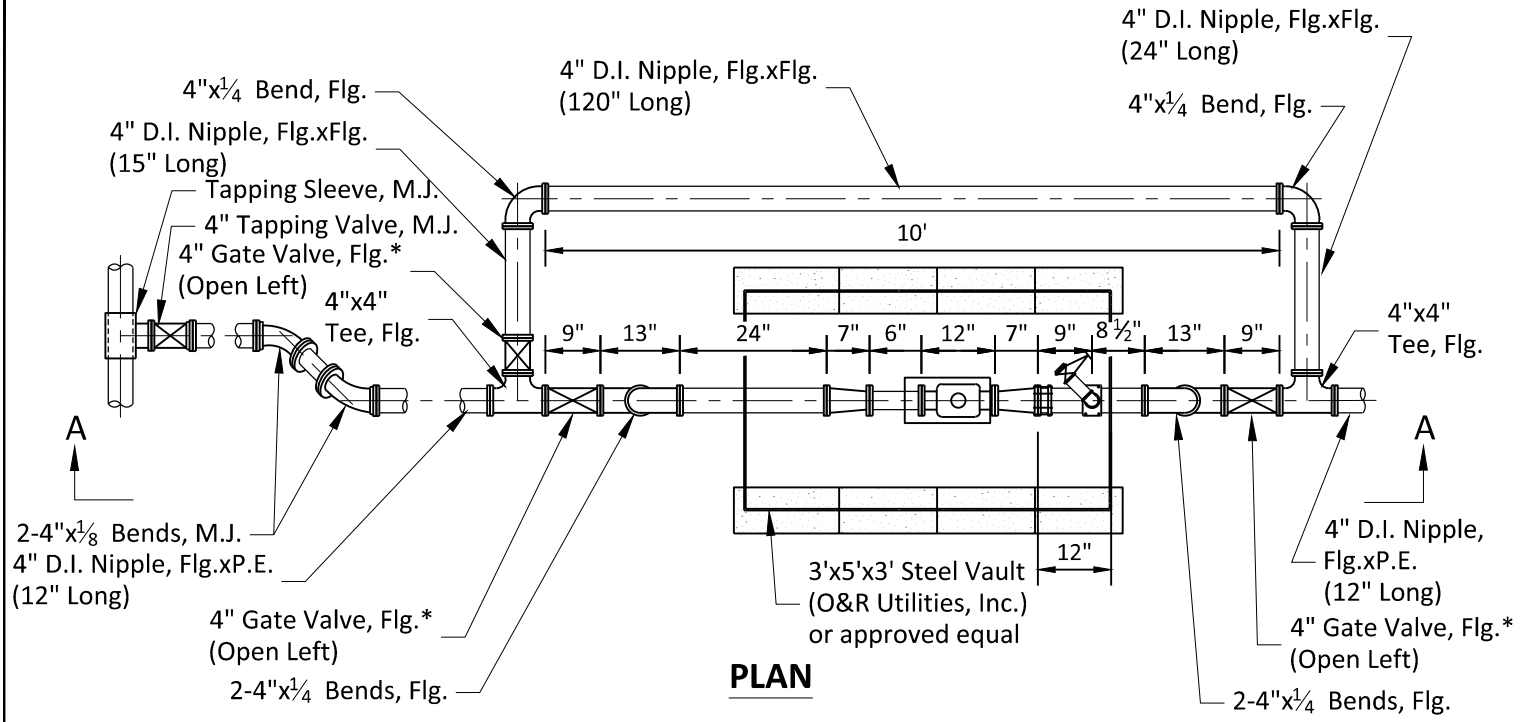
SINGLE SERVICE LINE - DUAL METER W/ EASEMENT



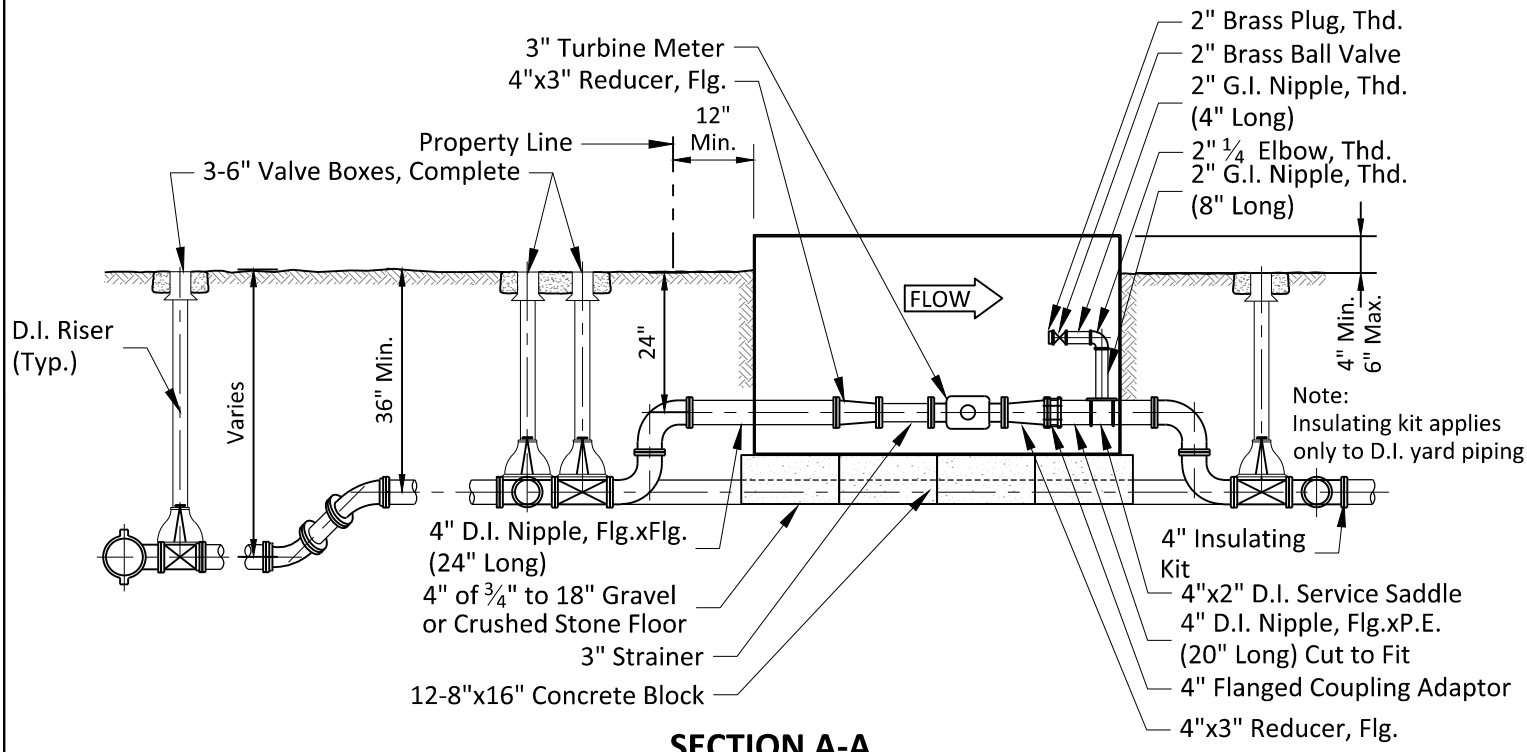
Type of Service	A	B	C
1" Service 2- ¾" Meters	¾"	1"	¾" x ¾" x 1"
1 ½" Service 2-1" Meter	1"	1 ½"	1" x 1" x 1 ½"

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



PLAN

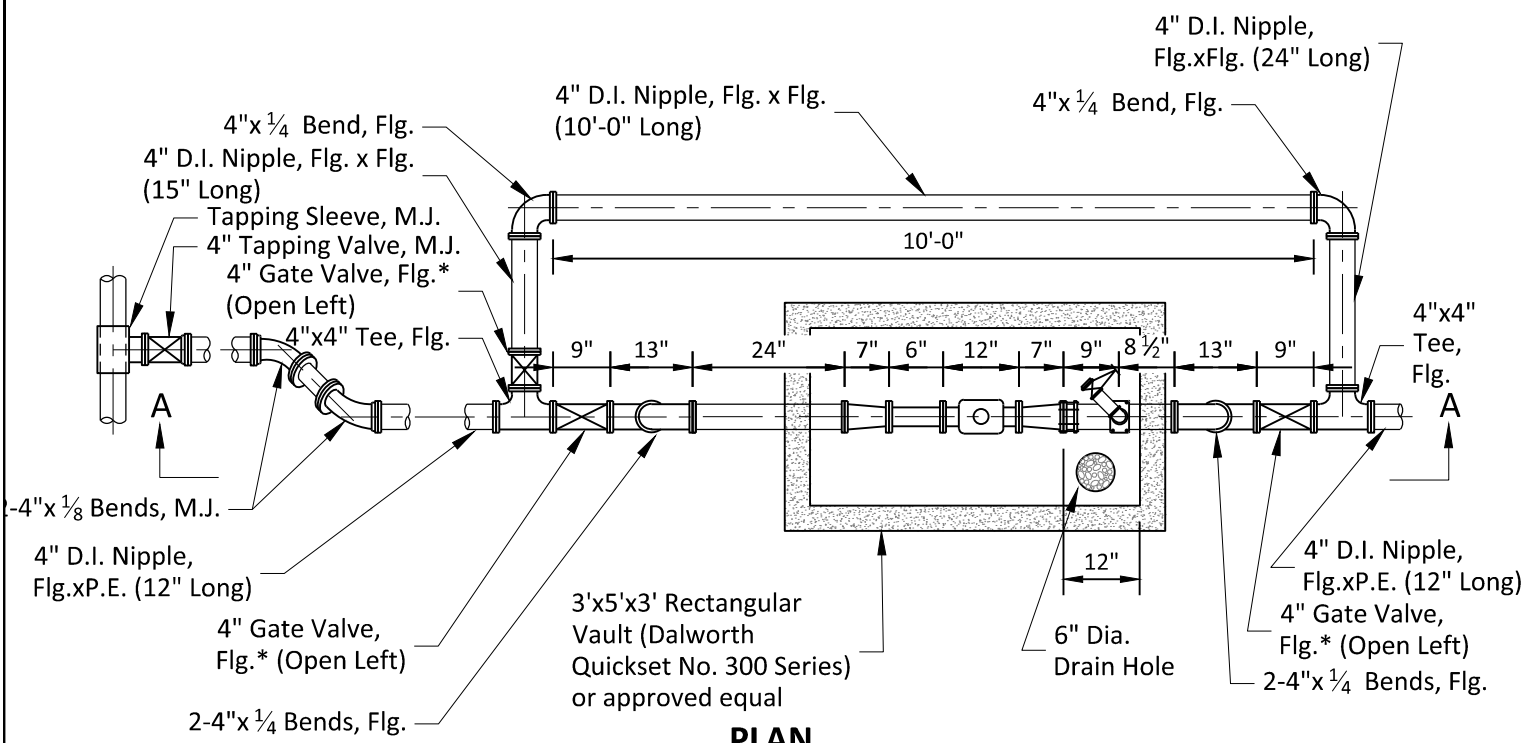


SECTION A-A

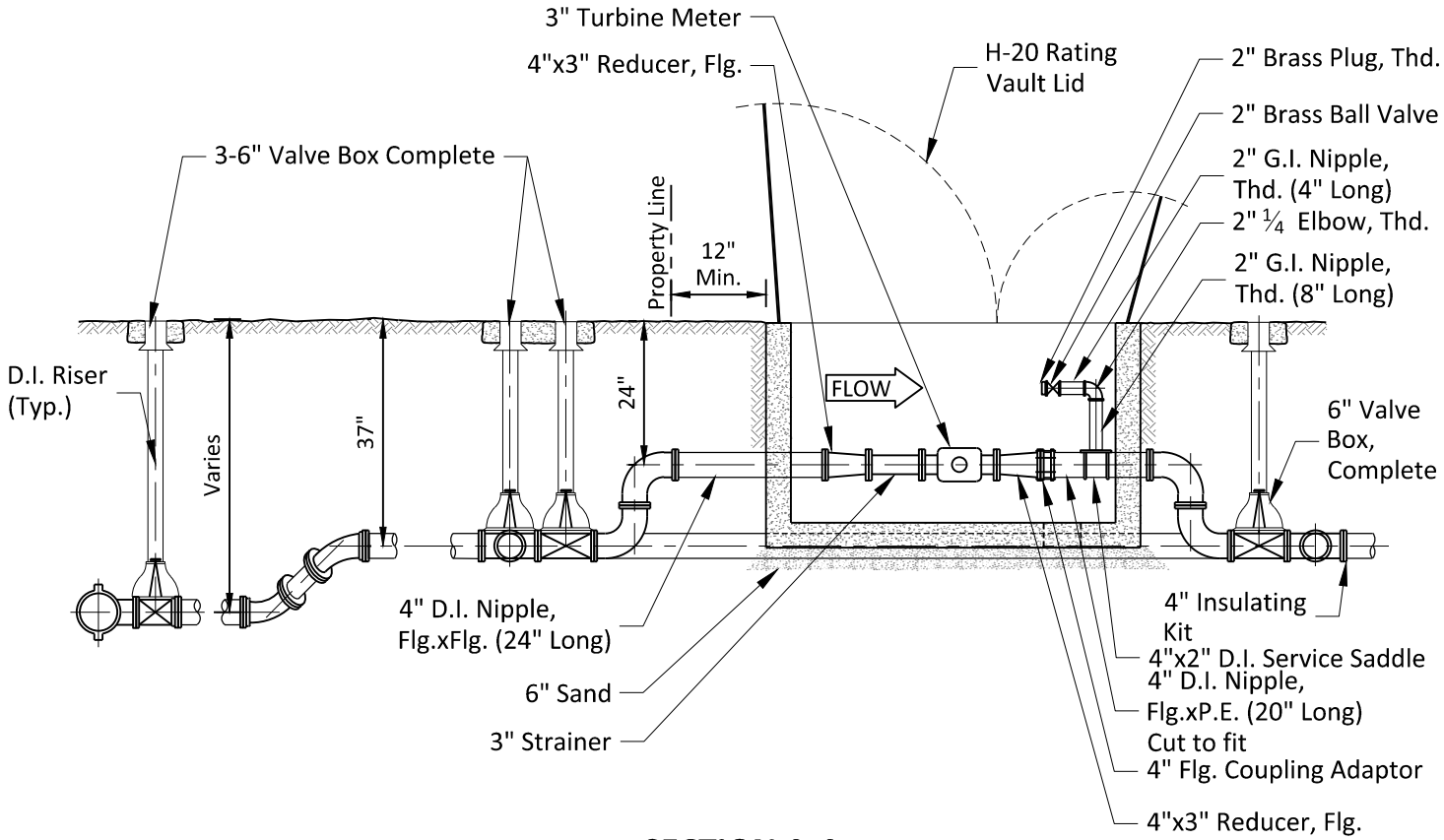
3'x5'x3' STEEL VAULT
(NON-TRAFFIC BEARING LOCATION)

*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



PLAN



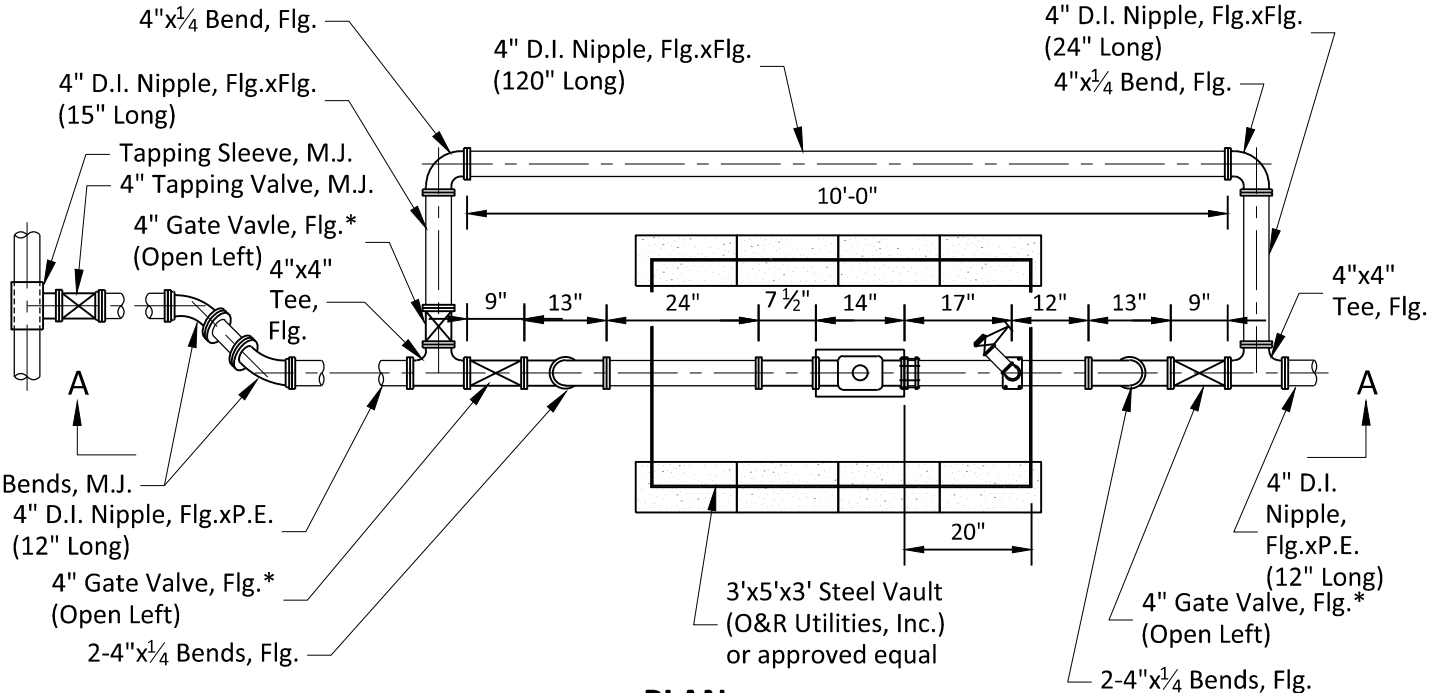
SECTION A-A

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

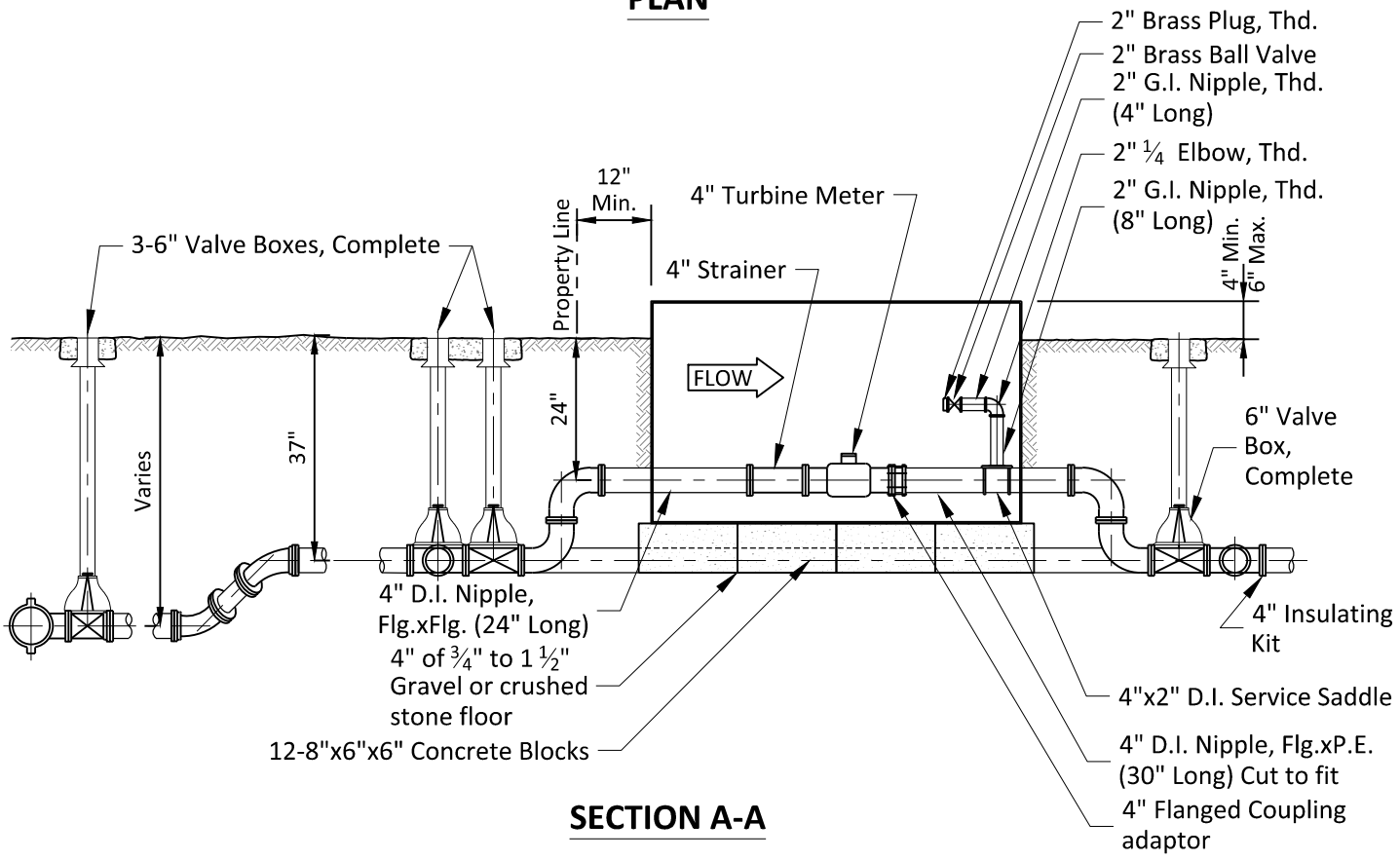
* Resilient Seat

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



PLAN



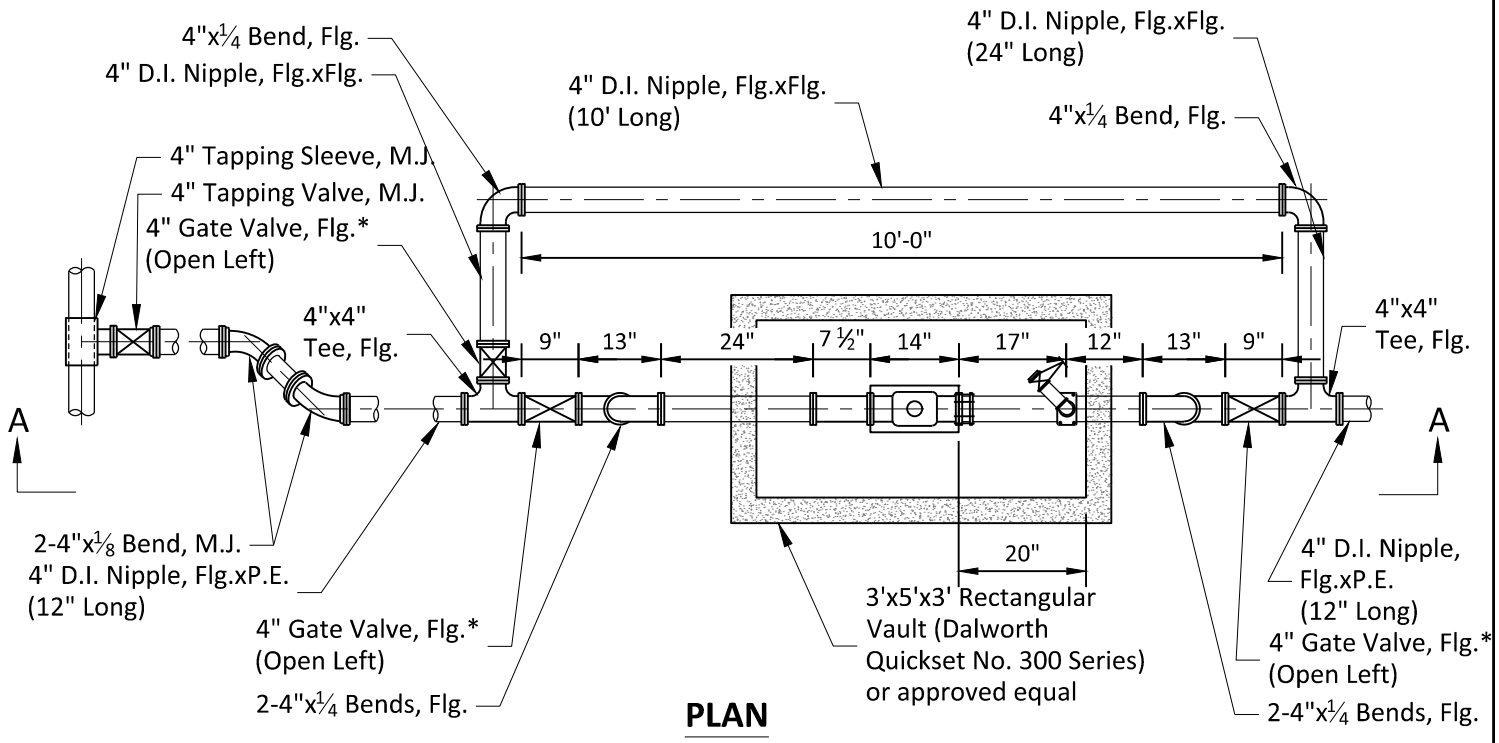
SECTION A-A

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

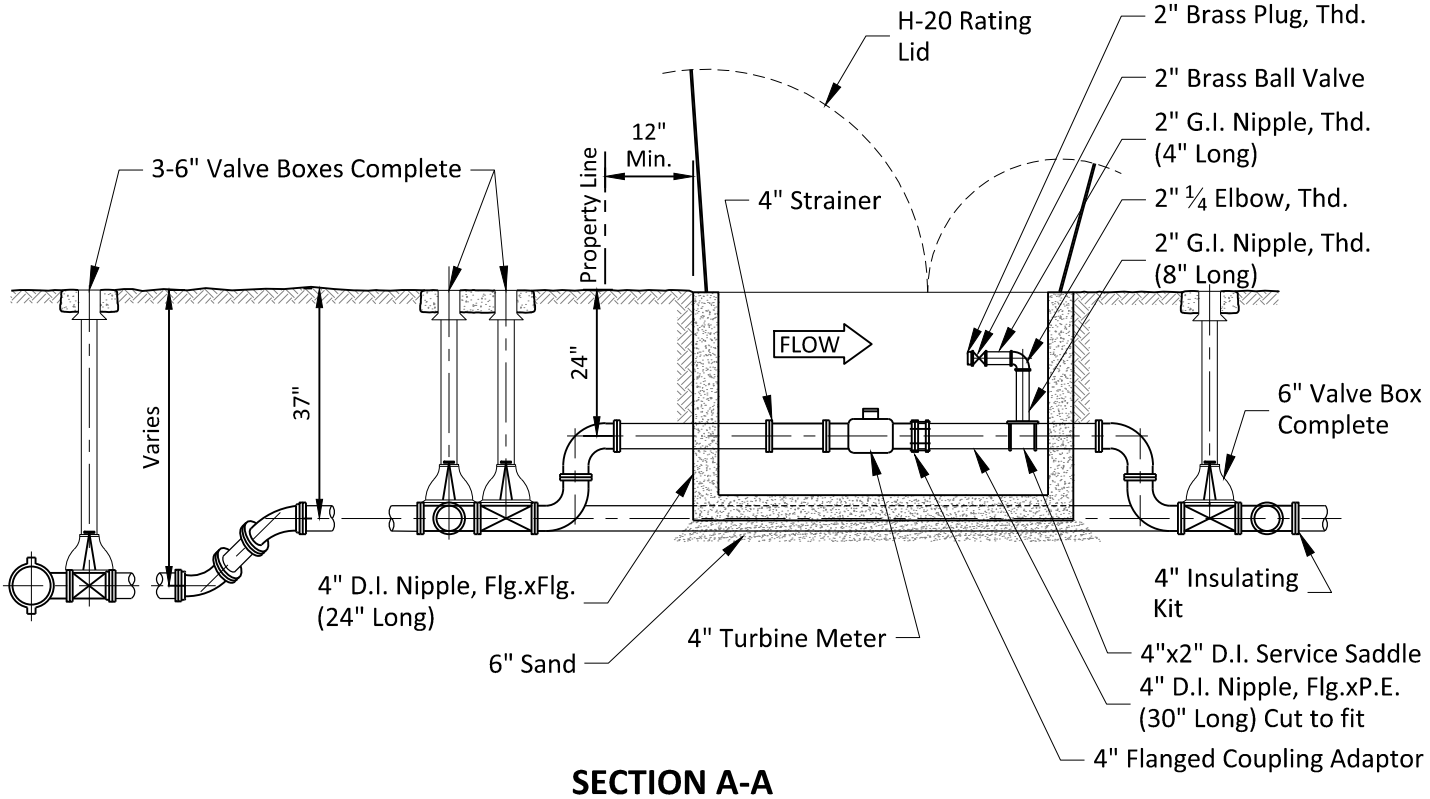
Note:
Insulating kit applies only to D.I. yard piping

* 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



PLAN



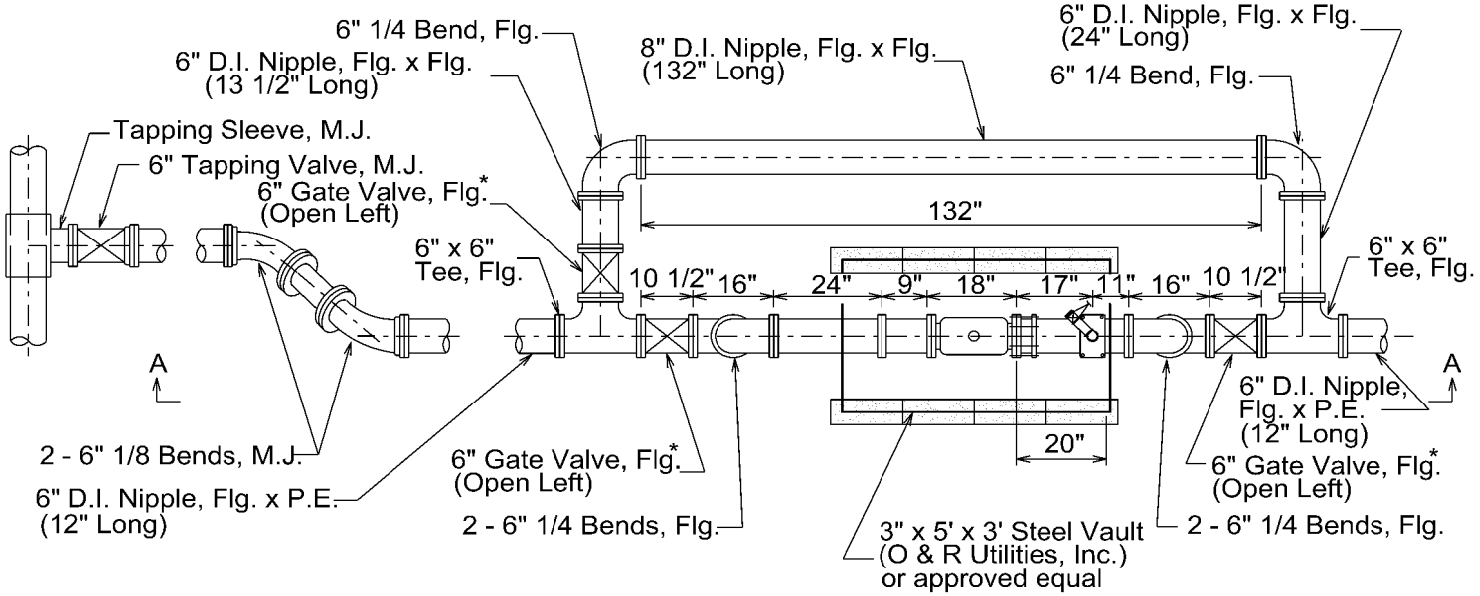
SECTION A-A

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

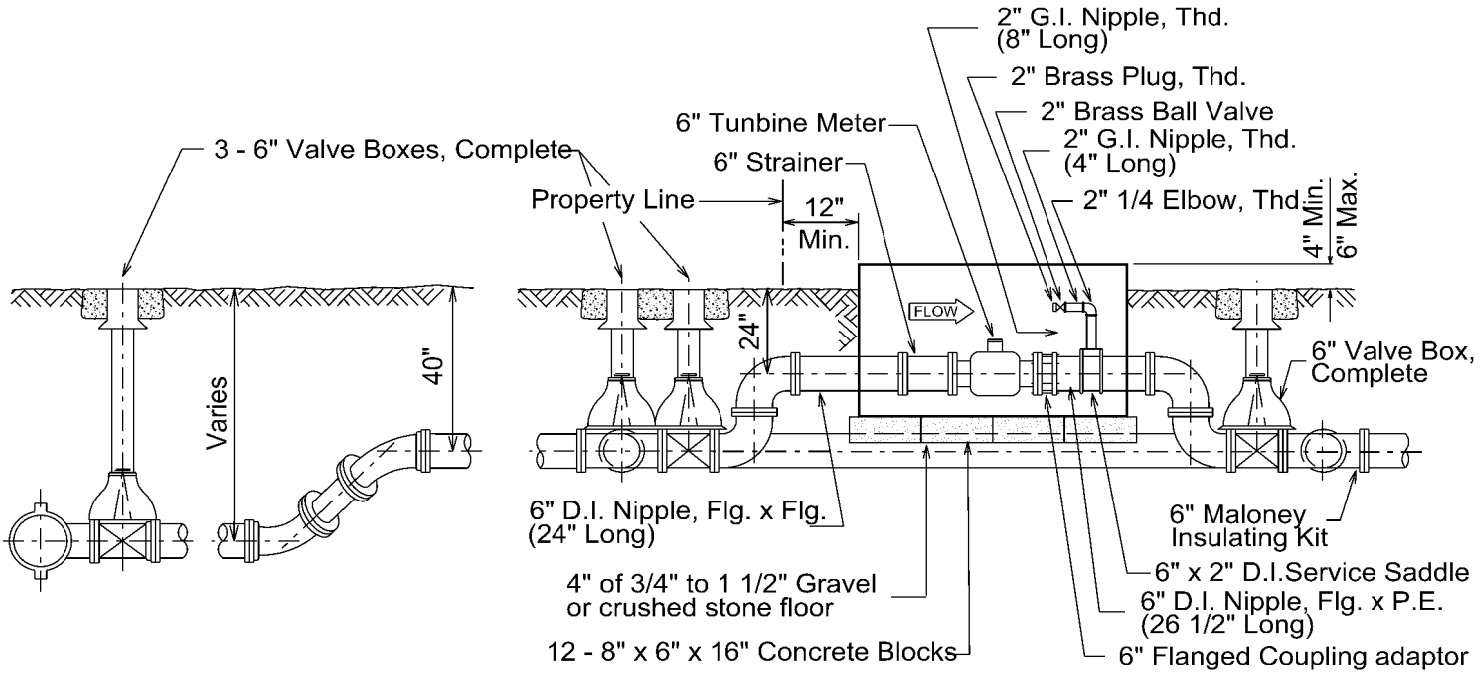
Note:
Insulating kit applies
only to D.I. yard piping

* 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



PLAN

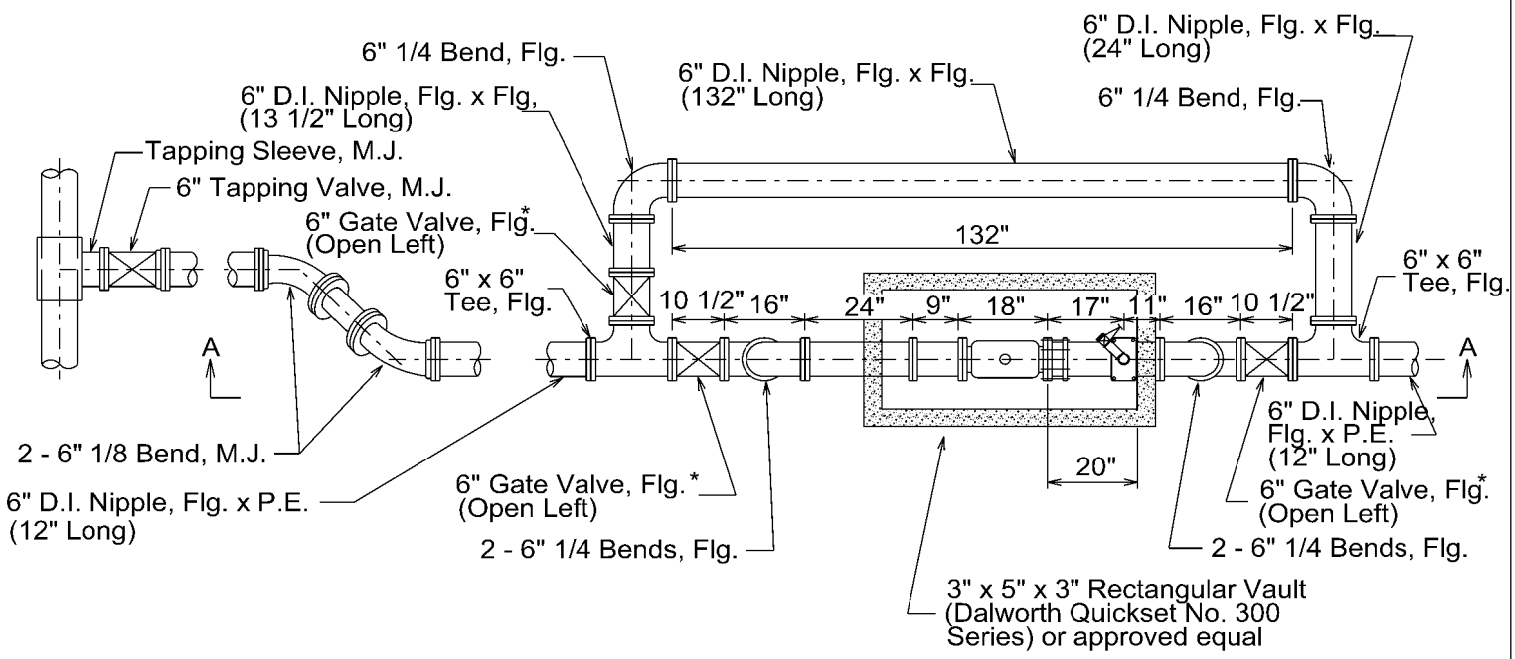


SECTION A-A

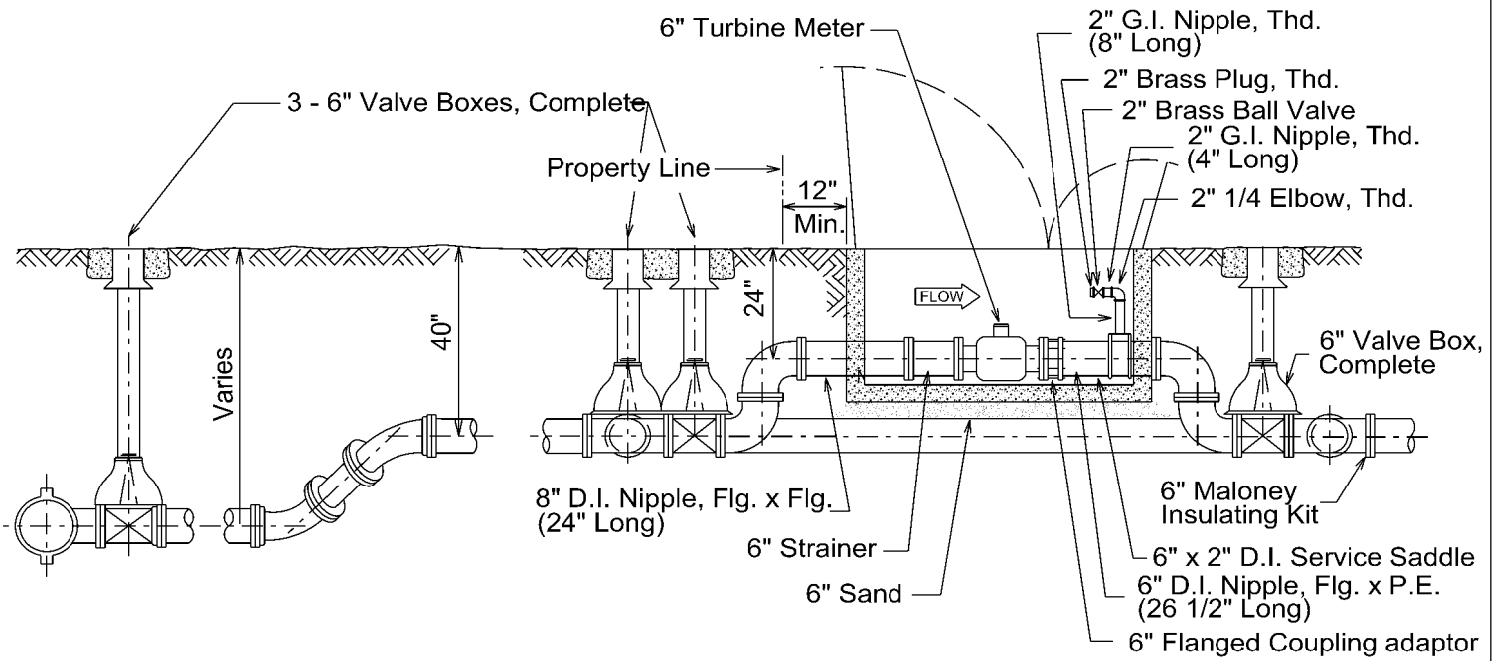
* Resilient Seat

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



PLAN

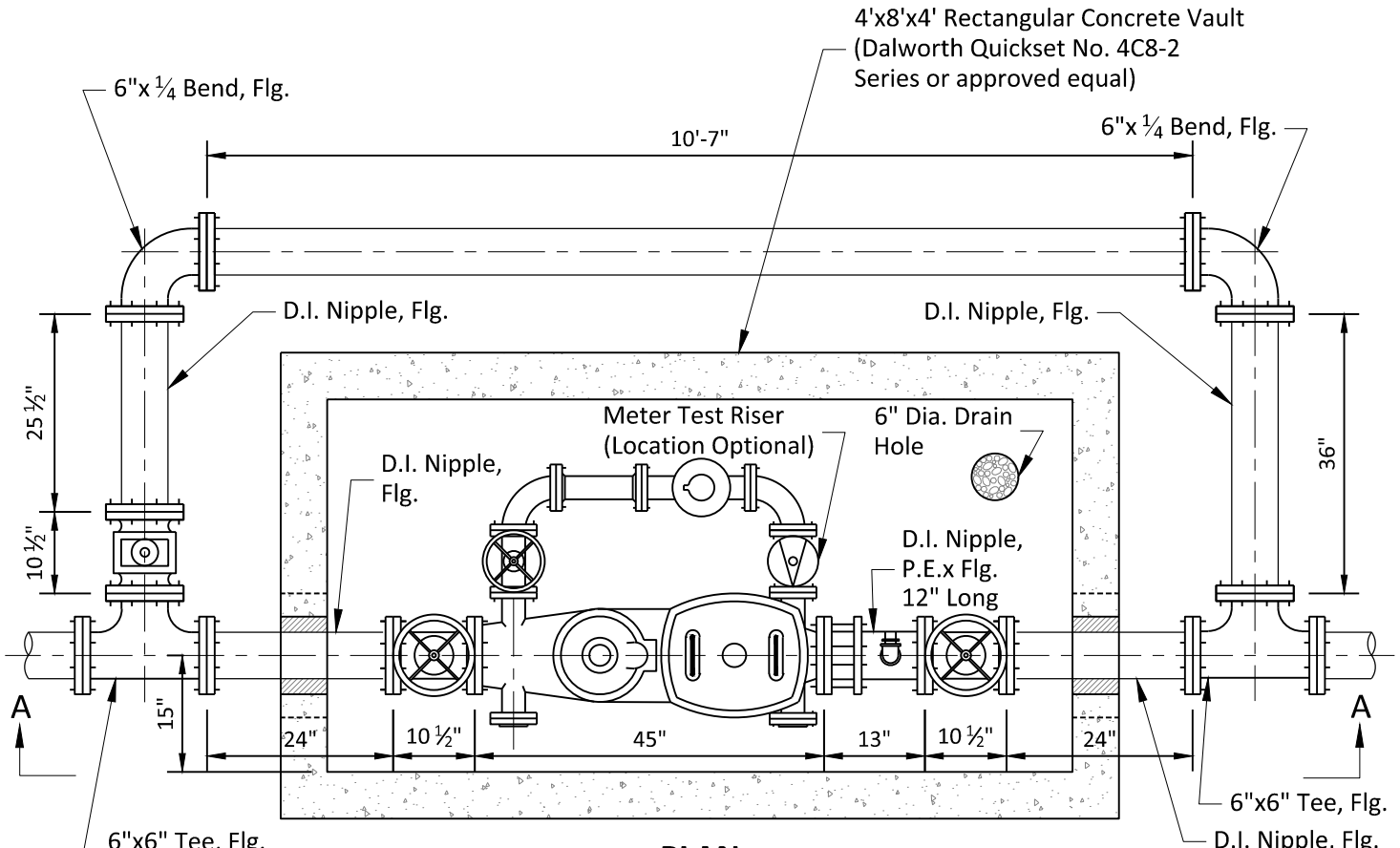


SECTION A-A

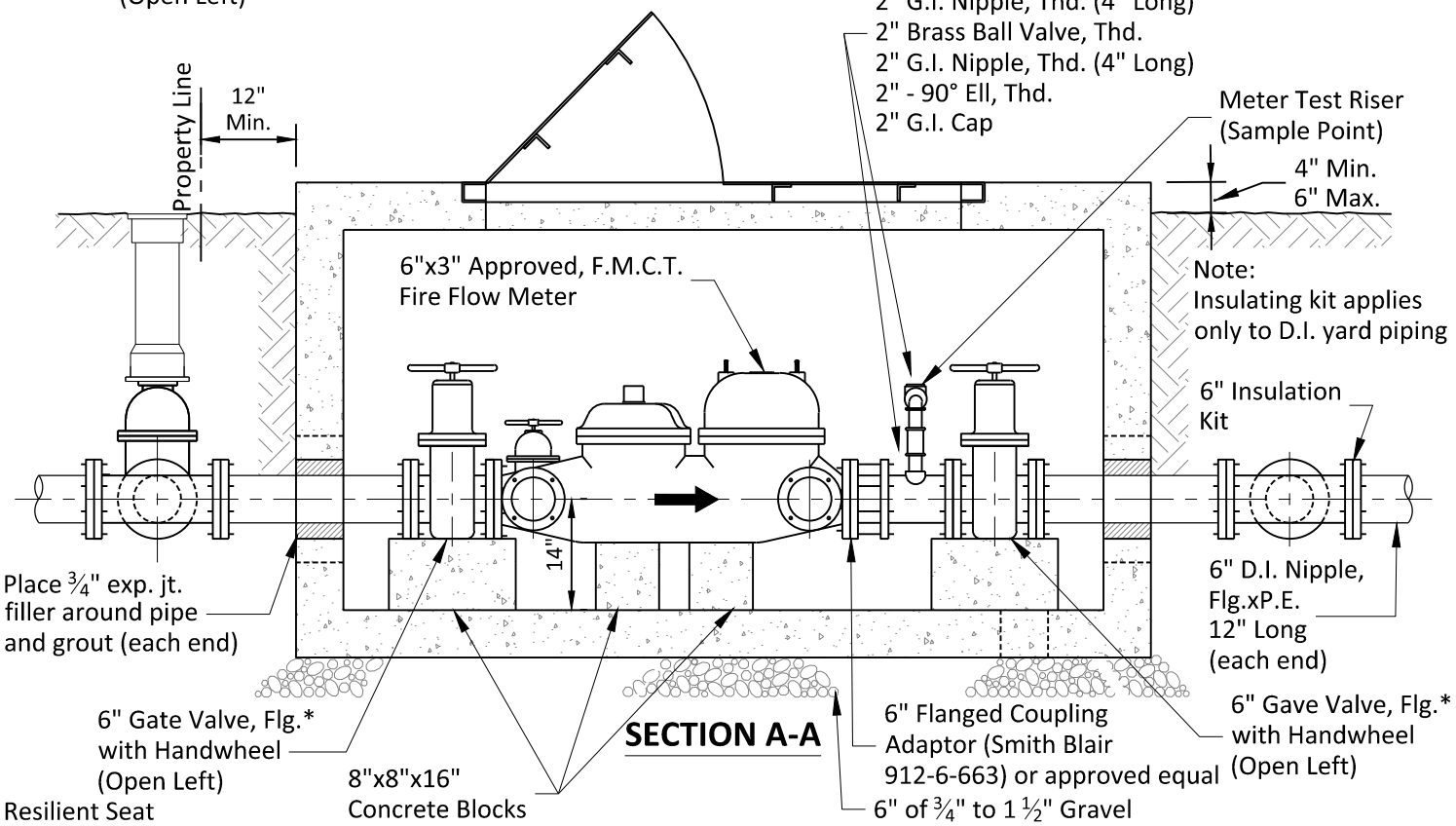
3' x 5' x 3' RECTANGULAR CONCRETE VAULT (TRAFFIC BEARING LOCATION)

* 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



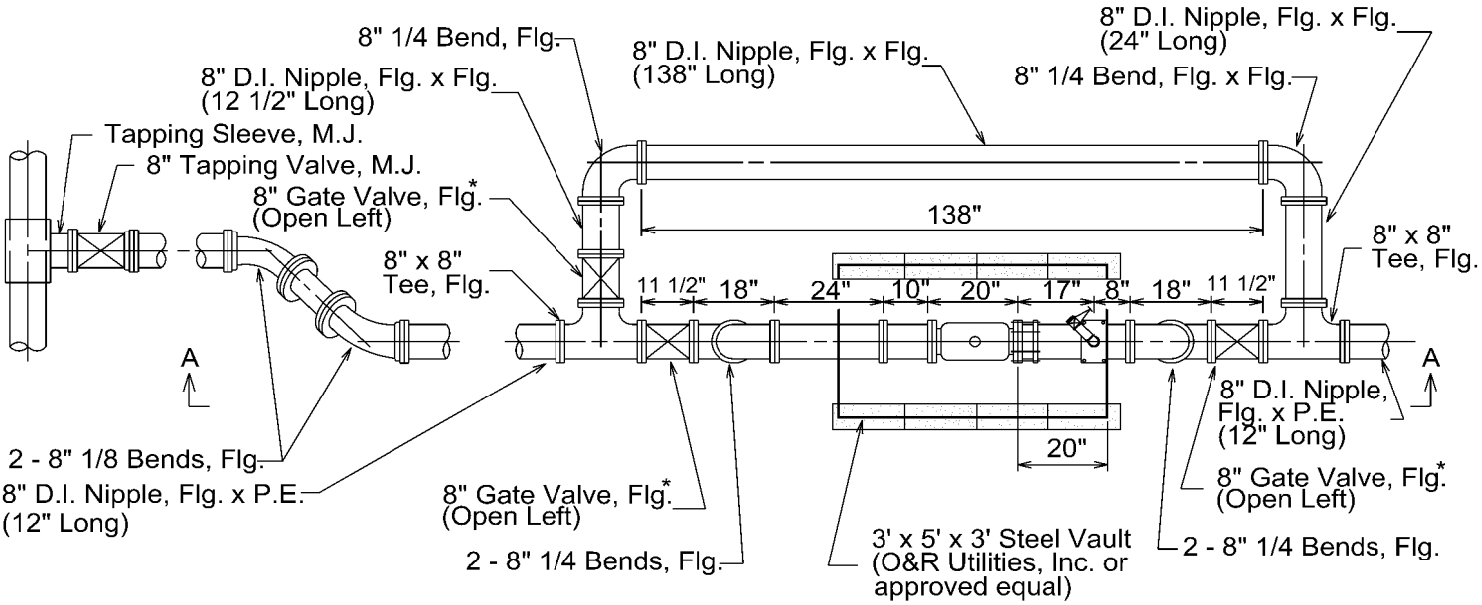
PLAN



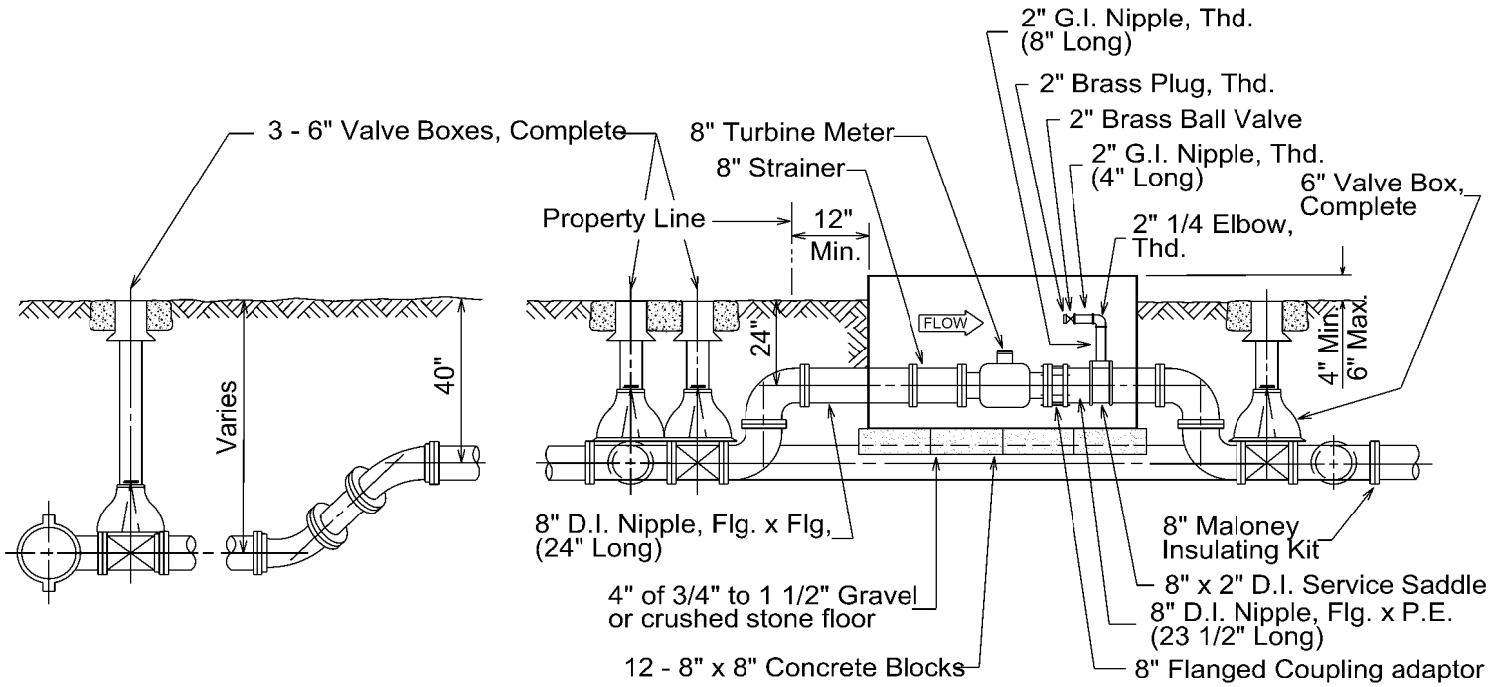
SECTION A-A

* 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



PLAN

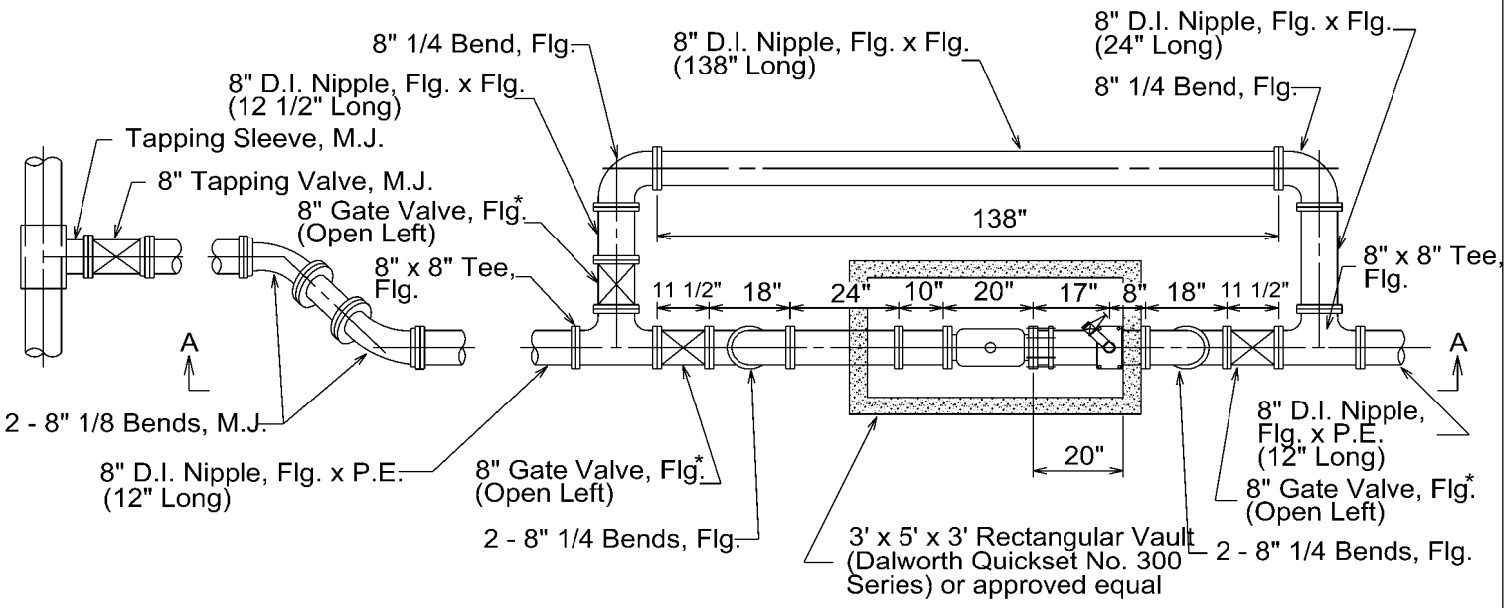


SECTION A-A

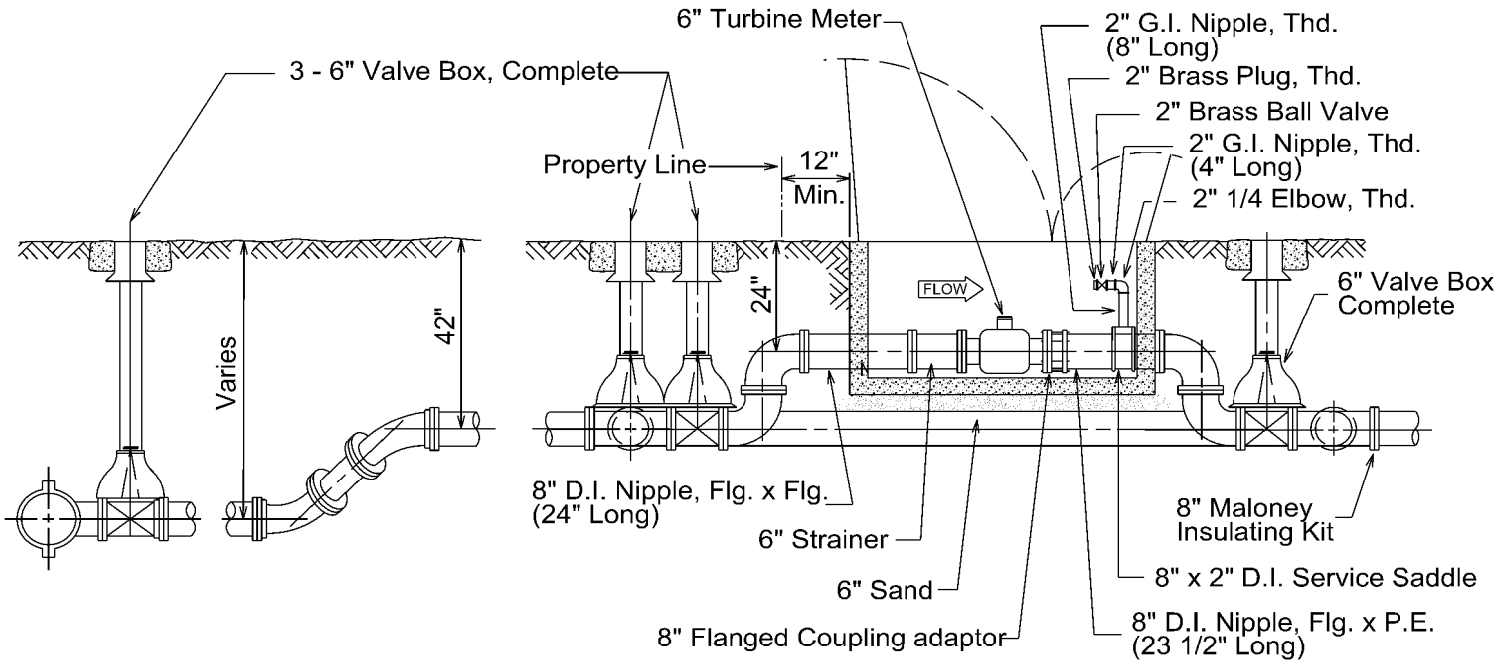
* Resilient Seat

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

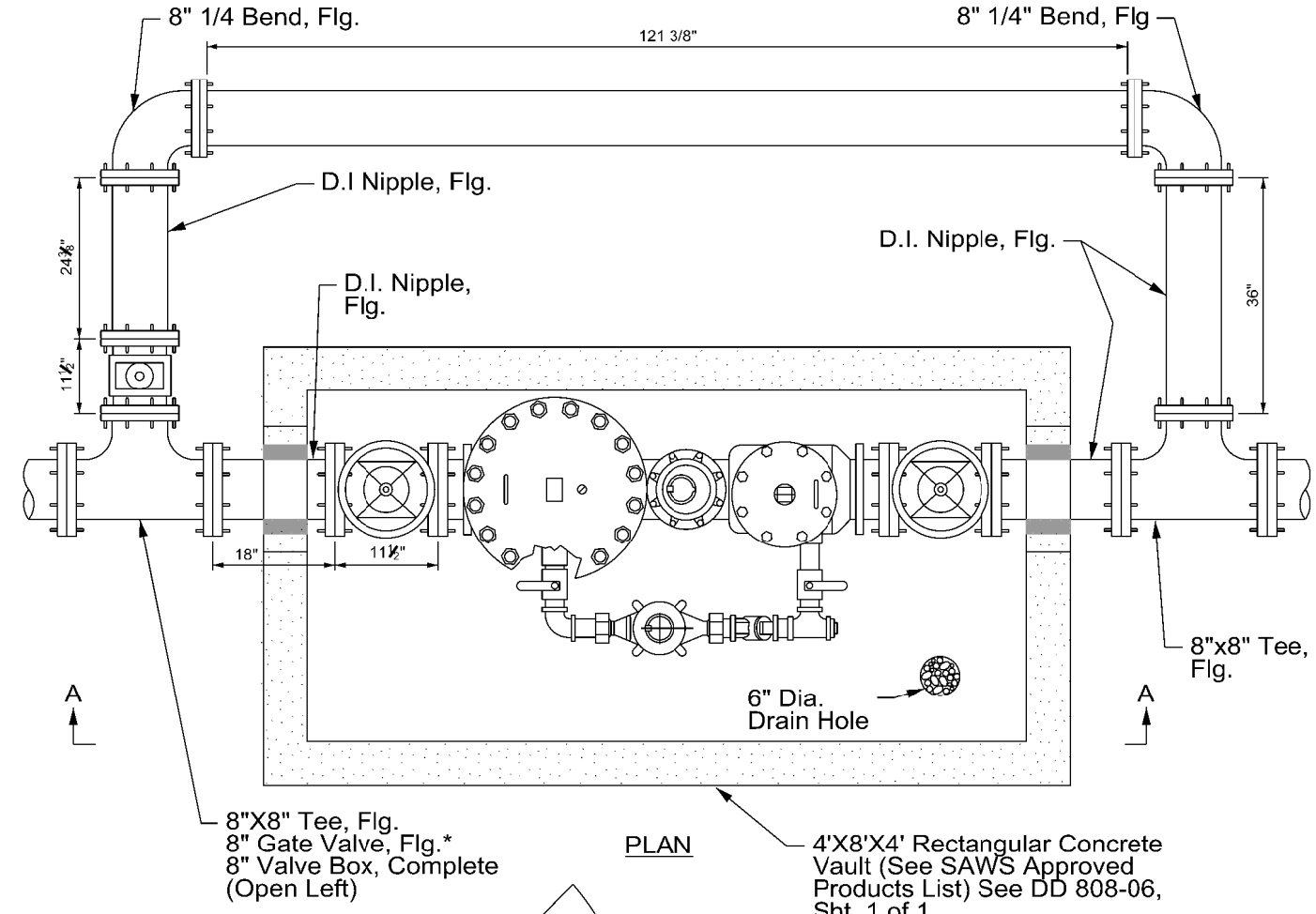


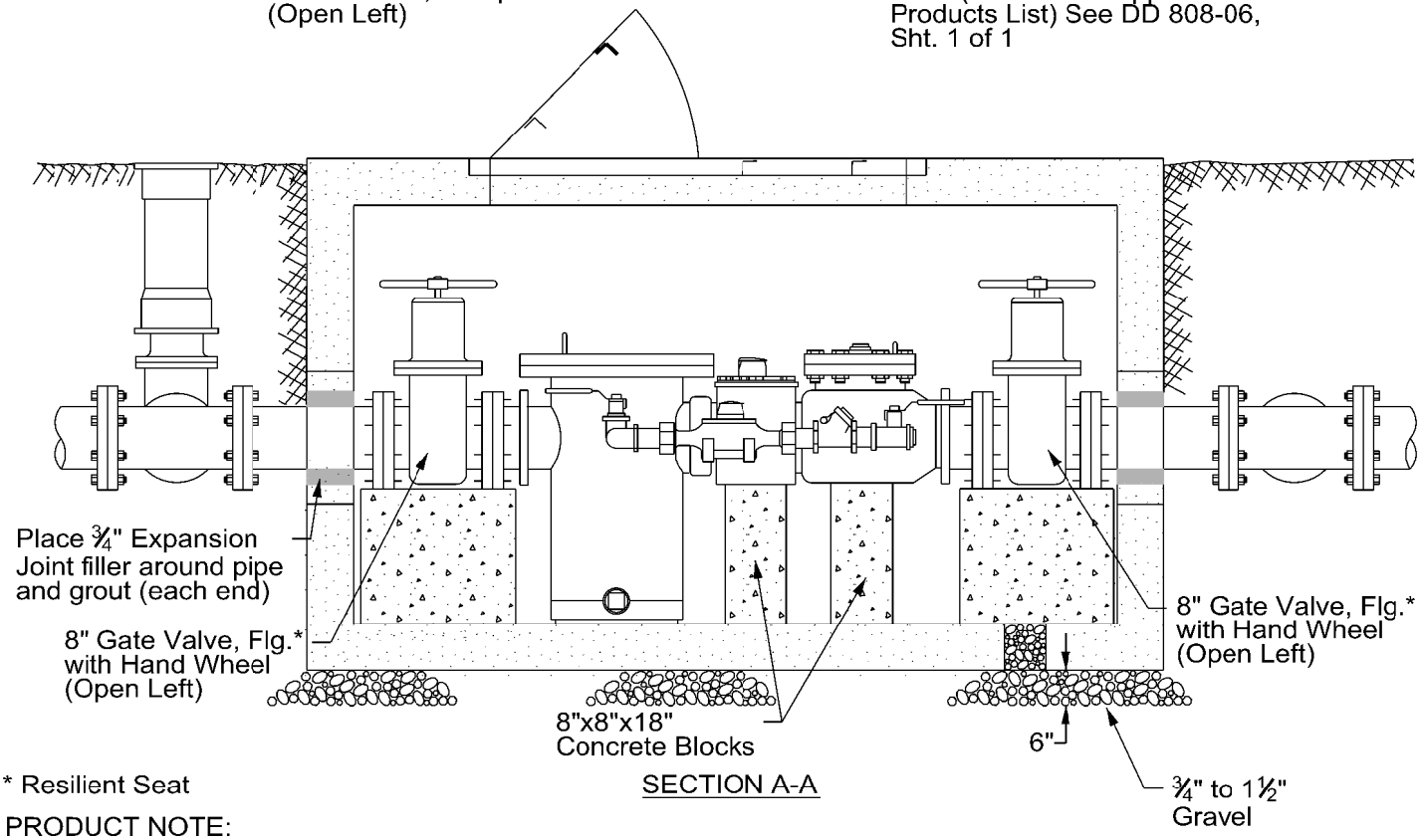
SECTION A-A

* 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



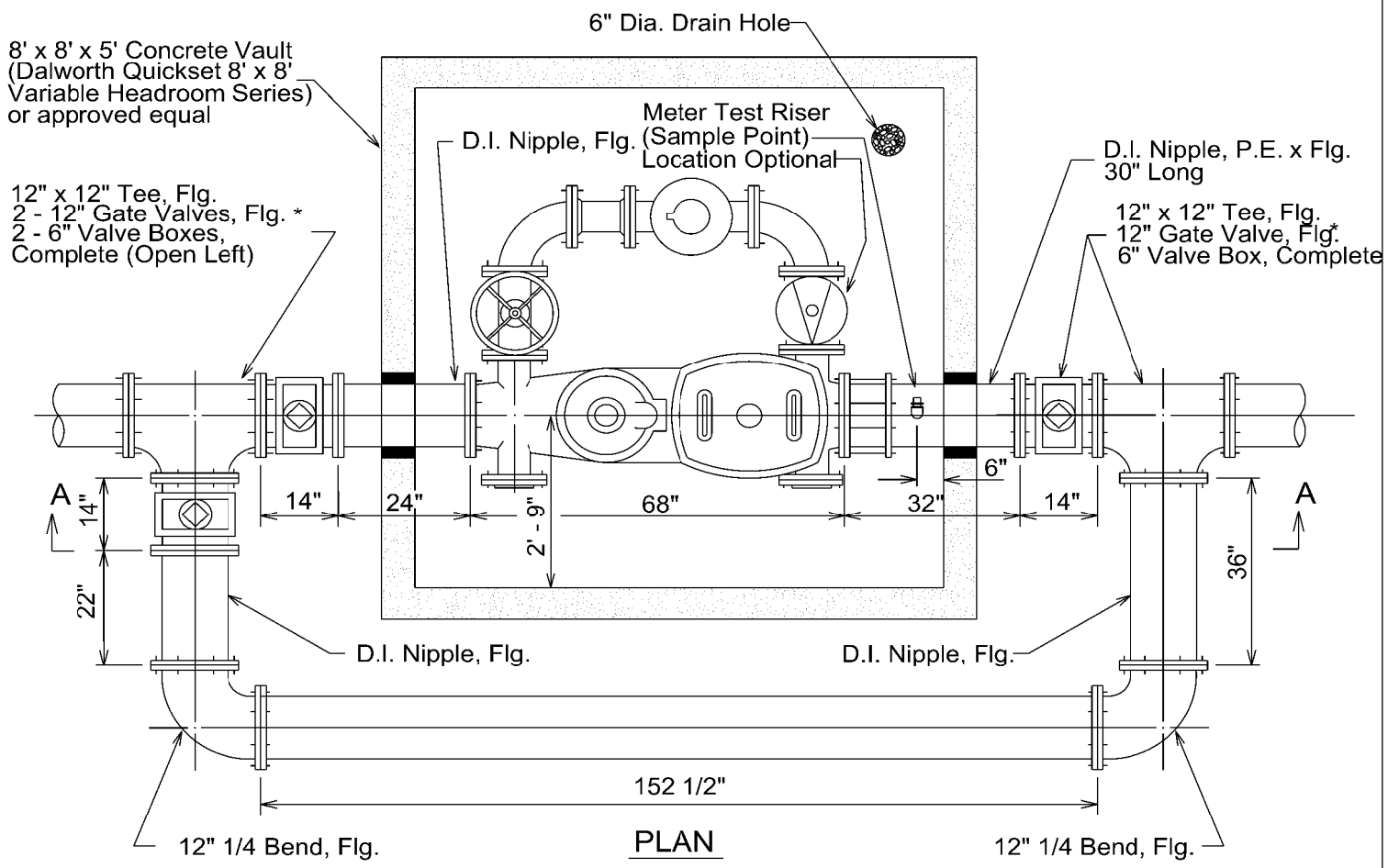


* Resilient Seat

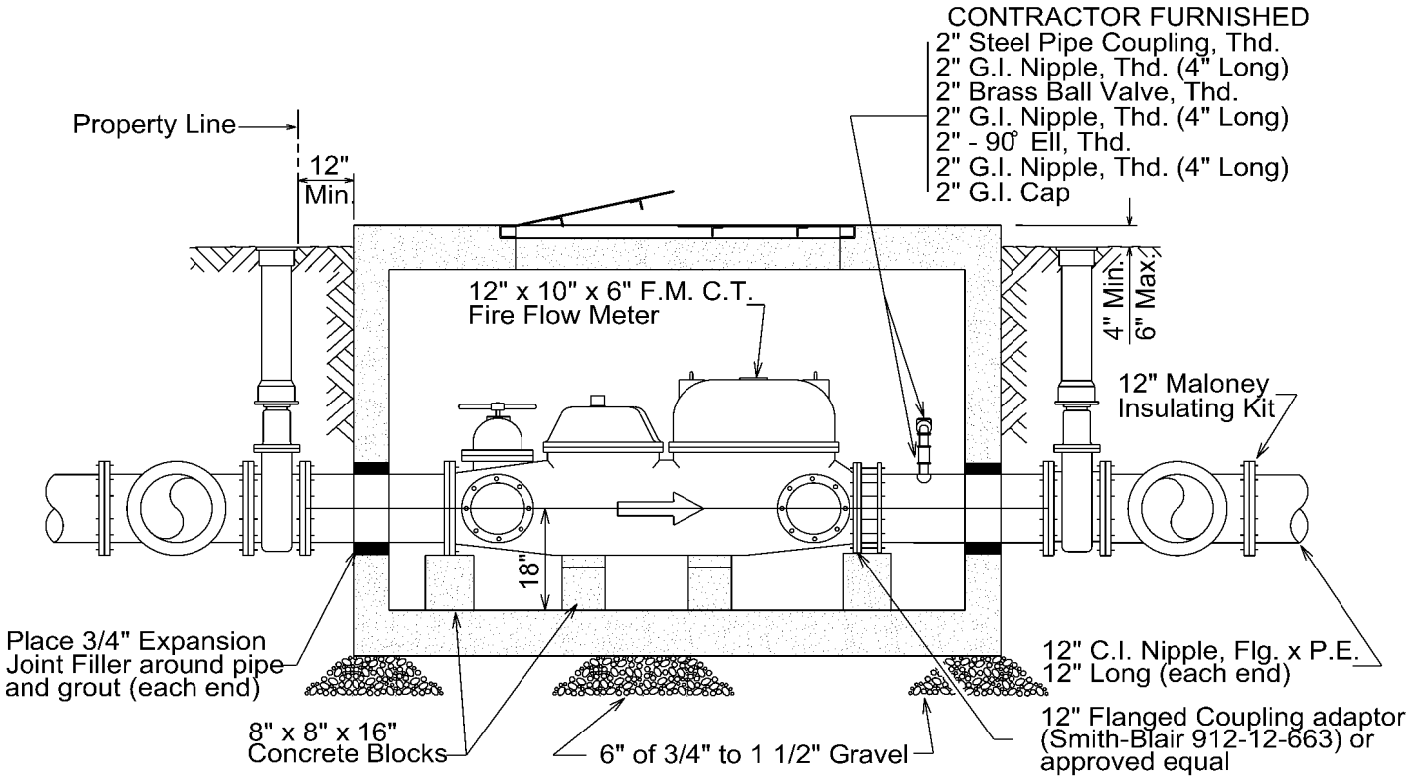
SECTION A-A

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



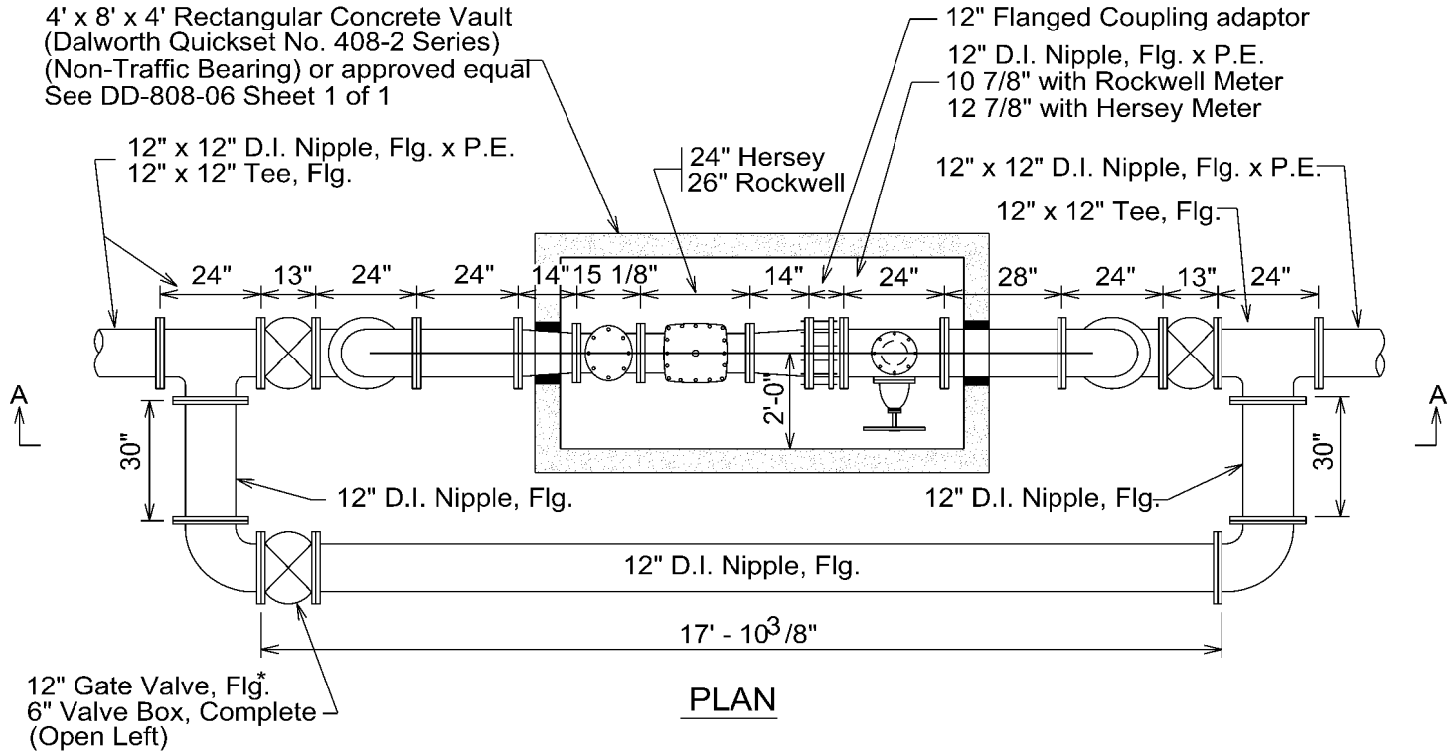
PLAN



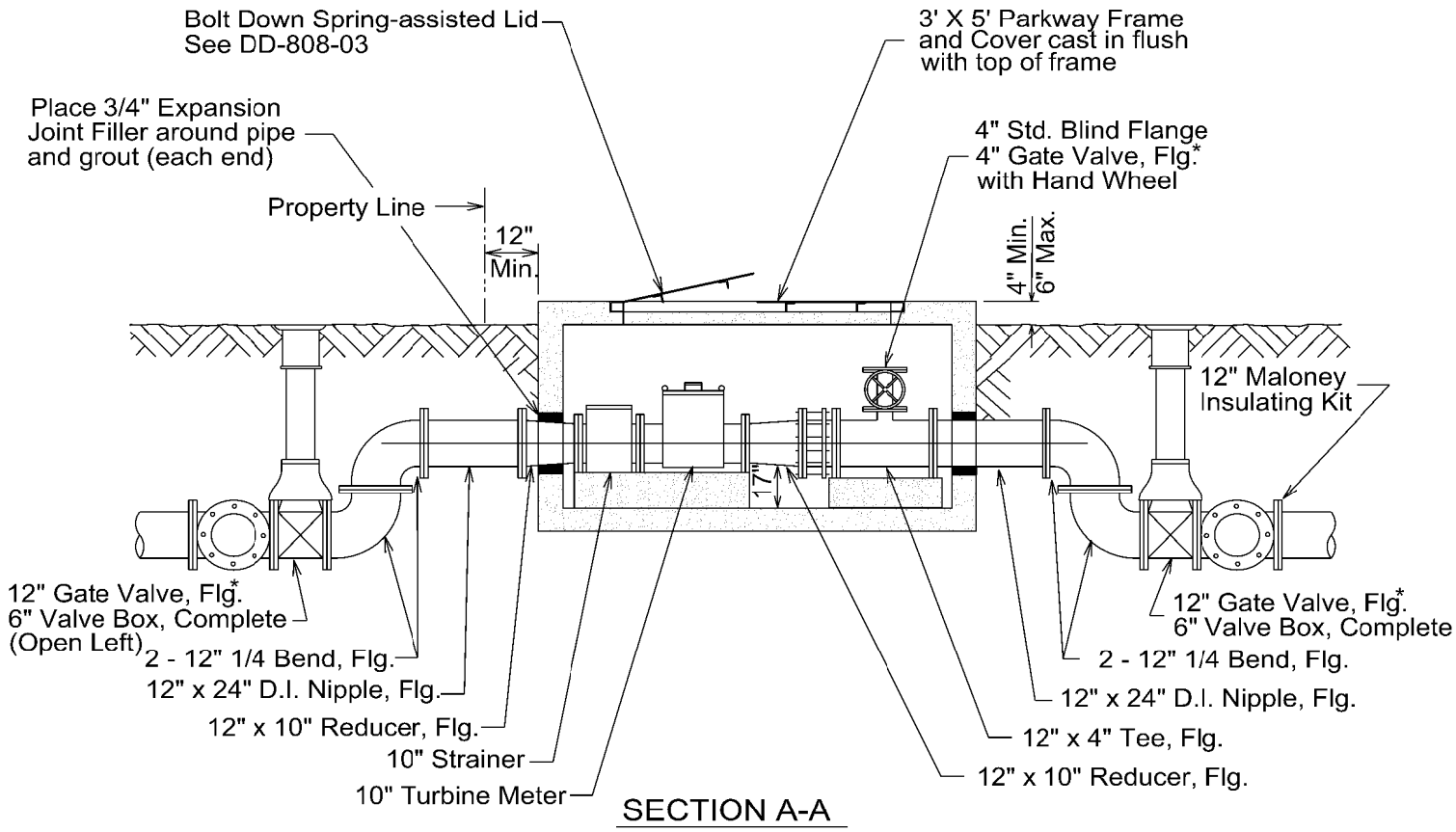
* Resilient Seat

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



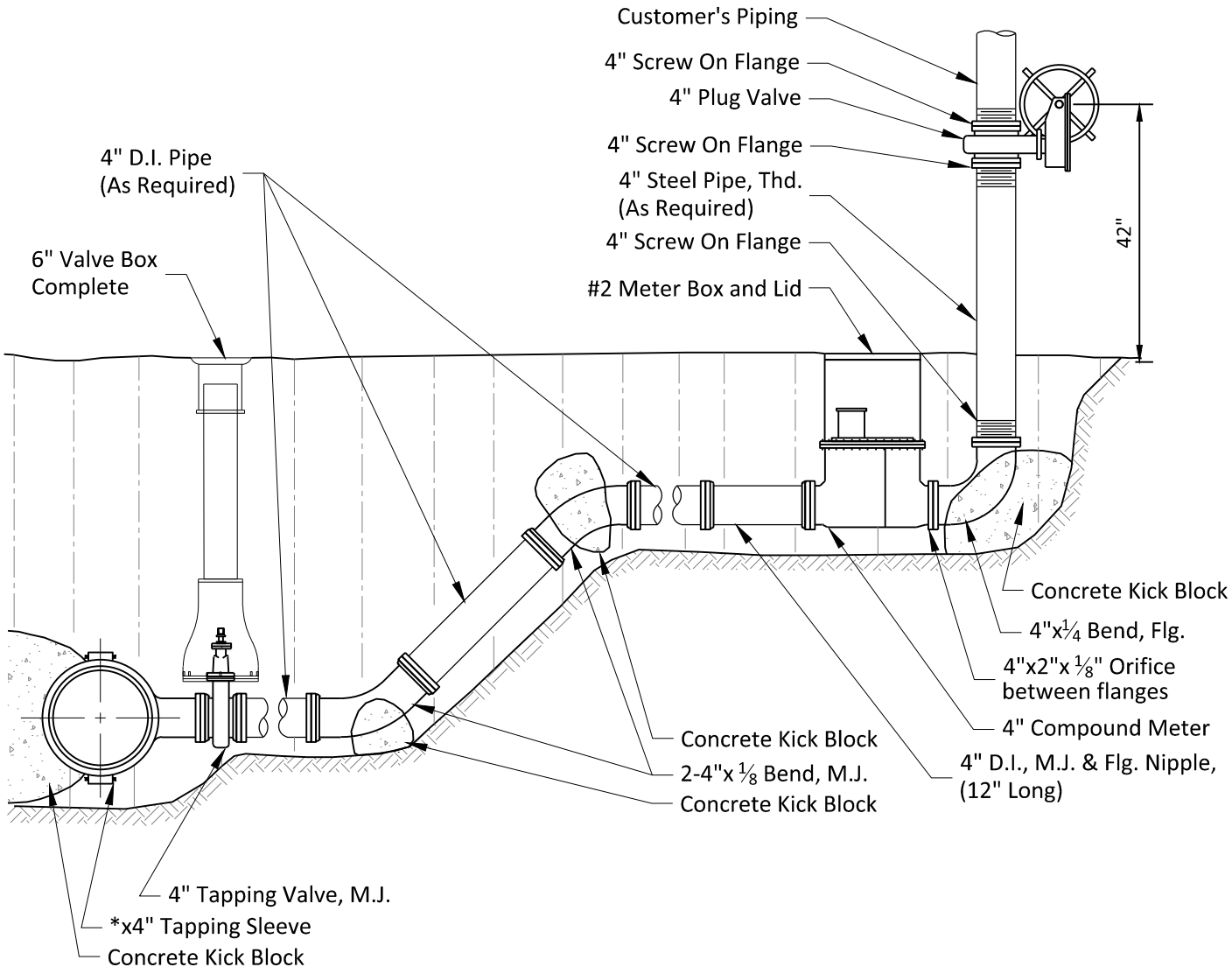
PLAN



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

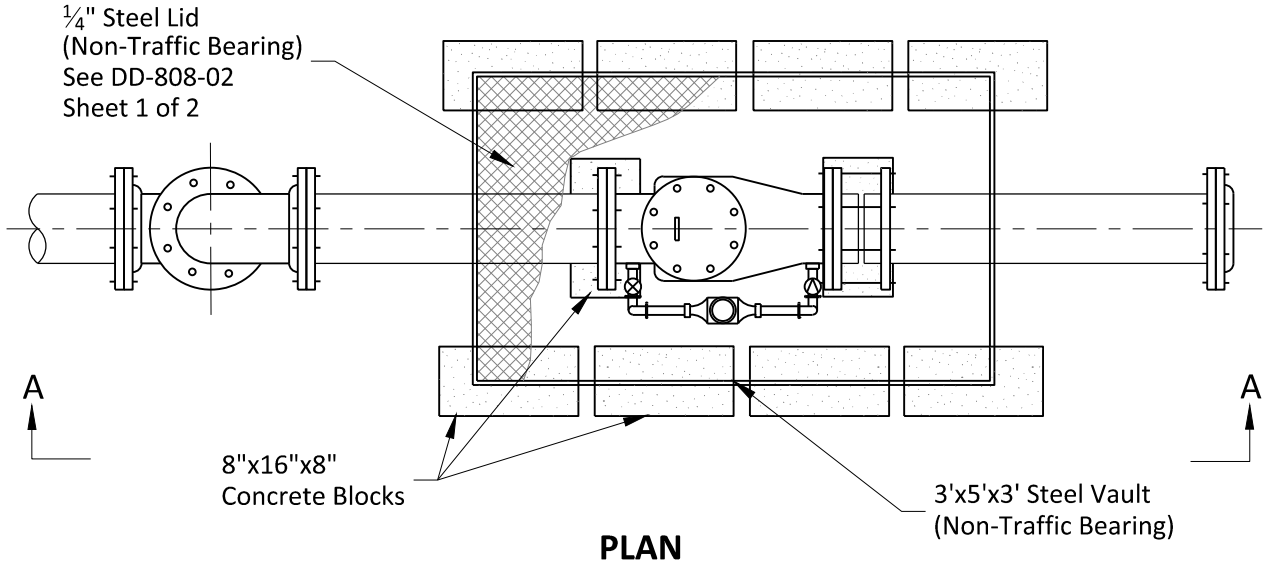


NOT TO SCALE

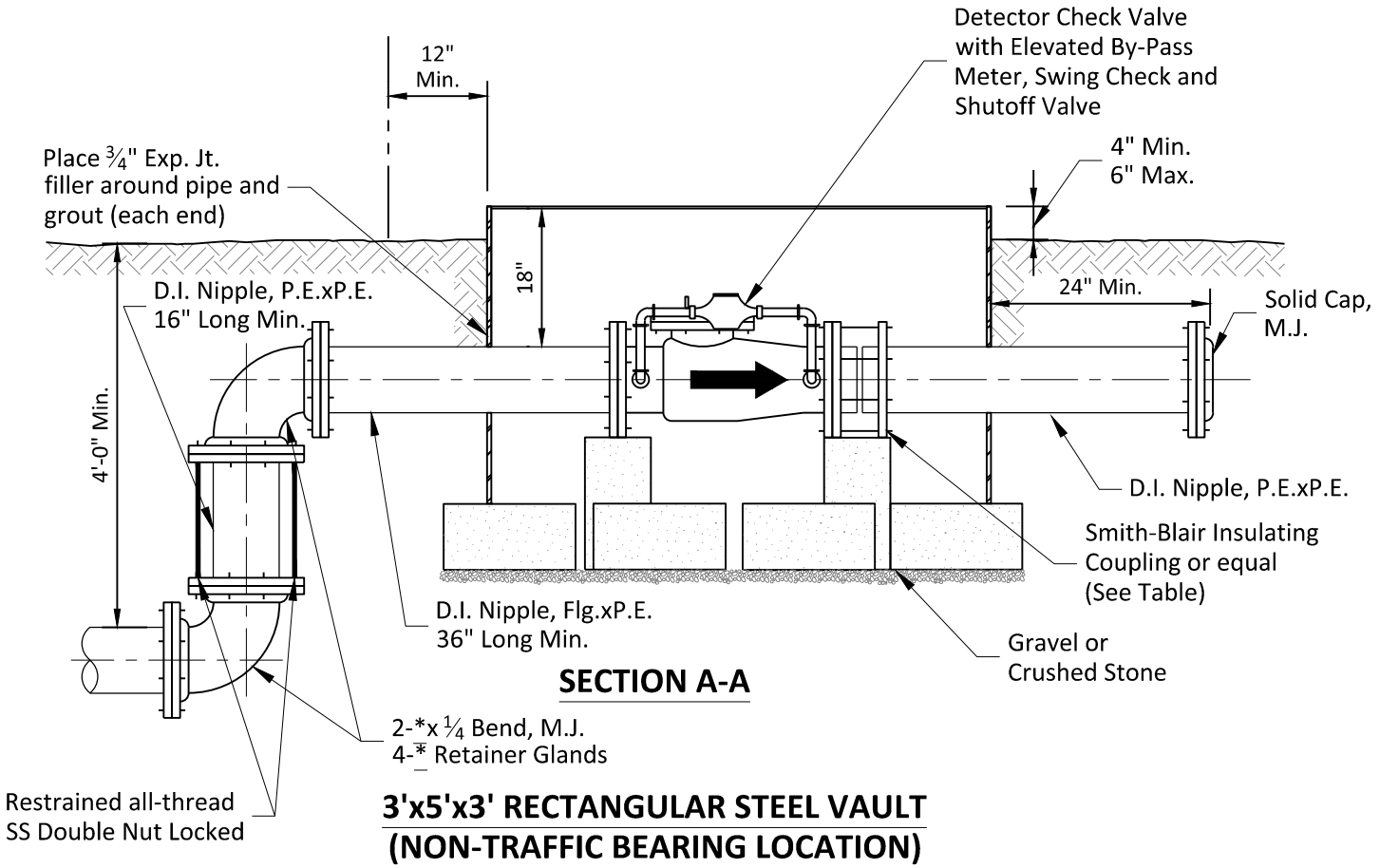
* Existing main size and type

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



PLAN

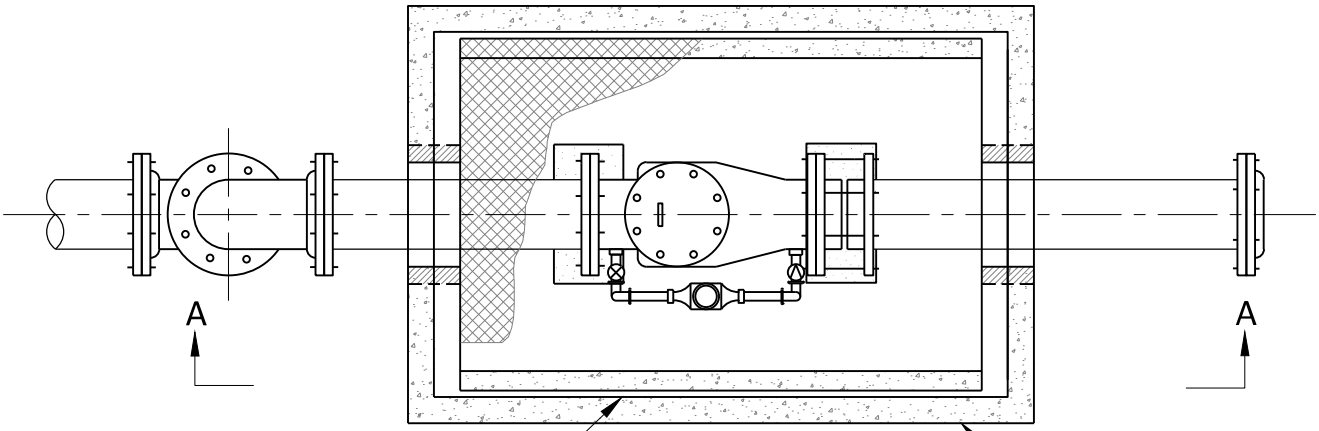


SECTION A-A

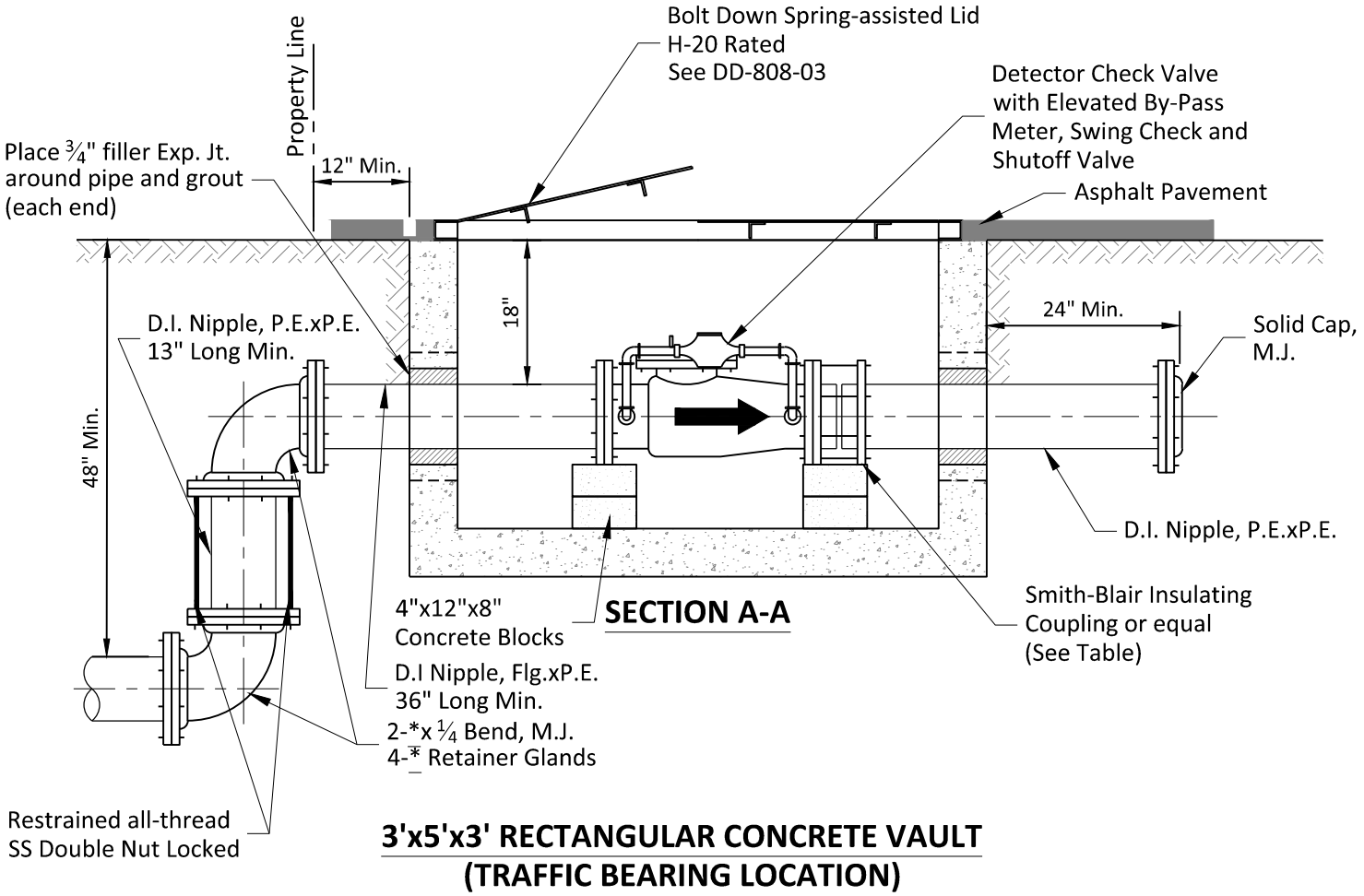
3'x5'x3' RECTANGULAR STEEL VAULT (NON-TRAFFIC BEARING LOCATION)

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



PLAN

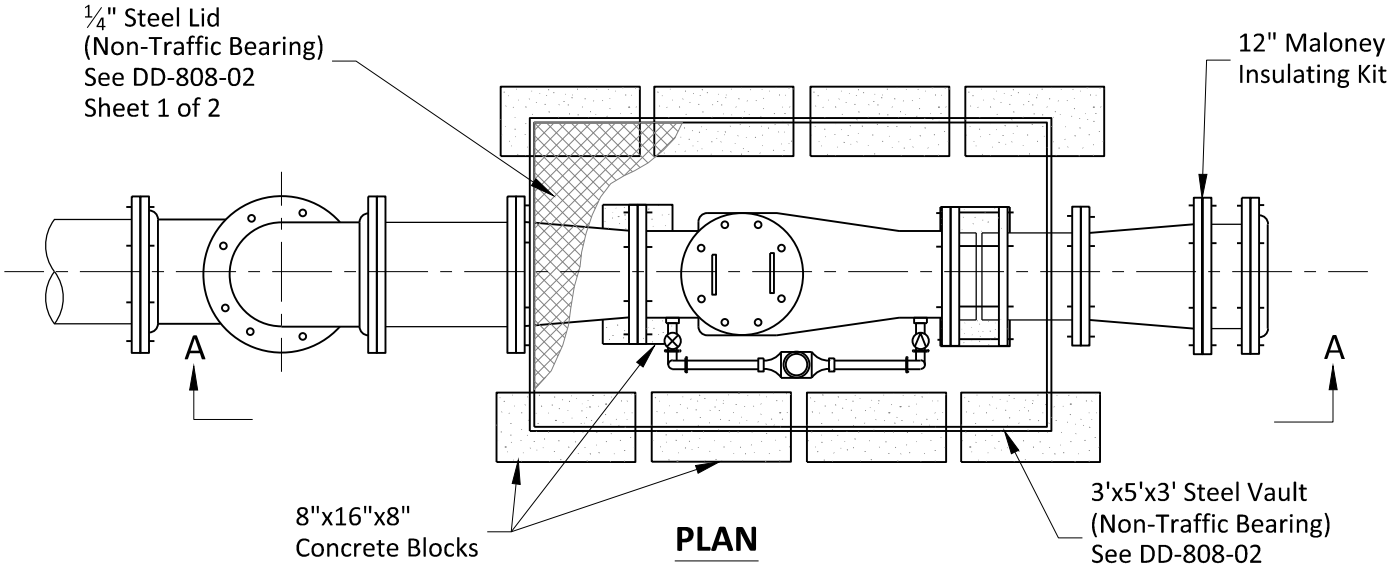


SECTION A-A

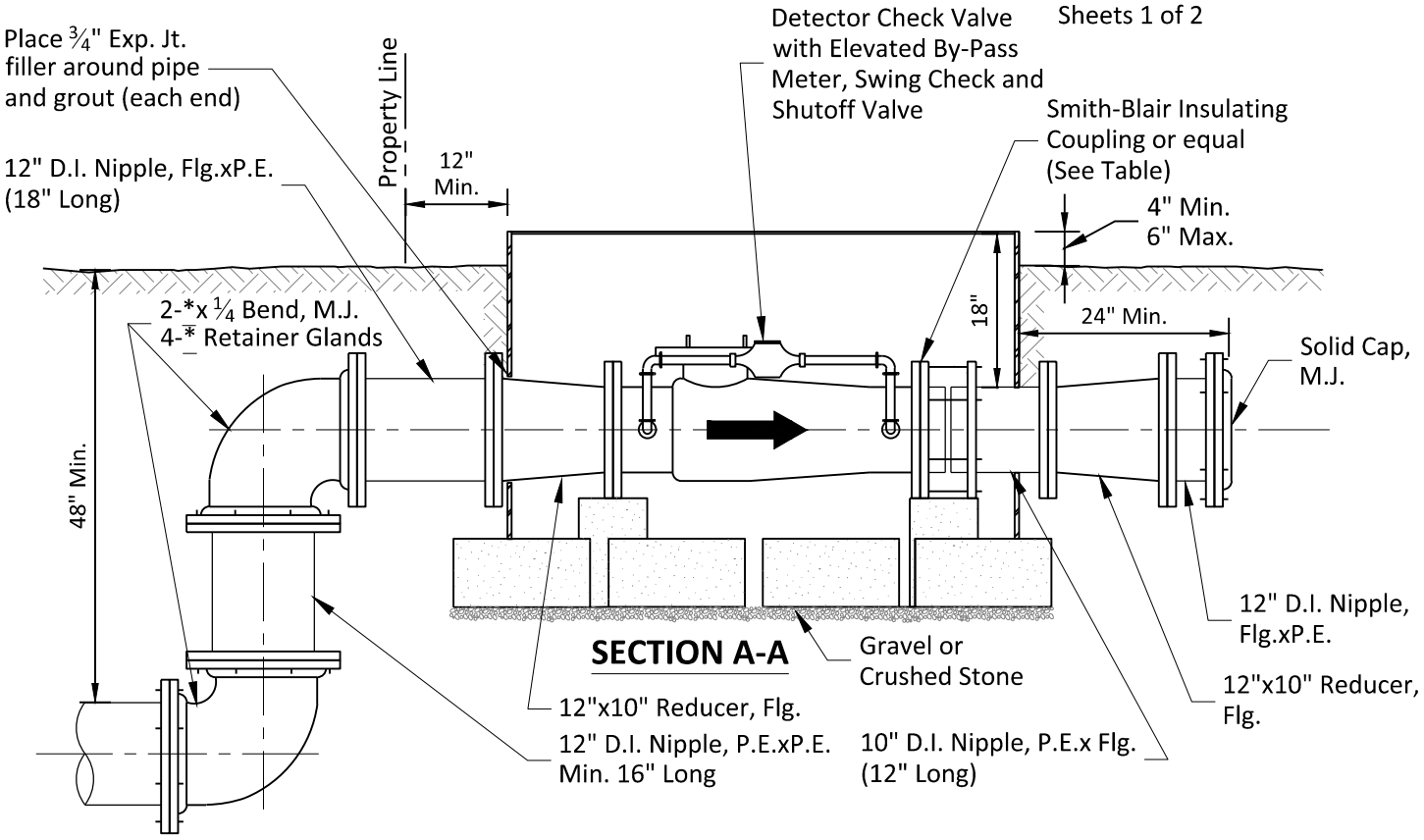
3'x5'x3' RECTANGULAR CONCRETE VAULT
(TRAFFIC BEARING LOCATION)

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



PLAN

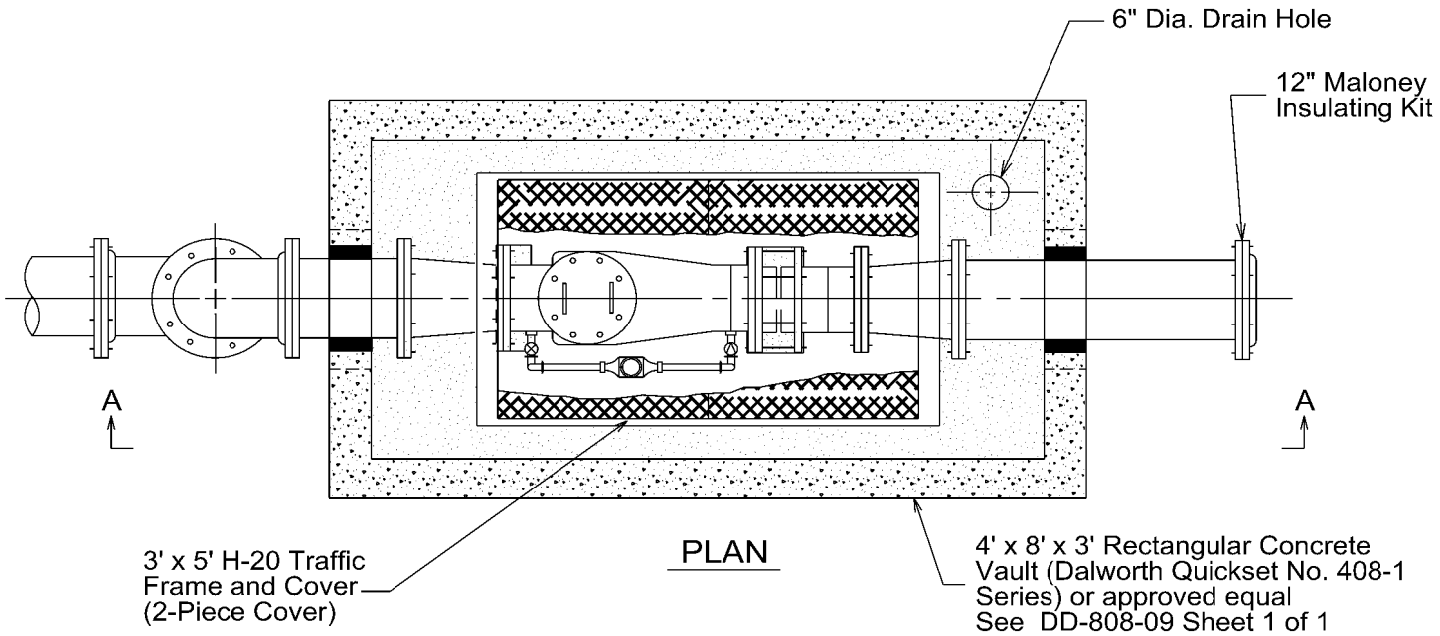


SECTION A-A

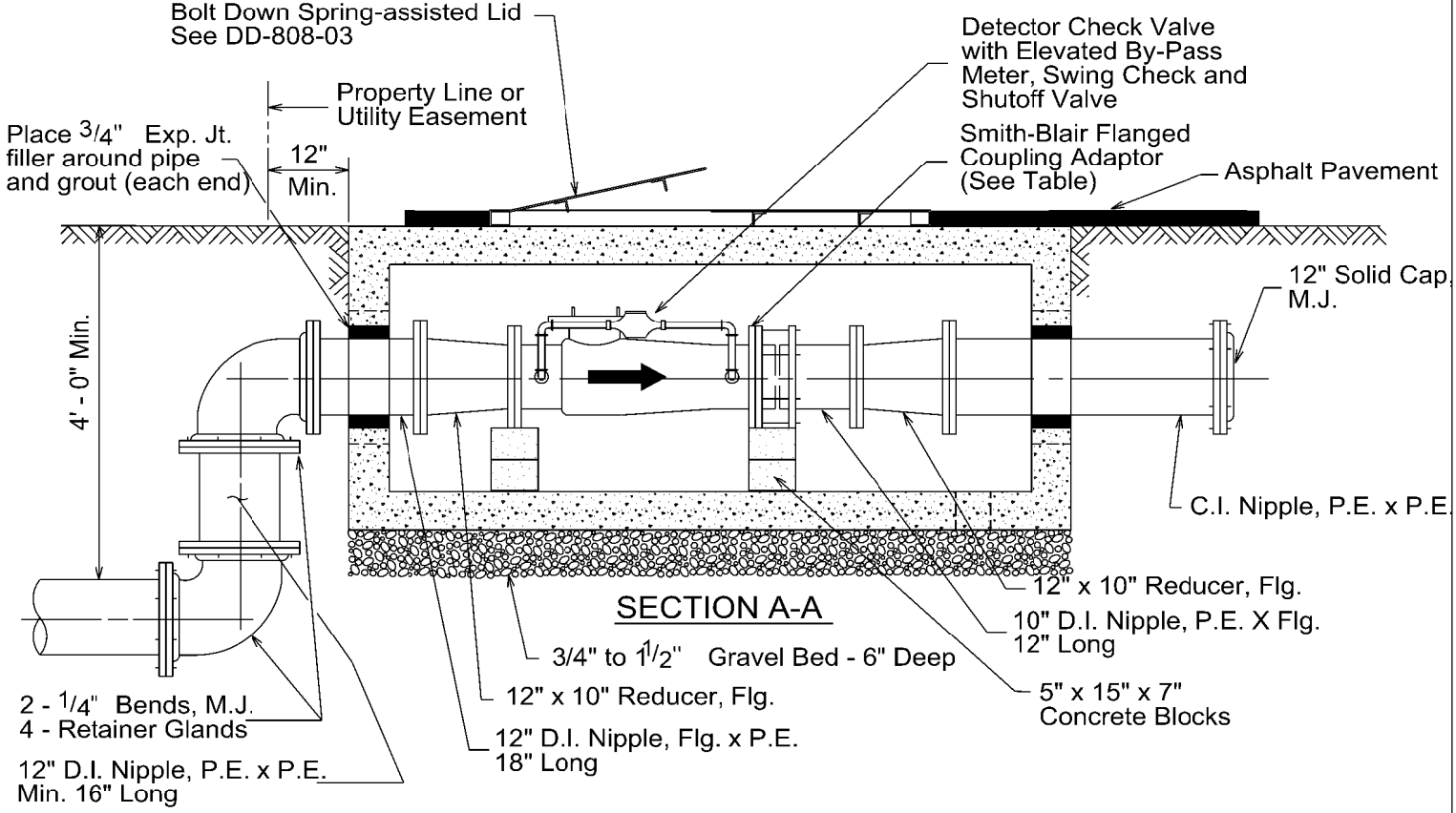
3'x5'x3' RECTANGULAR STEEL VAULT
(NON-TRAFFIC BEARING LOCATION)

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



PLAN

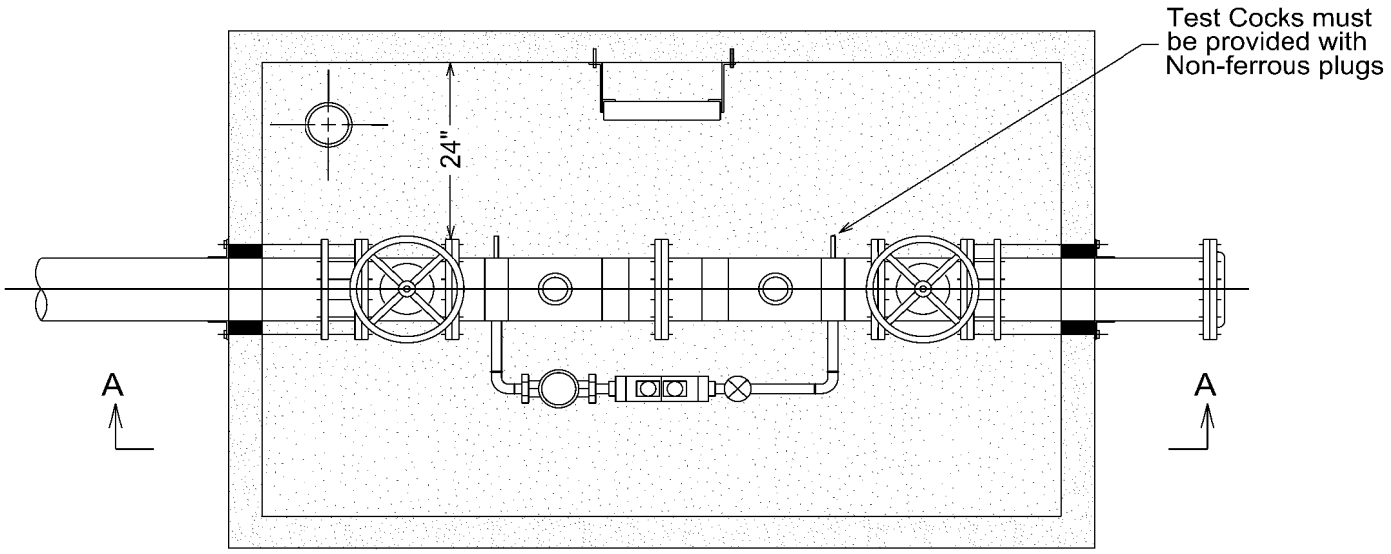


SECTION A-A

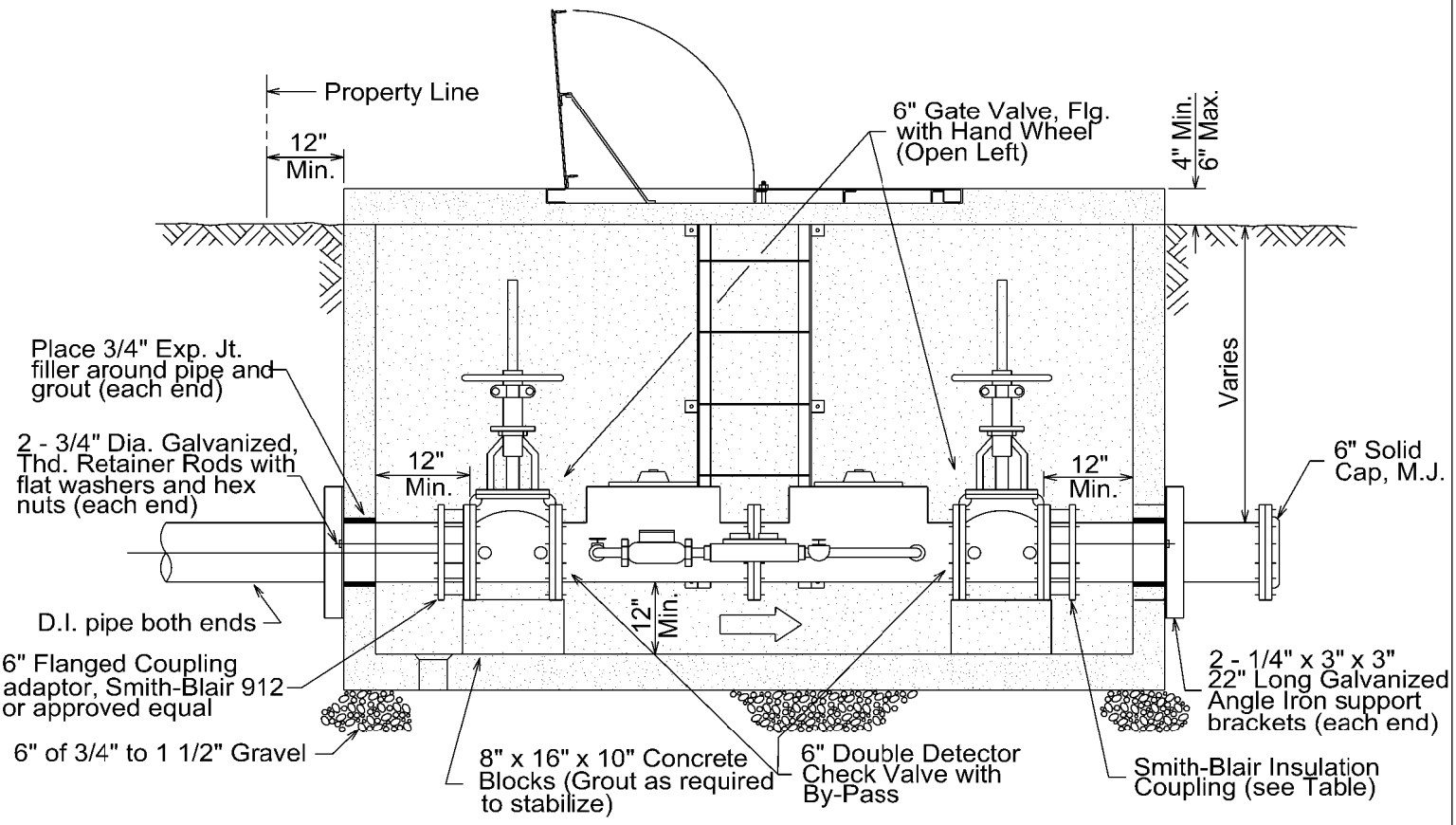
4' x 8' x 3' RECTANGULAR CONCRETE VAULT
(TRAFFIC BEARING LOCATION)

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

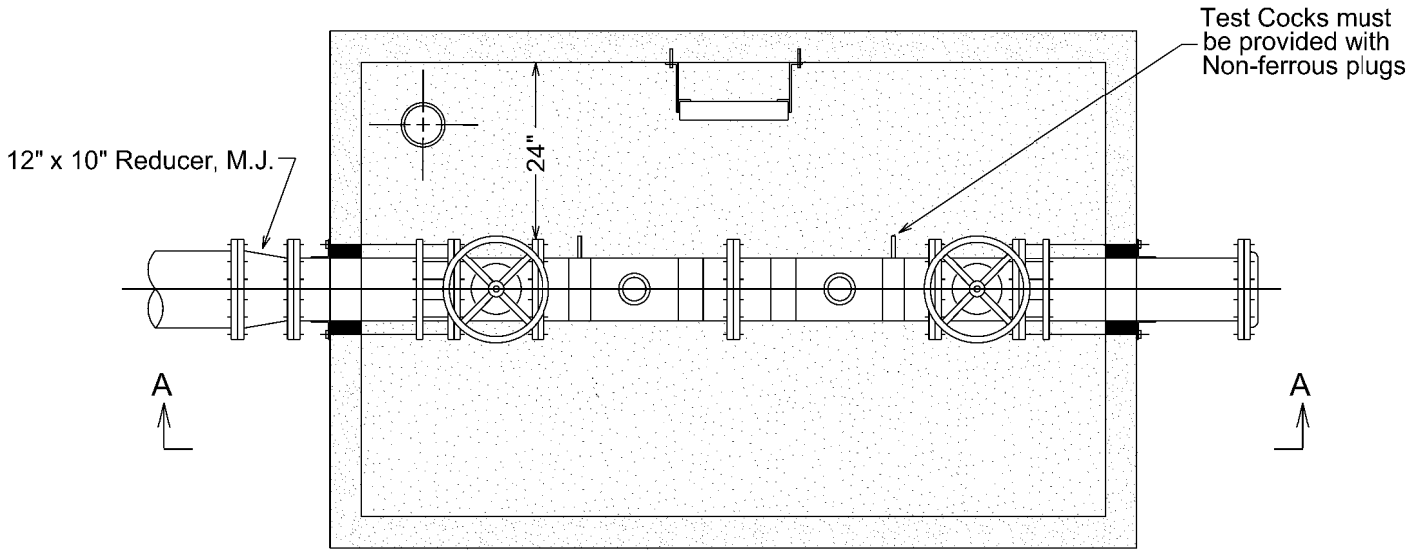


SECTION A-A

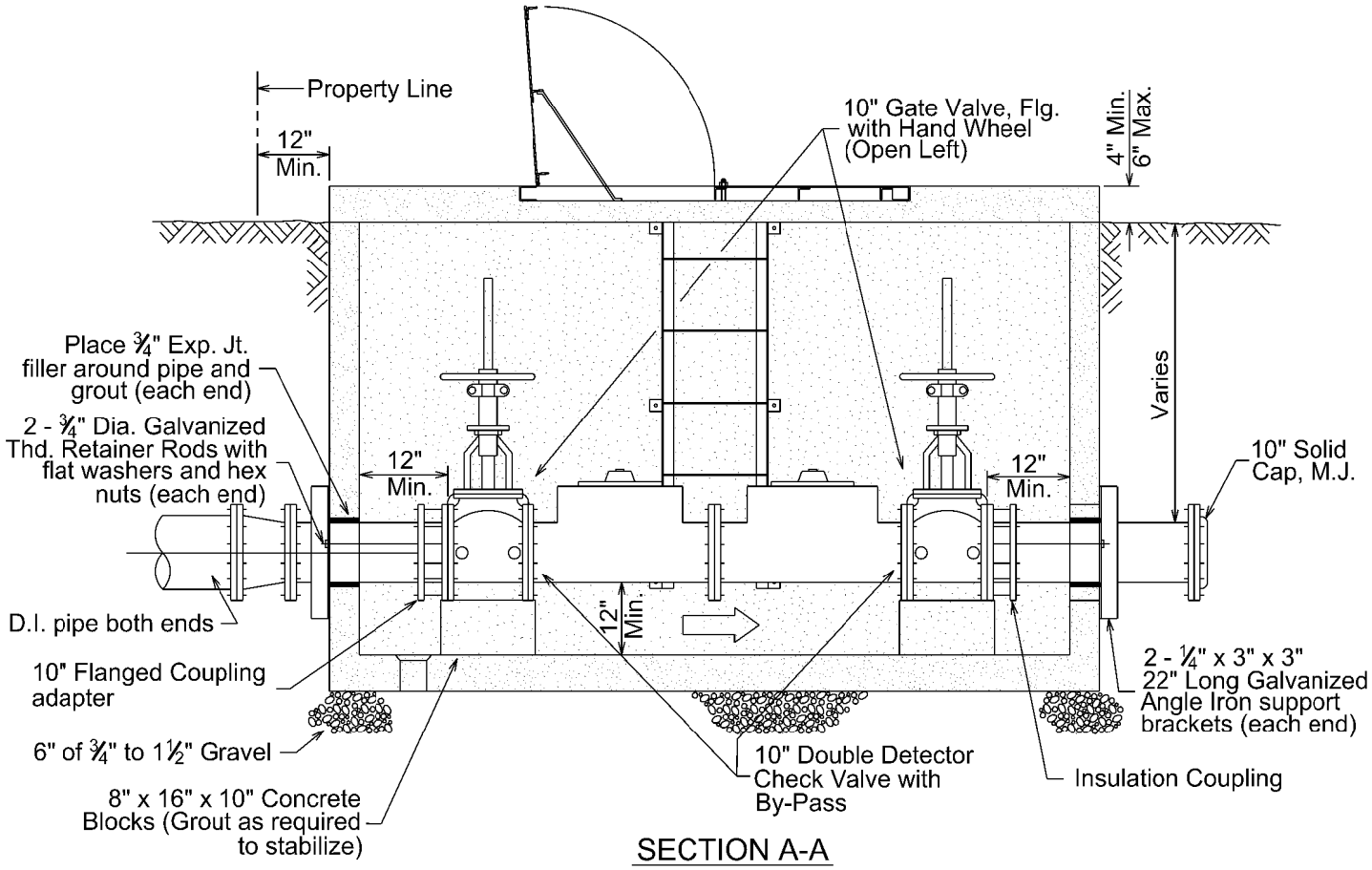
Notes:
1. Tamper switches may be required by Fire Code.
2. Assemblies must be U.L. Listed for Fire Protection purposes.

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"



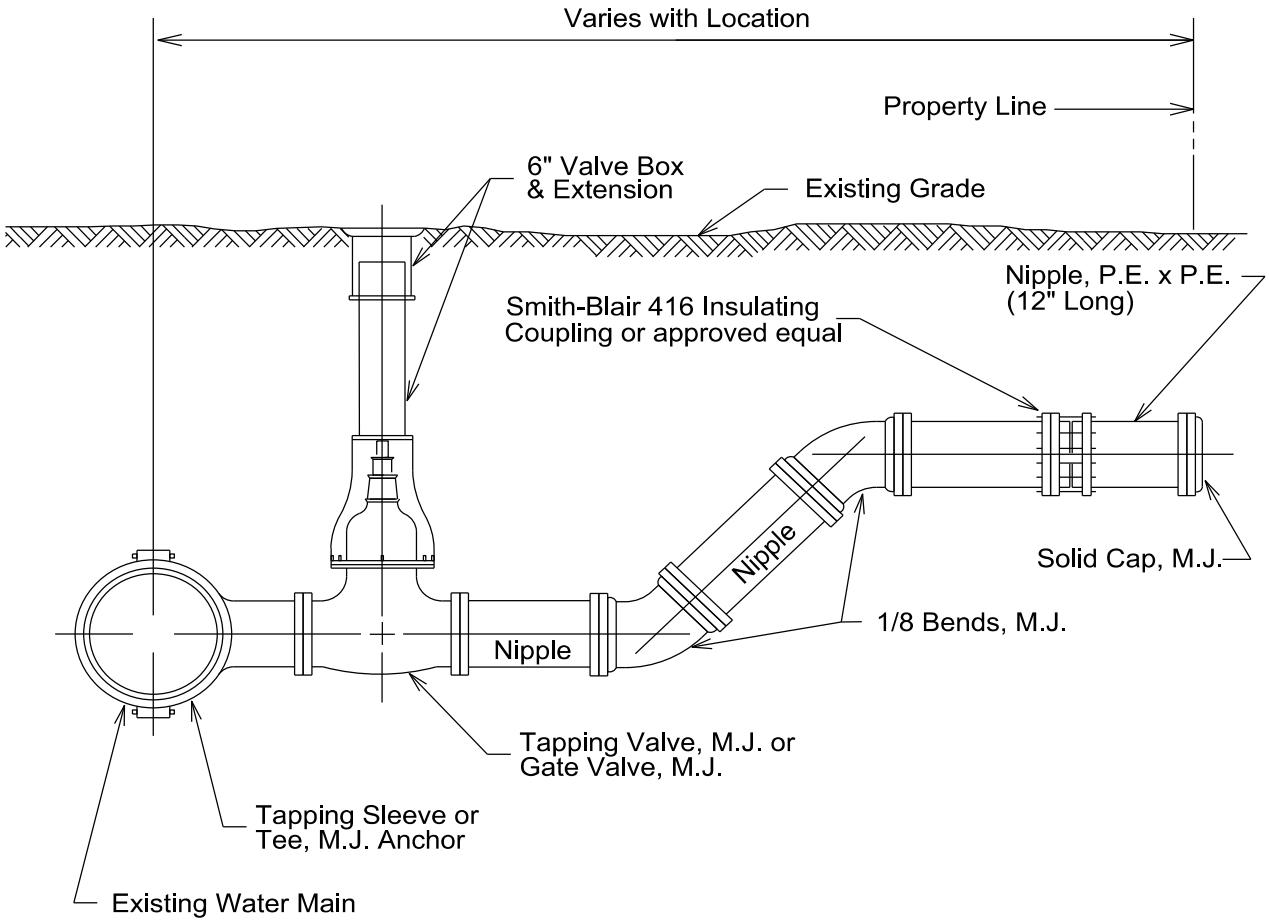
PLAN



SECTION A-A

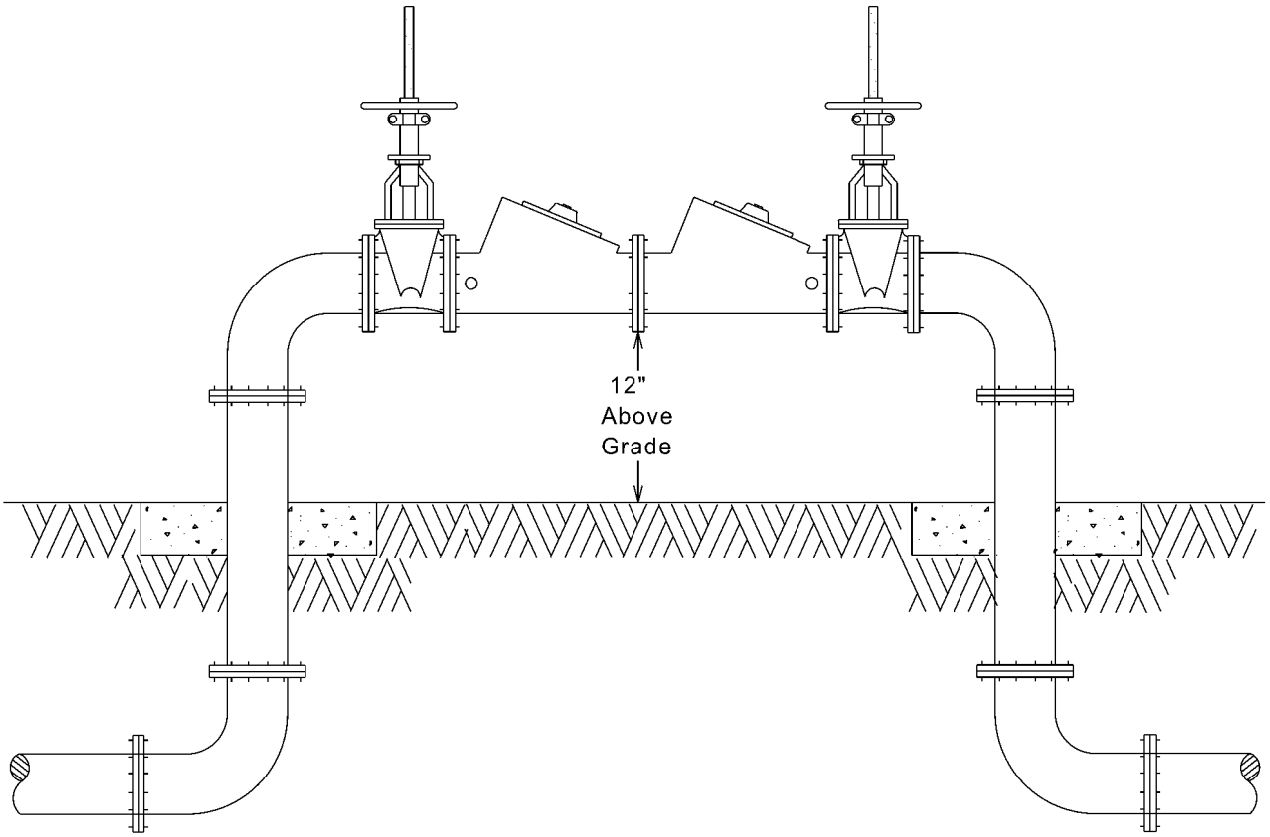
Notes:
1. Tamper switches may be required by Fire Code.
2. Assemblies must be U.L. Listed for Fire Protection purposes.

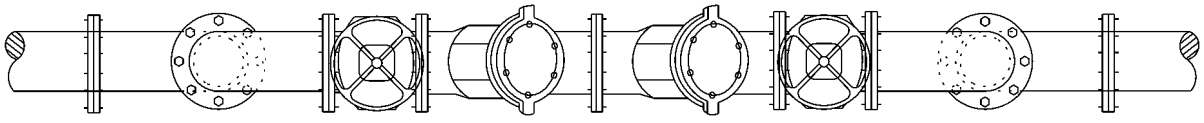
PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	10" DOUBLE CHECK ASSEMBLY INSTALLATION (DCVA)	APPROVED March 2008	REVISED AUG 2019
		DD-824-20	SHEET 1 OF 1



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. 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.

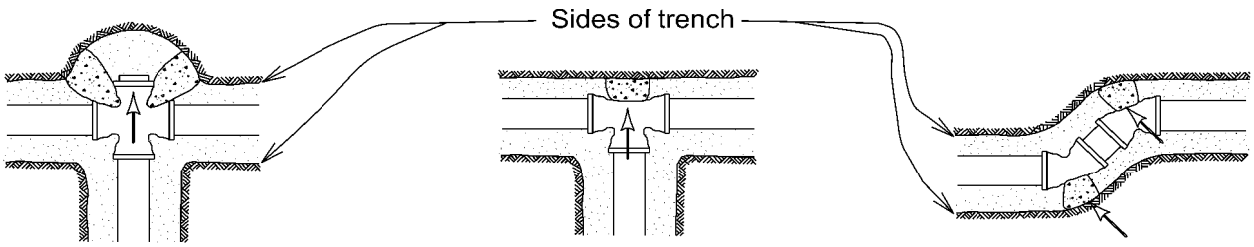
1. All mechanical (joint) restraints shall be bidirectional.
2. Anchor blocks shall be constructed solidly behind the fitting and symmetrical with the axis of resultant thrust, except where this is not possible as in the case of gravity anchorage for vertical bends.
3. If the restraint limits do not 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.

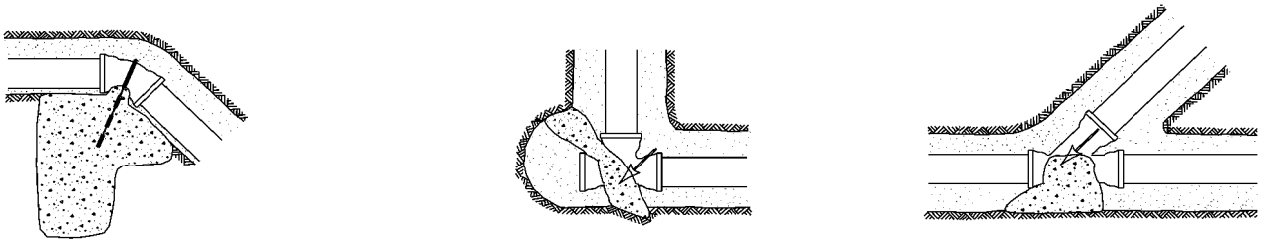
10. When specifically requested by the Contractor and approved by the Engineer, the maximum soil lateral load bearing capacity that will be allowed for the design of thrust blocking shall be 5,000 psf.
11. When soil lateral load bearing capacities of 4,000 psf or 5,000 psf are recorded for design of 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.

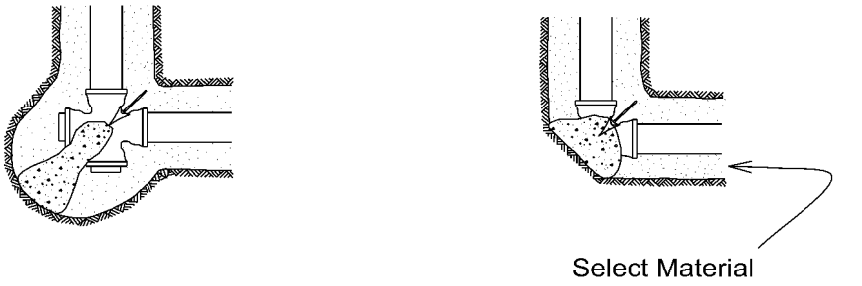
839.5 MEASUREMENT: Anchorage/Thrust Blocking or Joint Restraints are considered subsidiary to the work and no separate payment will be made to the Contractor for this work.

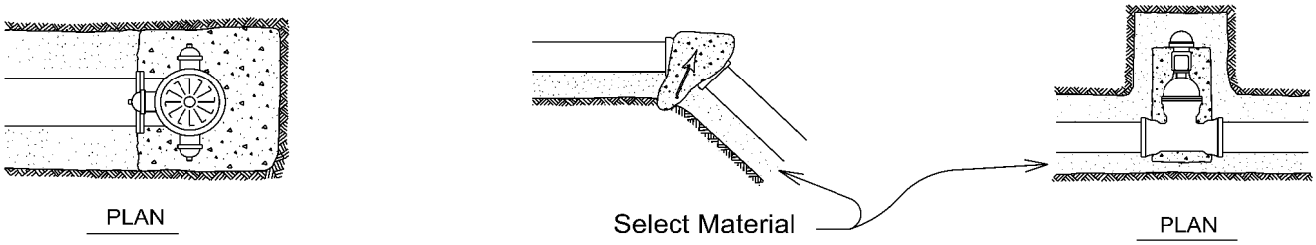
839.6 PAYMENT: Anchorage/Thrust Blocking or Joint Restraints are considered subsidiary to the work and no separate payment will be made to the Contractor for this work.

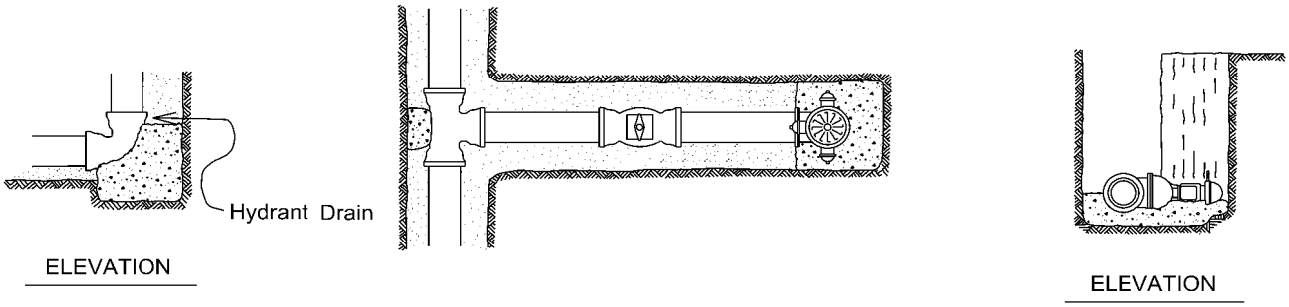
-End of Specification-



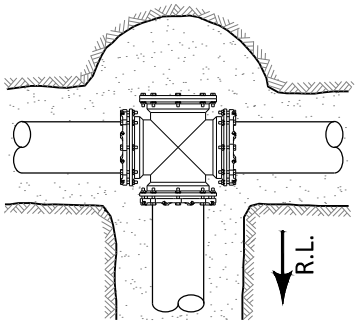


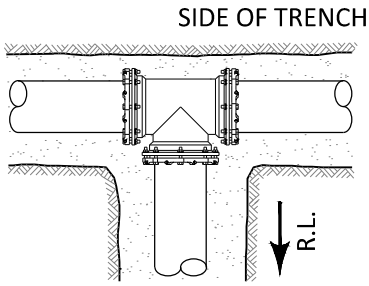


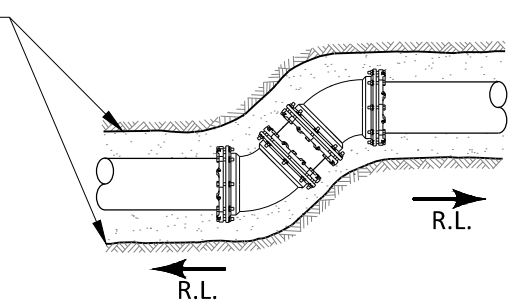


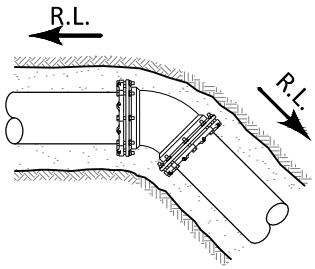


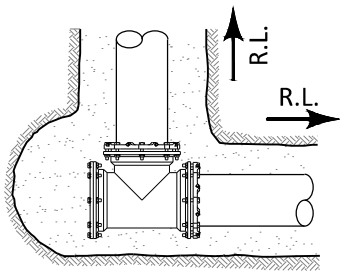
PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	THRUST BLOCKS FOR FITTINGS (WATER ONLY)	APPROVED March 2008	REVISED AUG 2019
		DD-839-01	SHEET 1 OF 2

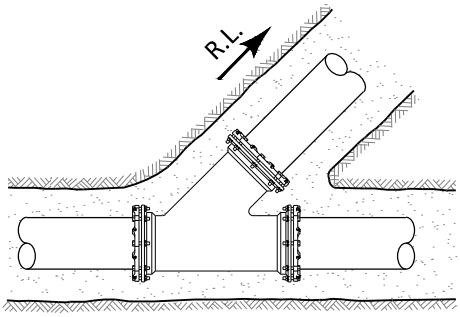




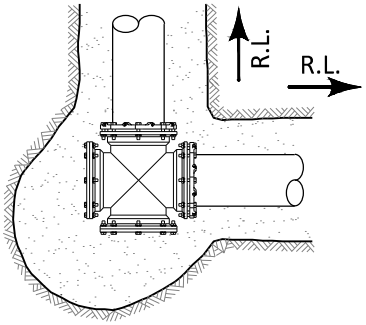


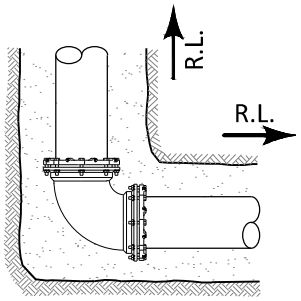


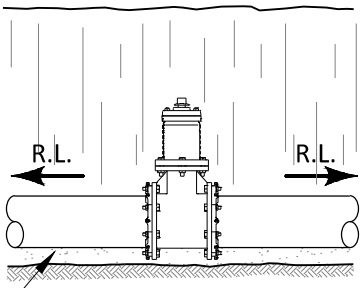


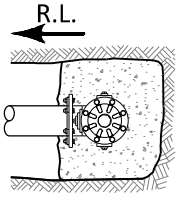


R.L. = RESTRAINED LENGTHS TO BE DETERMINED BY DESIGN ENGINEER



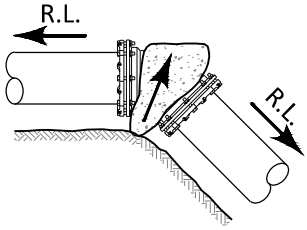


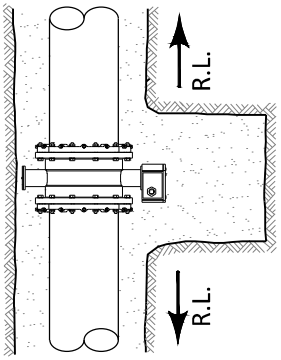




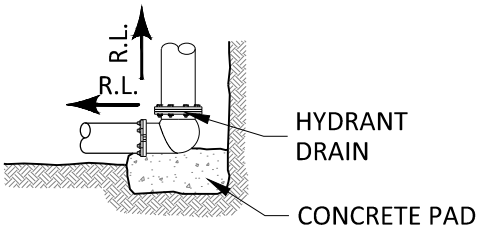
PLAN

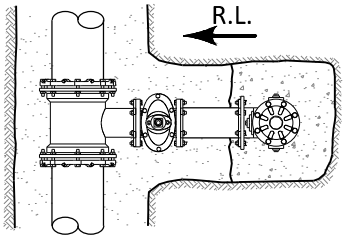
POUR CONCRETE AFTER HYDRANT HAS BEEN PLACED



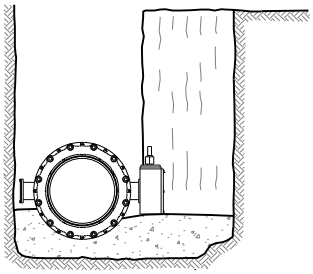


PLAN





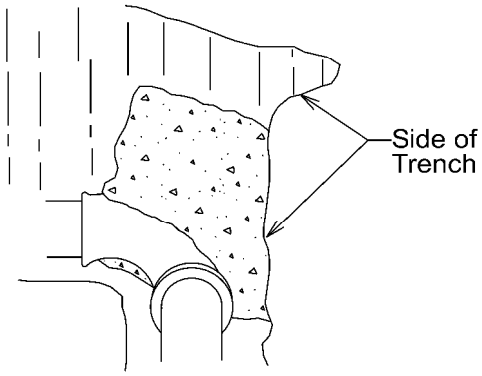
ELEVATION



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

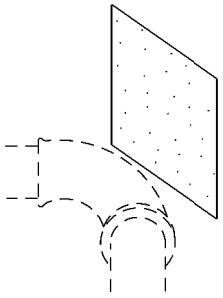
Typical blocking for 90° Bend



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

Area Sq. Ft.

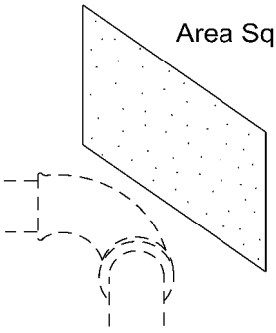
2 Sq. Ft. in rock
&
4 Sq. Ft. in other soils



6" Class 200

Area Sq. Ft.

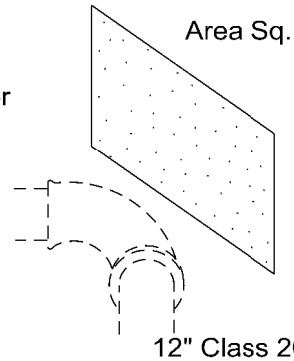
4 Sq. Ft. in rock
&
6 Sq. Ft. in other soils



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)

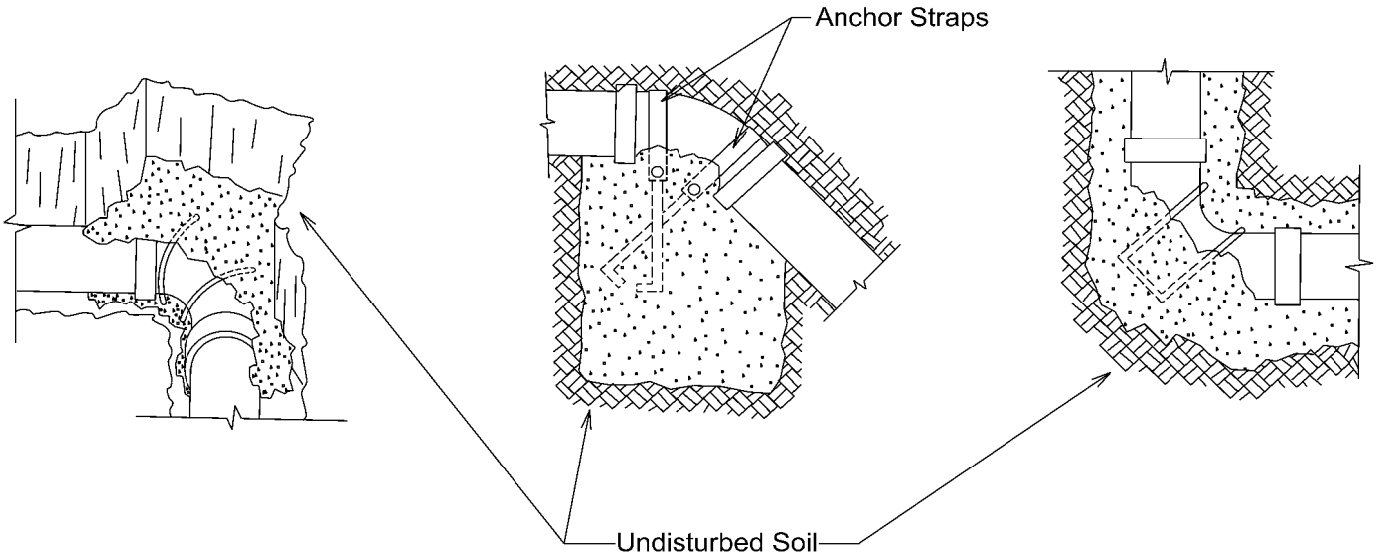
Square feet of blocking required for rock excavation

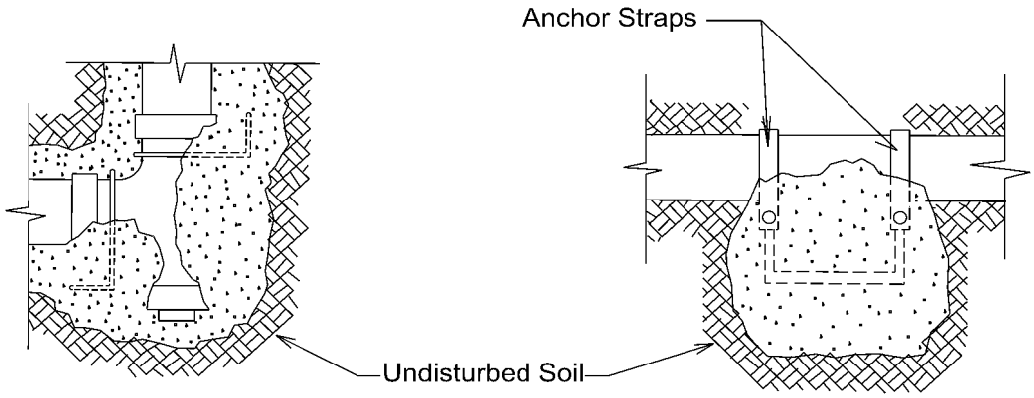
SIZE PIPE	TEES & DEAD ENDS	90° BENDS	45° BENDS	22 1/2° BENDS
6"	2	2	1	1
8"	3	4	2	1
12"	6	9	5	2
16"	11	15	8	4

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

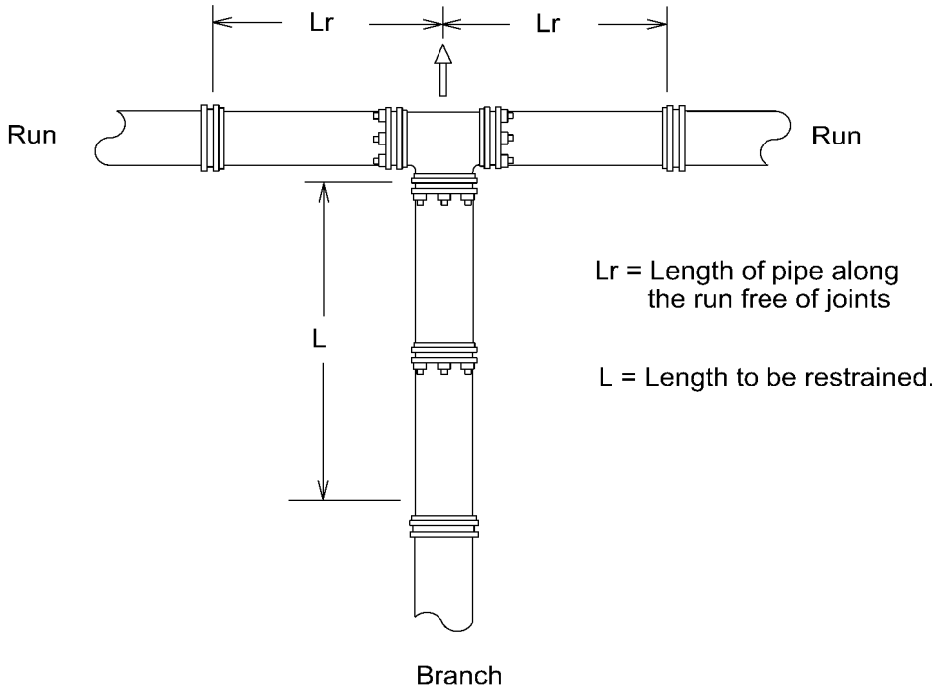
PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	THRUST BLOCKING FOR HIGH PRESSURE SYSTEM	APPROVED March 2008	REVISED AUG 2019
		DD-839-02	SHEET 1 OF 1





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

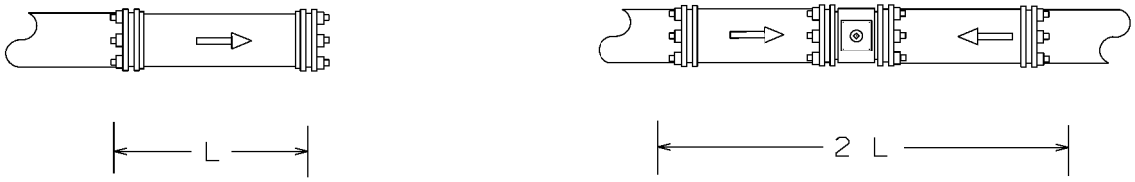
RESTRAINED LENGTH FOR TEES (Cont'd)

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

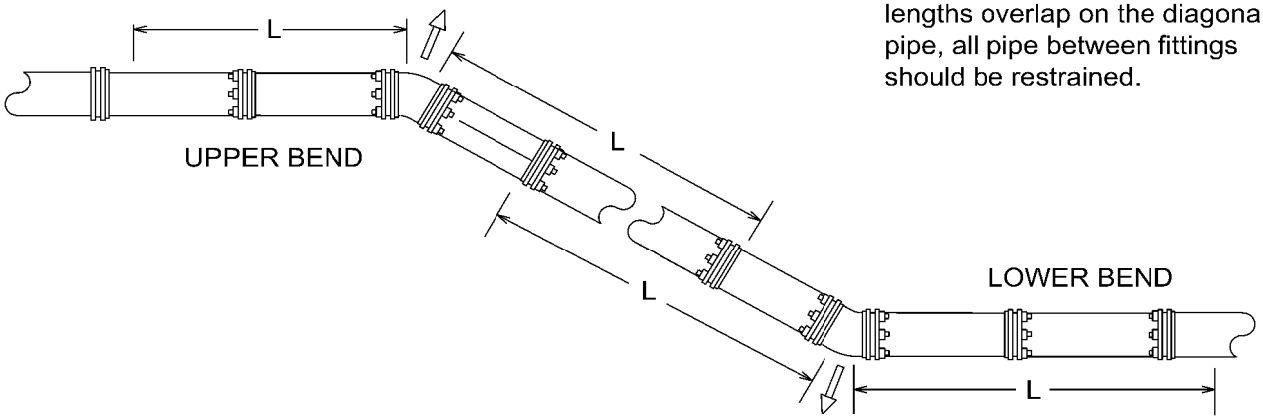
RESTRAINED LENGTH DESIGN

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.



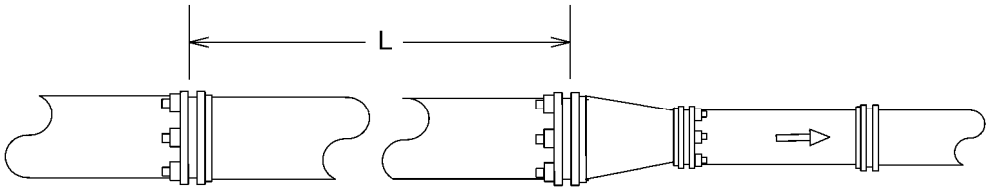
PIPE SIZE (inch)	BEND ANGLE (deg.)	LOW SIDE DEPTH	UPPER BEND RESTRAINED LENGTH IIN FEET TEST PRESSURE = 200 psi	LOWER BEND RESTRAINED LENGTH IN FEET TEST PRESSURE = 200psi	UPPER BEND RESTRAINED LENGTH IN FEET TEST PRESSURE = 150 psi	LOWER BEND RESTRAINED LENGTH IN FEET TEST PRESSURE = 150 psi
6	45	5	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

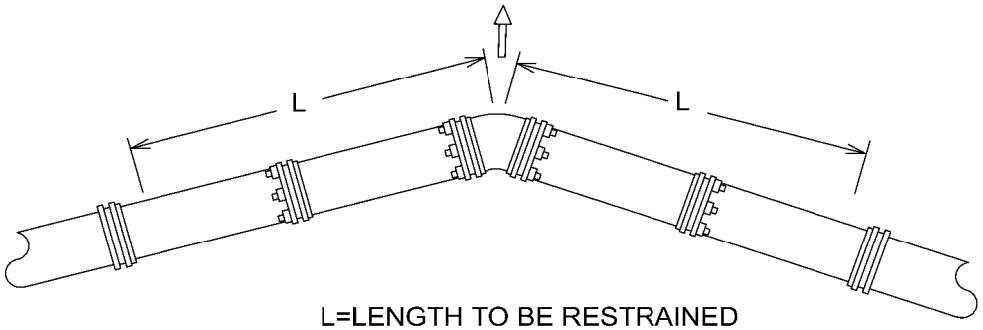
PIPE SIZE (inch)	SMALL SIZE (inch)	RESTRAINED LENGTH IN FEET, WHEN TEST PRESSURE = 200 psi	RESTRAINED LENGTH IN FEET, WHEN TEST PRESSURE = 150 psi
6	4	30	23
8	4	55	42
8	6	32	24
12	4	95	71
12	6	80	60
12	8	58	43

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. 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.

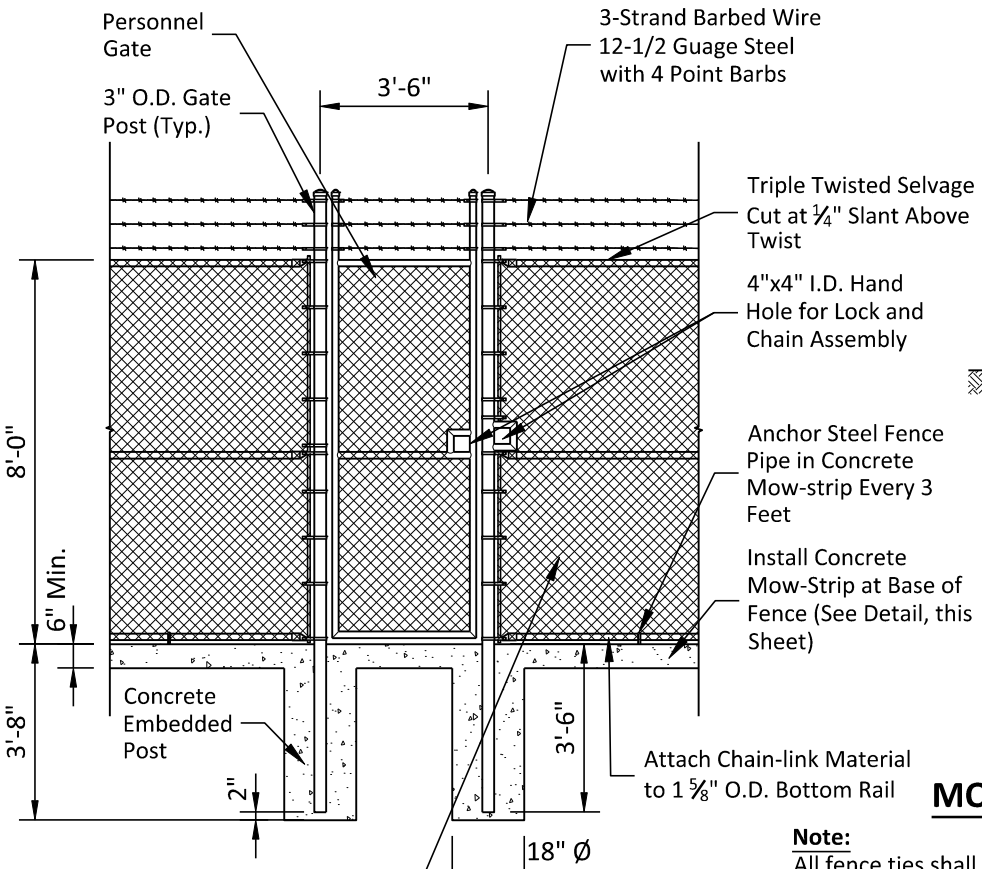
845.6 MEASUREMENT:

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.

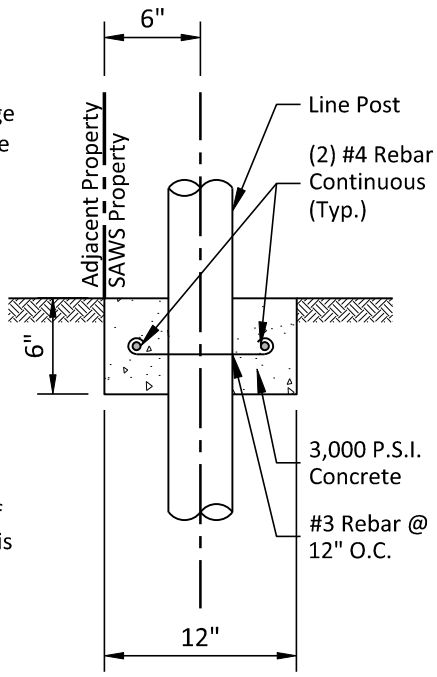
845.7 PAYMENT:

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-

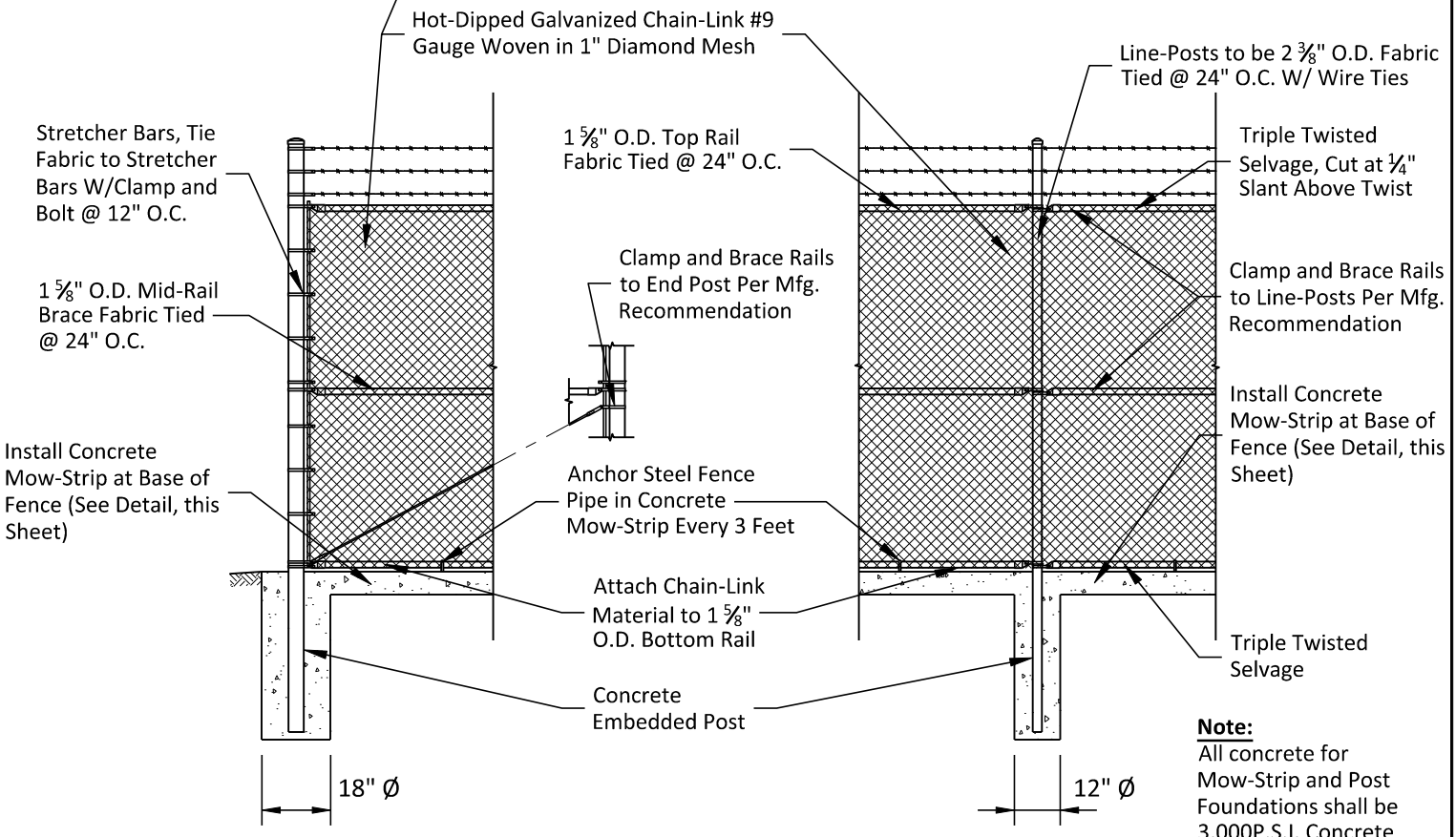


PERSONNEL GATE



MOW-STRIP SECTION DETAIL

Note:
All fence ties shall be 9 Gauge Galvanized Steel to be twisted on the inside of fence.

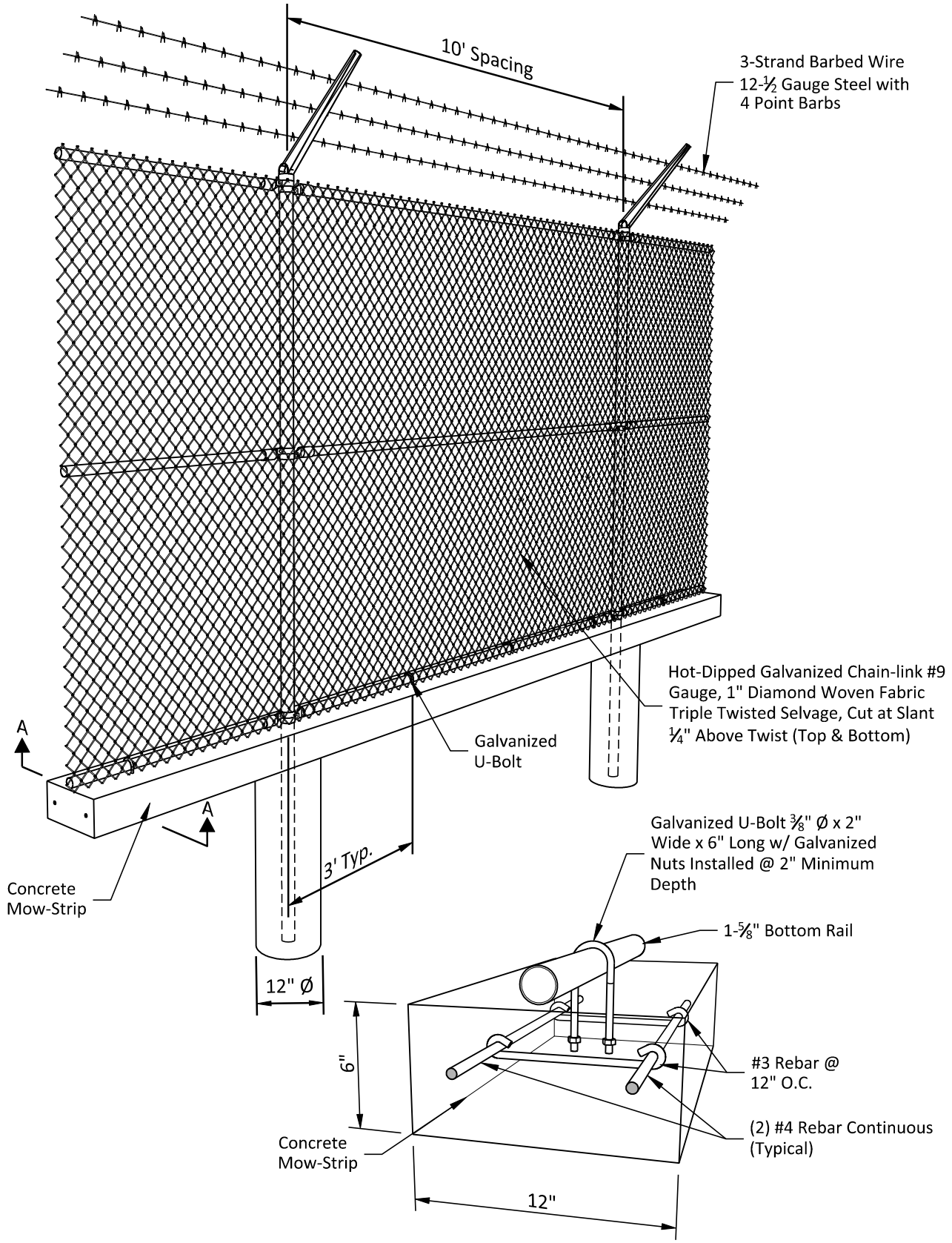


FENCE CORNER-POST

INLINE-POST

Note:
All concrete for Mow-Strip and Post Foundations shall be 3,000P.S.I. Concrete

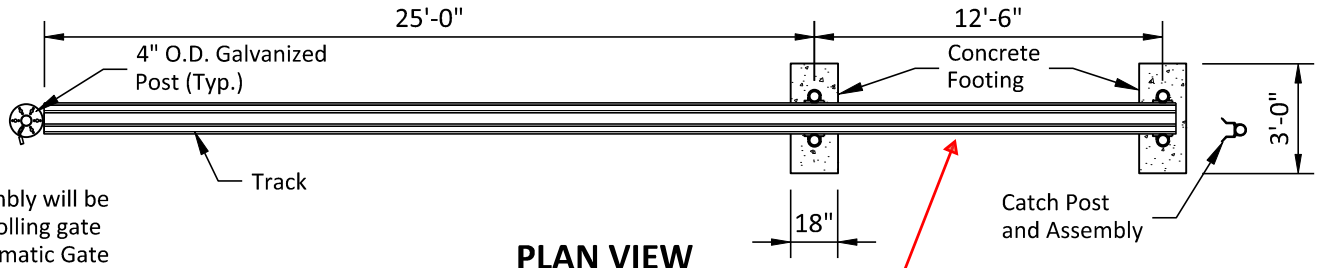
PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	FENCE DETAILS	APPROVED MARCH 2011	REVISED AUG 2019
		DD-903-17	SHEET 1 OF 2



NOTE:
All fence ties shall be 9 Gauge Galvanized steel to be twisted on the inside of the fence

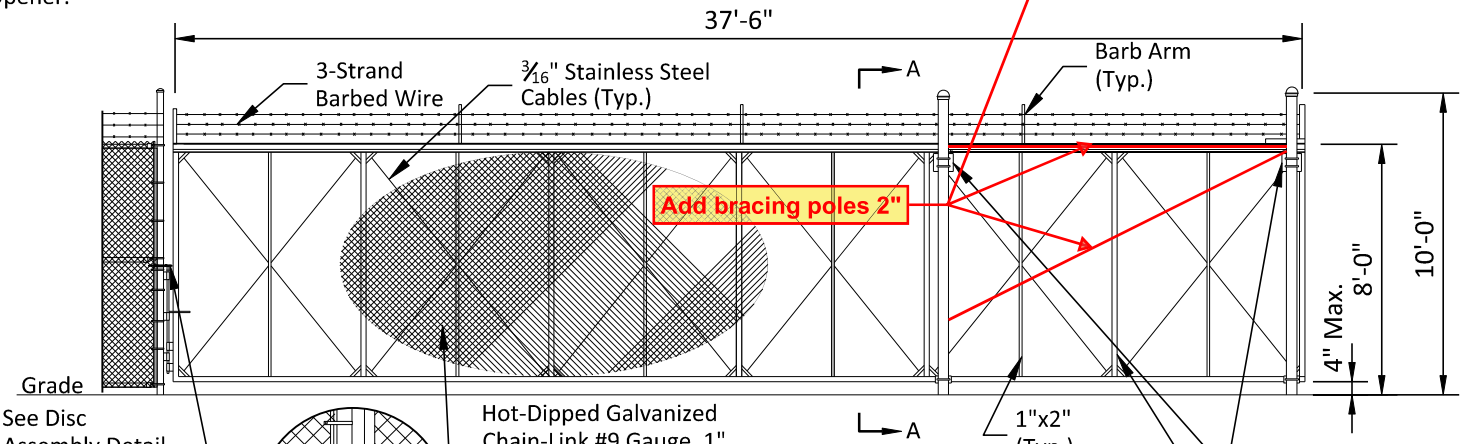
SECTION A-A

PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	FENCE DETAILS	APPROVED MARCH 2011	REVISED AUG 2019
		DD-903-17	SHEET 2 OF 2

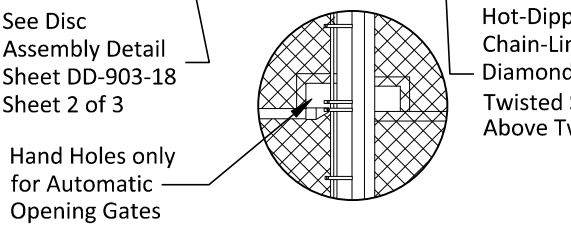


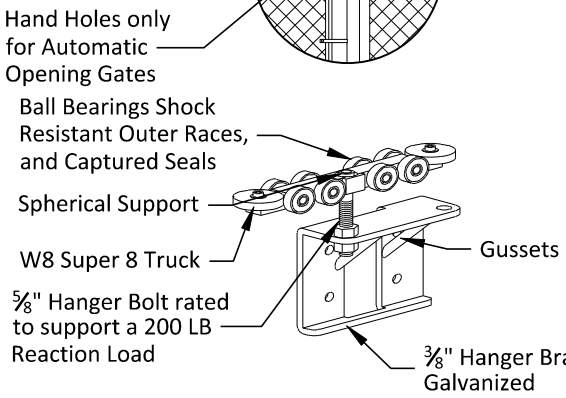
Note:
No Disc Assembly will be used on any rolling gate with an Auto-matic Gate Opener.

PLAN VIEW

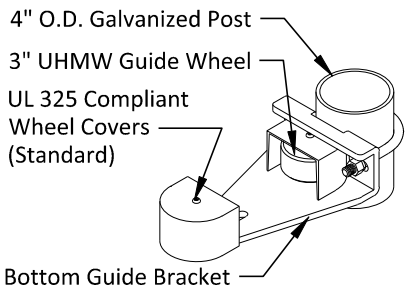


ELEVATION

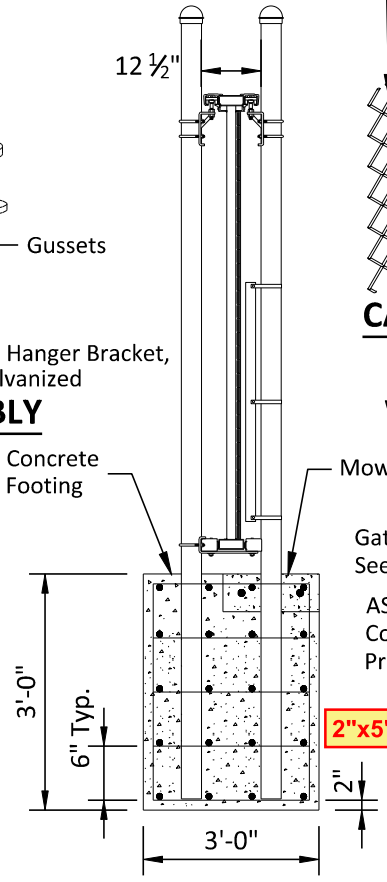




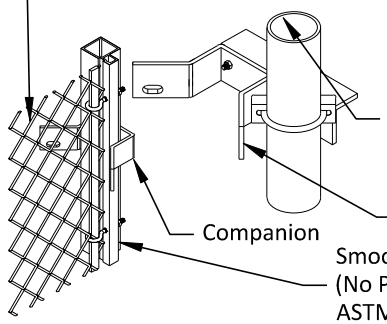
GATE HANGER ASSEMBLY



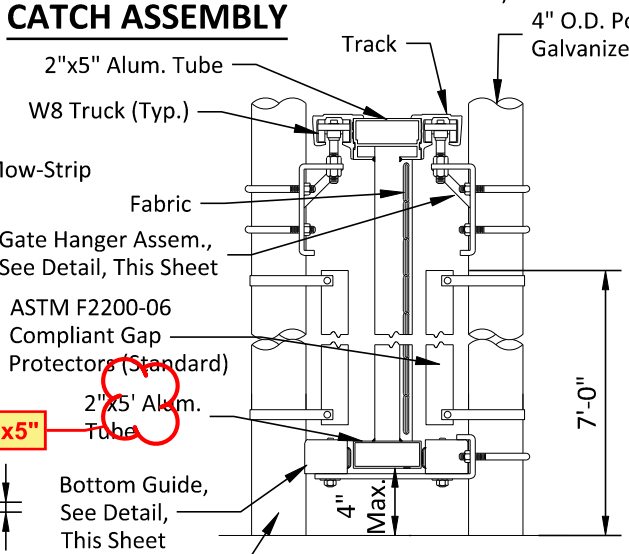
BOTTOM GUIDE



SECTION A-A



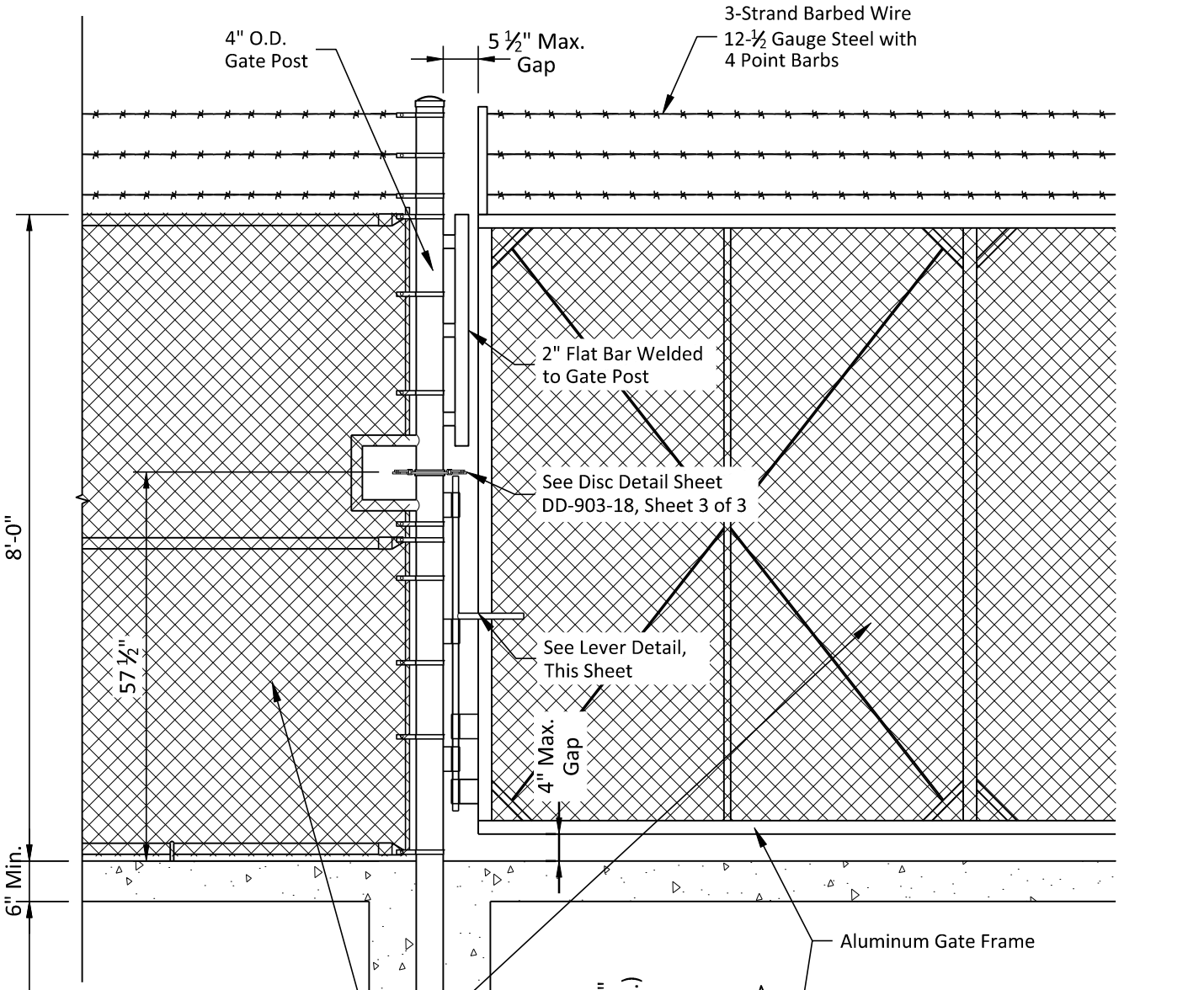
CATCH ASSEMBLY

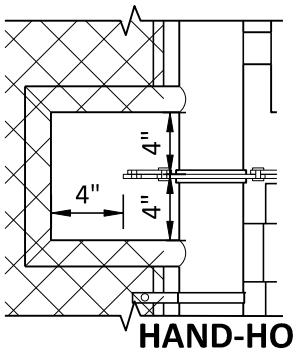


ENLARGED SECTION

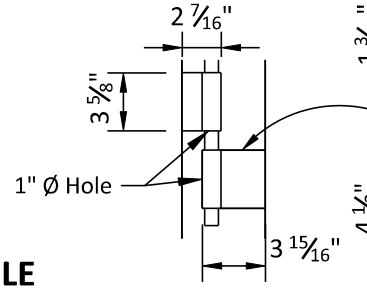
Notes:
1. Gate Frame to be fabricated from 6063 - T6 Aluminum Alloy Extrusions.
2. Gate Track to be fabricated from 6006A Aluminum Alloy Extrusions

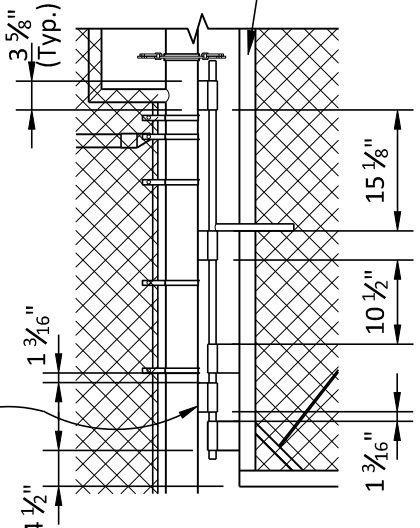
PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	HEAVY DUTY CANTILEVER SLIDE GATE	APPROVED MARCH 2011	REVISED AUG 2019
		DD-903-18	SHEET 1 OF 3



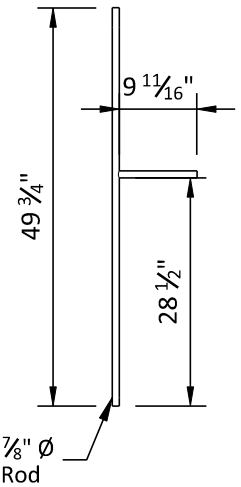


HAND-HOLE





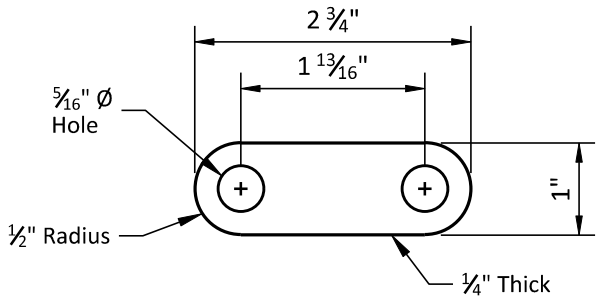
DISC ASSEMBLY DETAIL



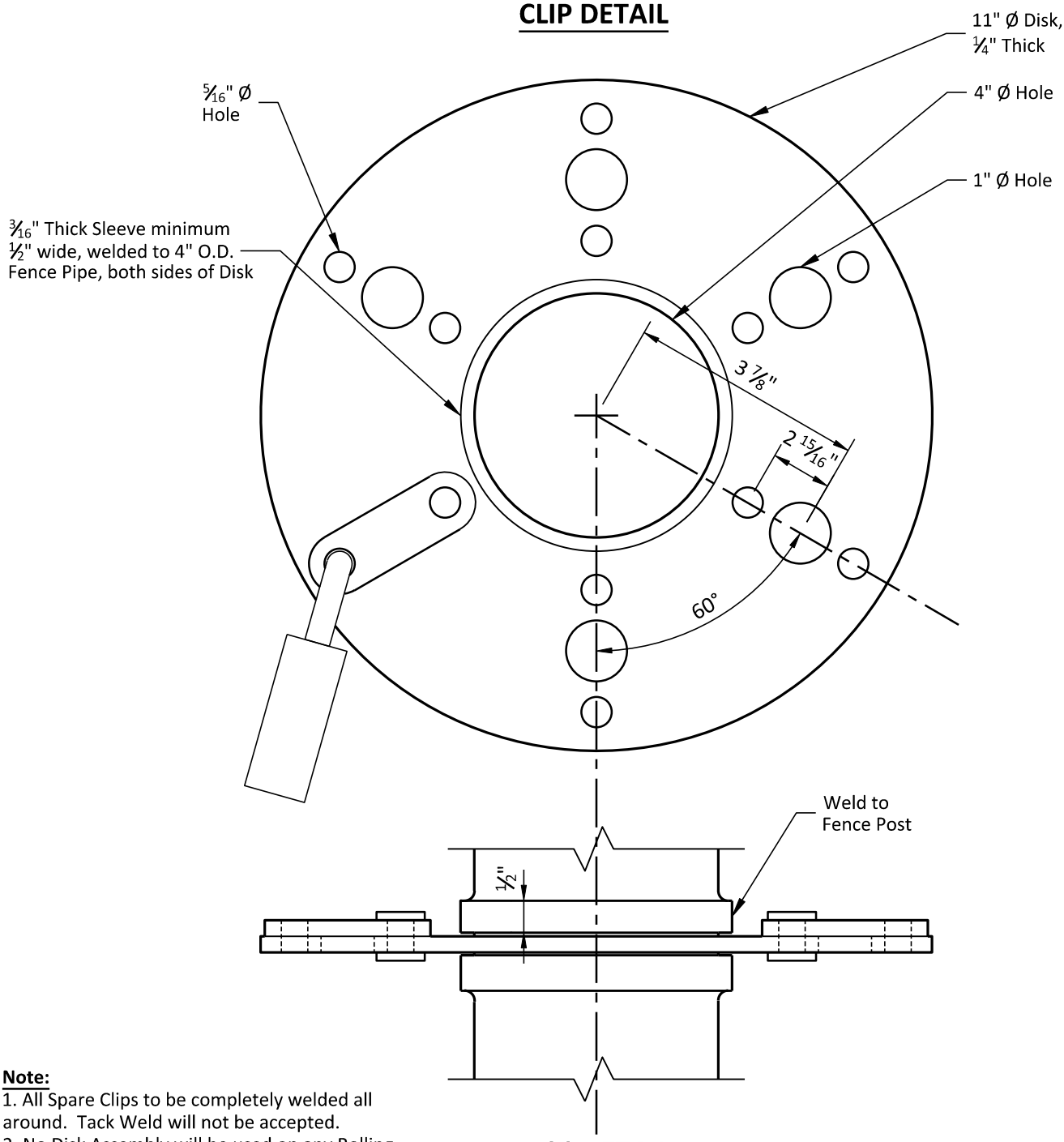
LEVER DETAIL

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

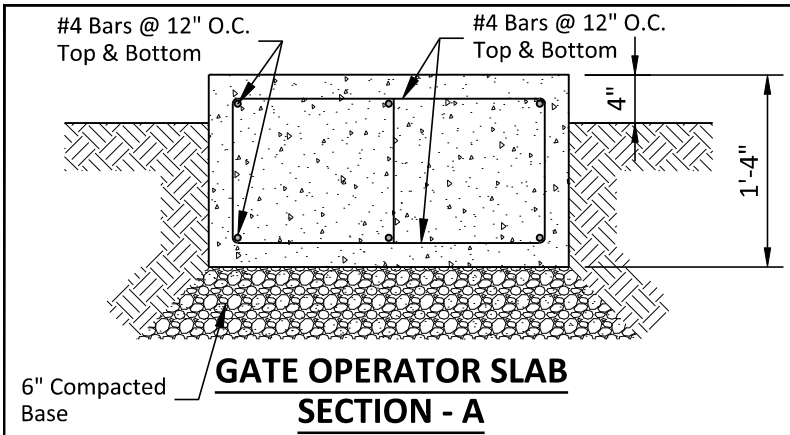


DISC DETAIL

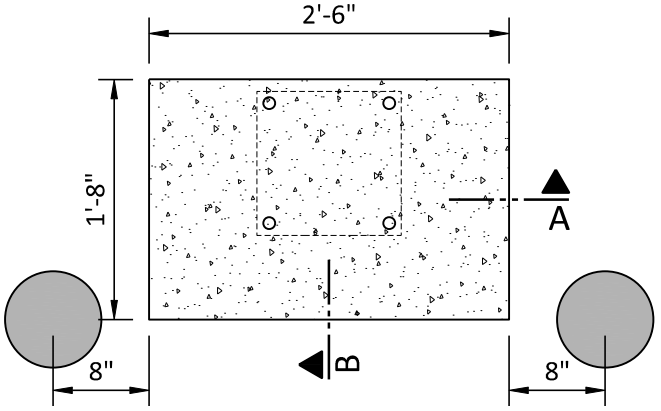
Note:

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.

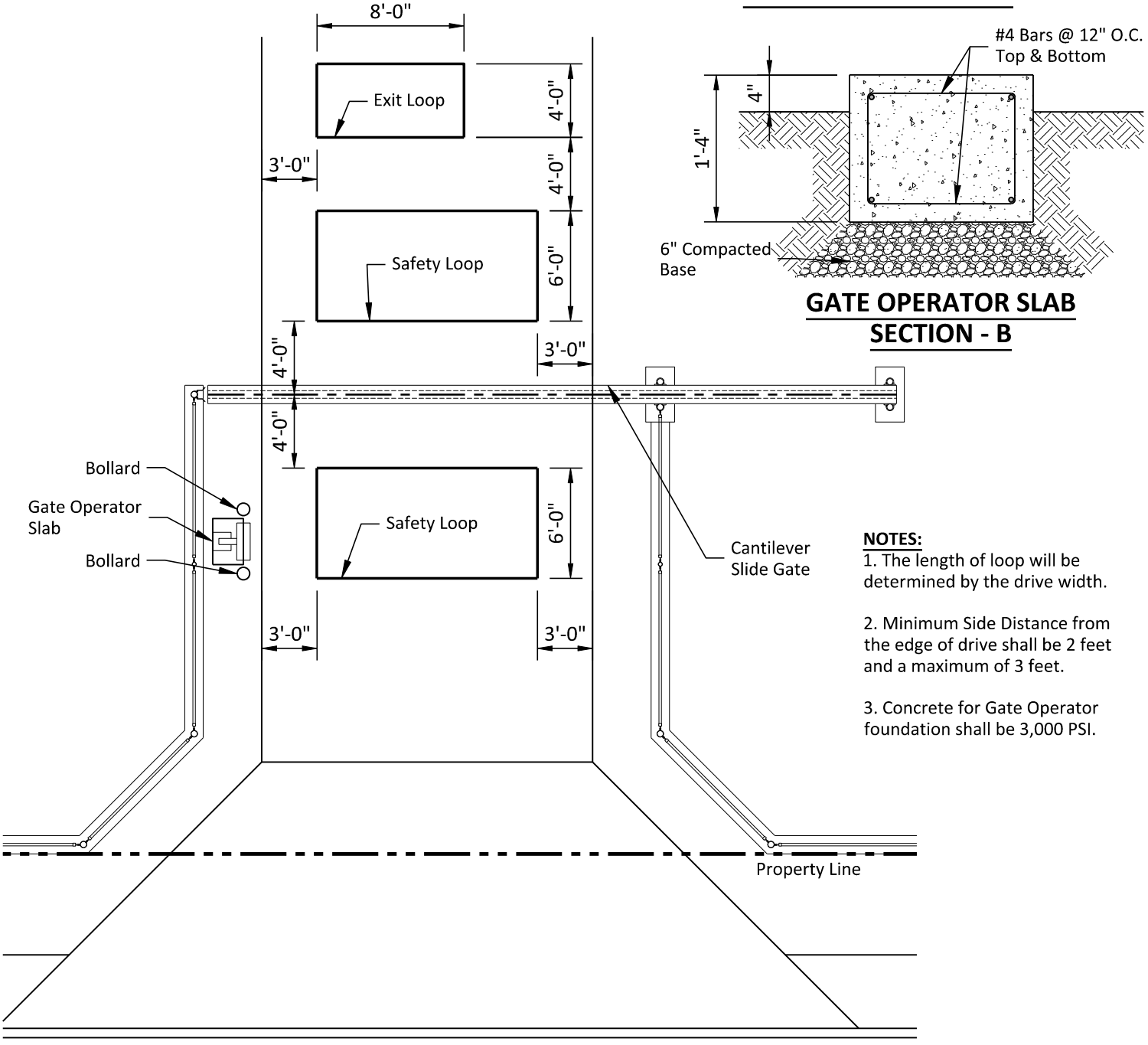
PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	HEAVY DUTY CANTILEVER SLIDE GATE	APPROVED MARCH 2011	REVISED AUG 2019
		DD-903-18	SHEET 3 OF 3



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. 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.

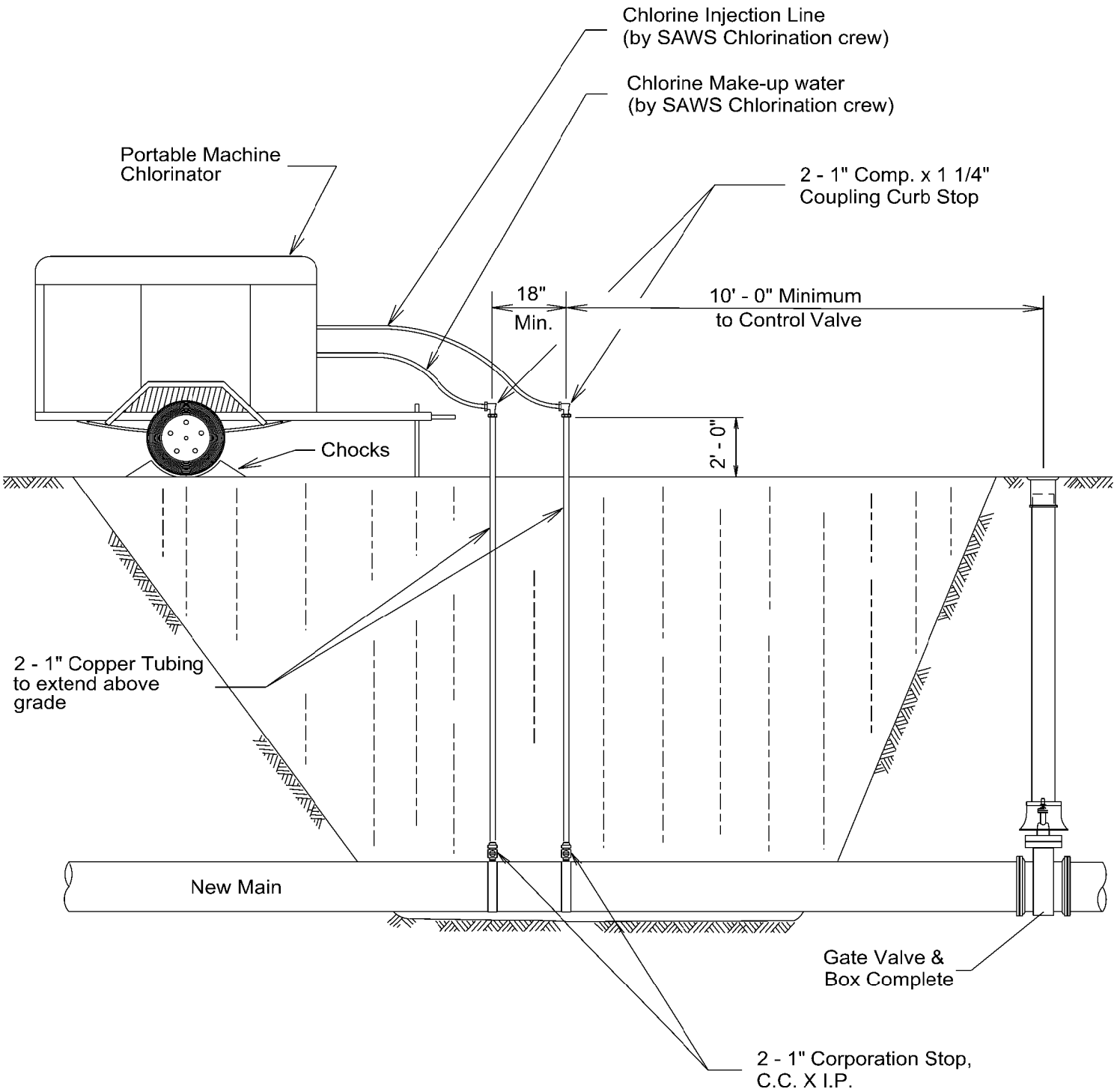
847.7 PAYMENT: Disinfection operations are considered subsidiary to the work and no separate payment will be made to the Contractor for this work. The Contractor is required to provide all appurtenances to the pipe to allow for machine chlorination at no additional cost or separate pay item.

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.

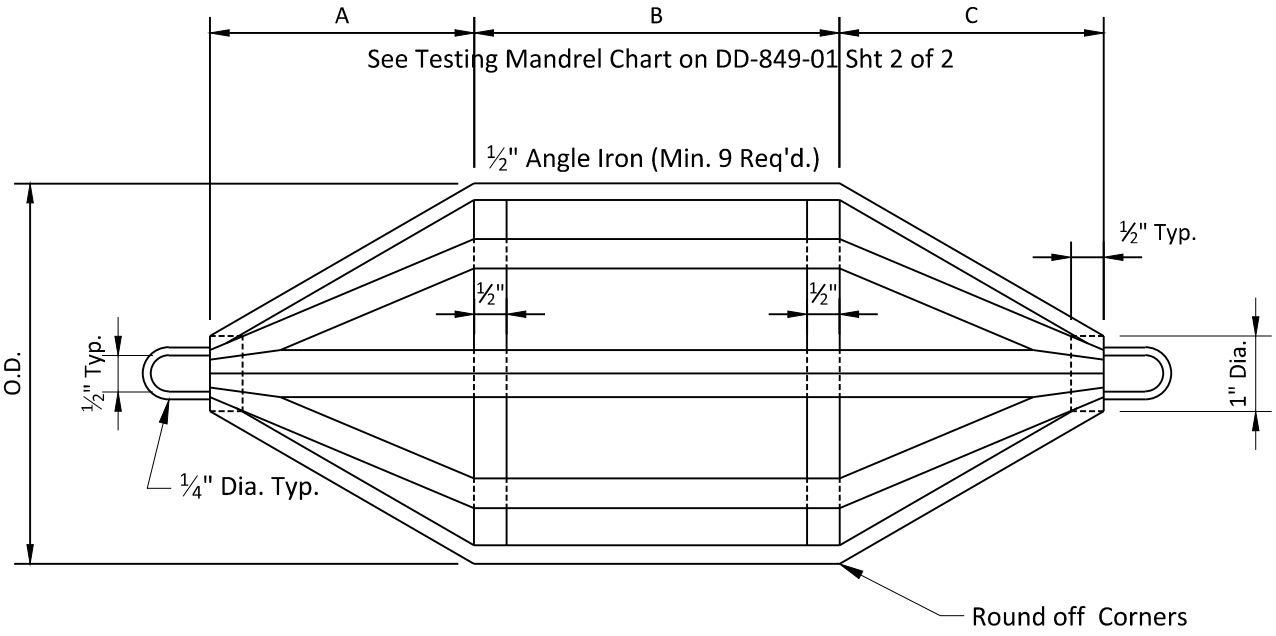
l. Excessive sags shall be documented in video and shall be in accordance with NASSCO-(PACP) requirements per SAWS Specification Item No. 866.

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.

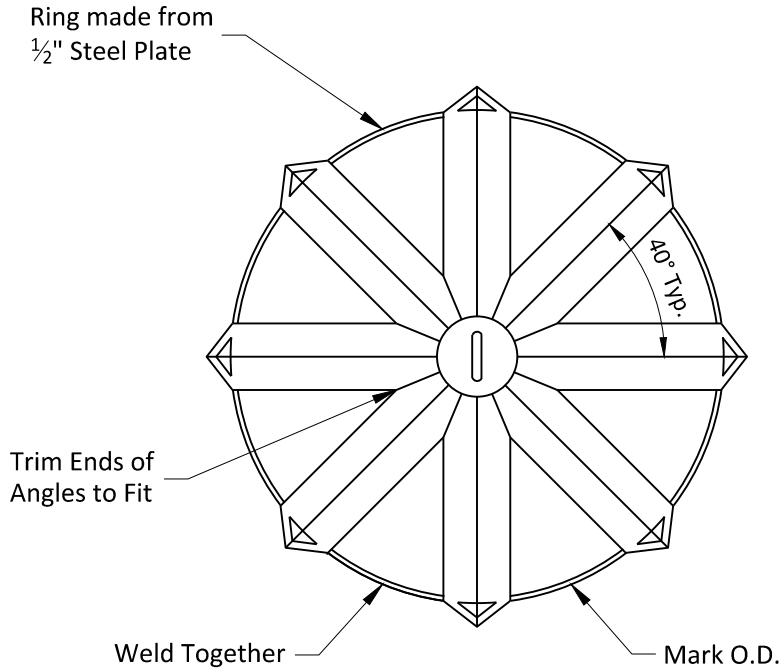
849.6 MEASUREMENT: Air/Infiltration/Exfiltration, and Deflection Testing will not be measured for payment.

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.

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 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.

l. 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.
    a. Manufacturer shall be approved by SAWS Products Standard Committee and be on the APL.

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.

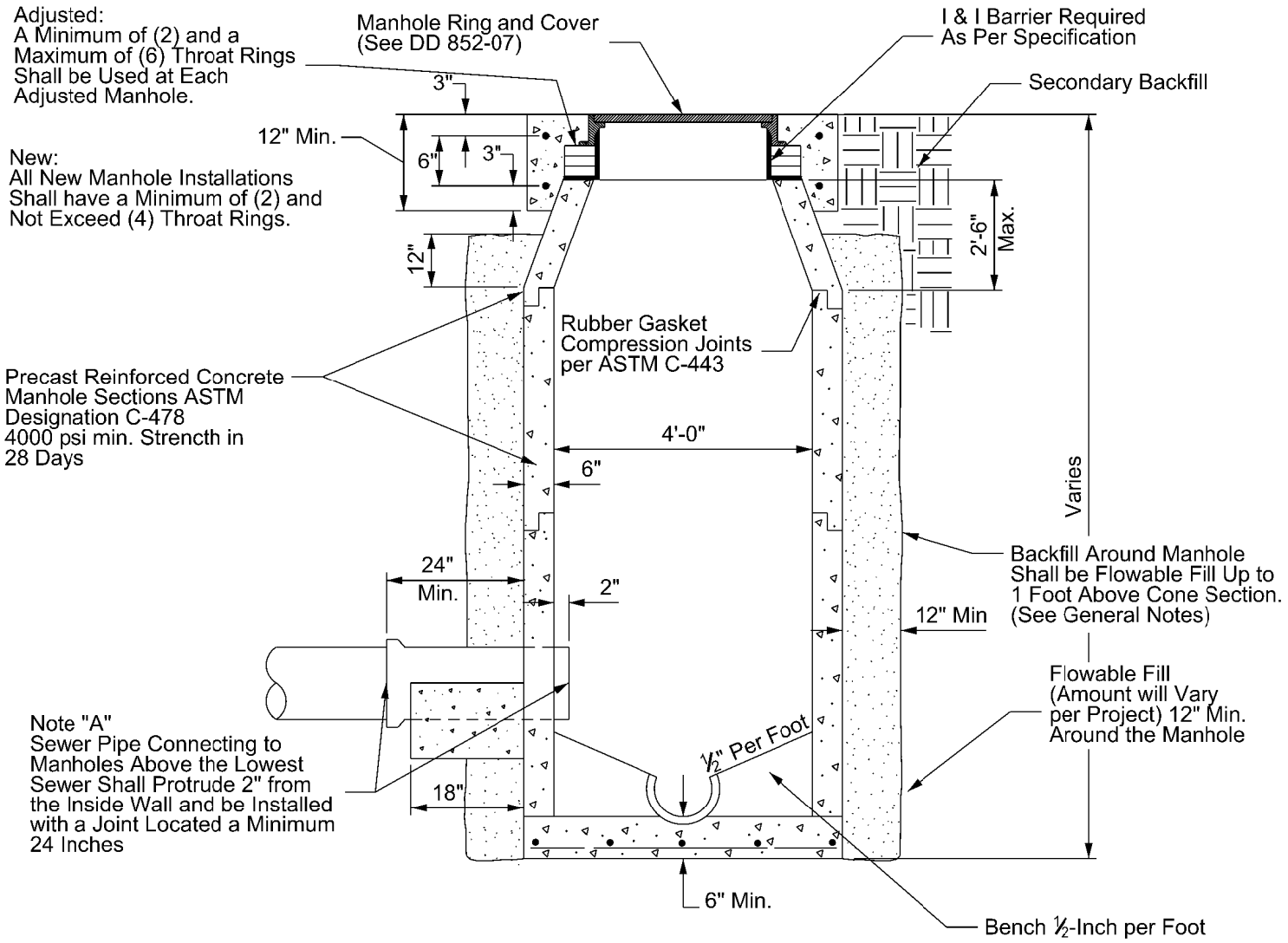
1. Manholes deeper than 6 feet shall be measured by the number of vertical feet in excess of 6 feet.

852.8 PAYMENT:

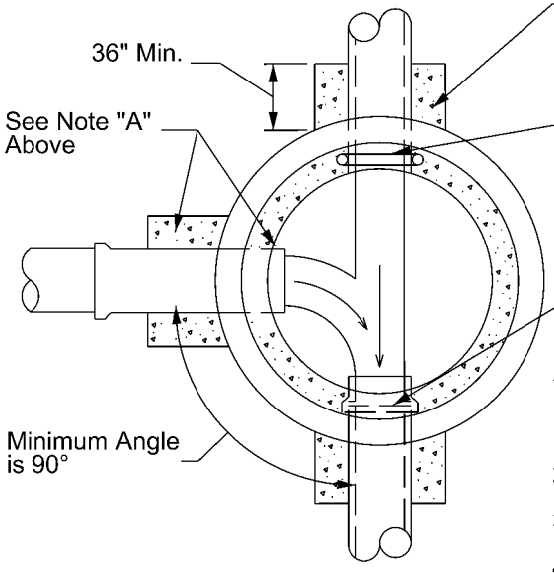
1. All manholes shall be paid at the contract unit price bid for each such manhole, which price shall be full compensation for all precast sections or throat rings, UV stabilized polyethylene liner, cones, bases, rings and covers, manhole ring, encasement, manhole rubber joint seal, flowable fill, mortar, 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.

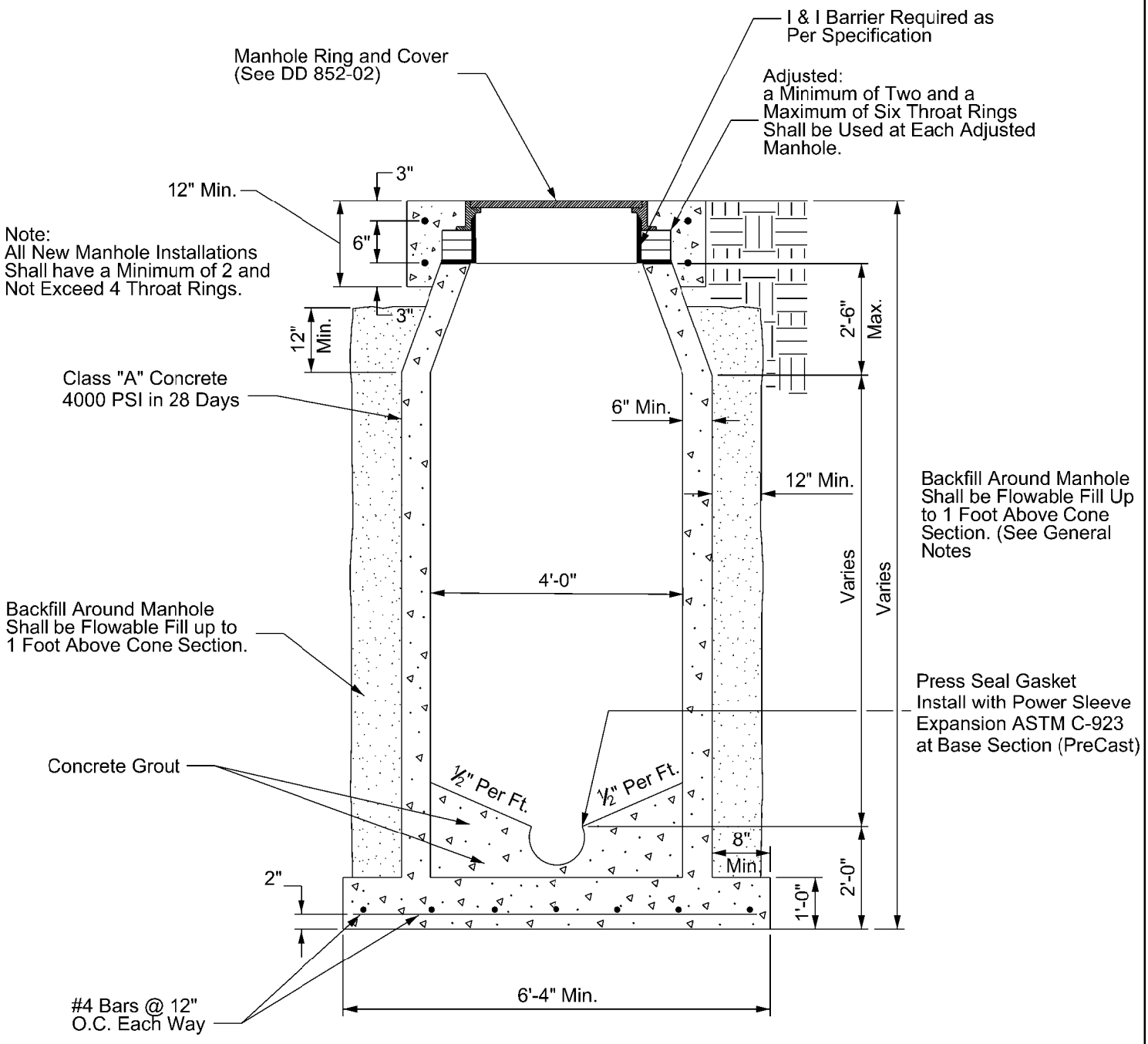
No Joints for Pipe will be Allowed within Wall Section

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

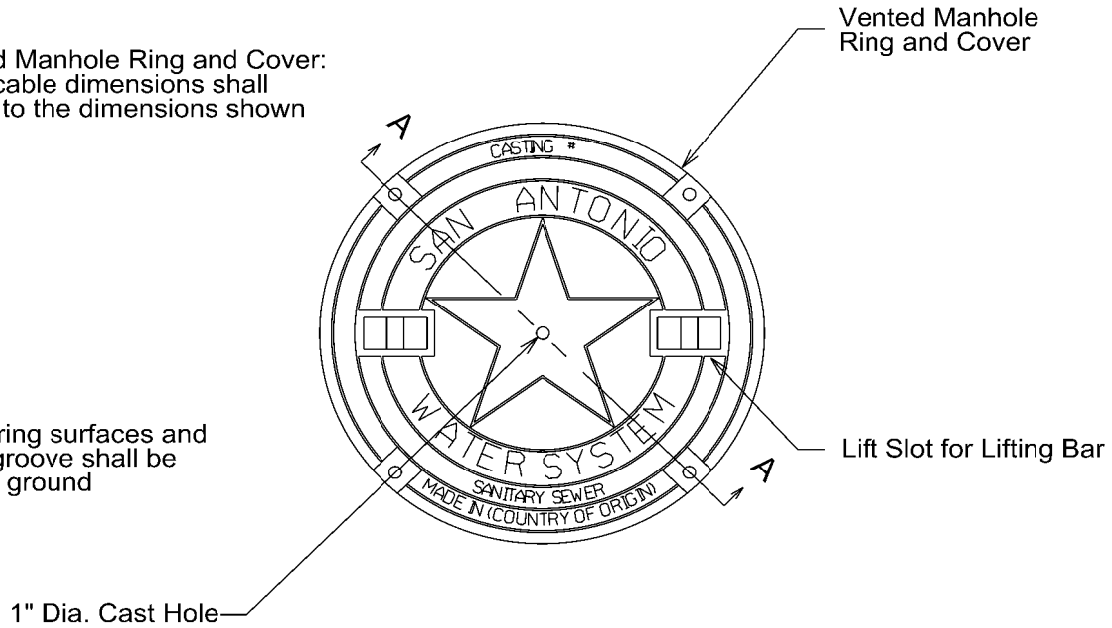
General Notes:

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.

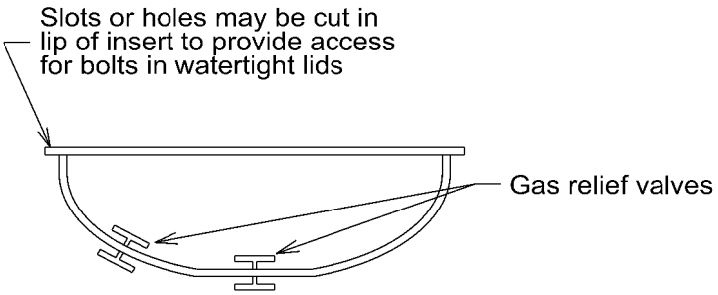
PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	STANDARD MONOLITHIC MANHOLE	APPROVED March 2008	REVISED AUG 2019
		DD 852-01	SHEET 2 OF 2

Note:
Standard Manhole Ring and Cover:
All applicable dimensions shall conform to the dimensions shown here

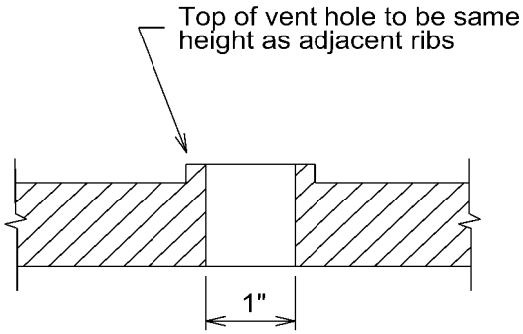
Note:
The bearing surfaces and O-Ring groove shall be Machine ground



VENTED MANHOLE RING AND COVER



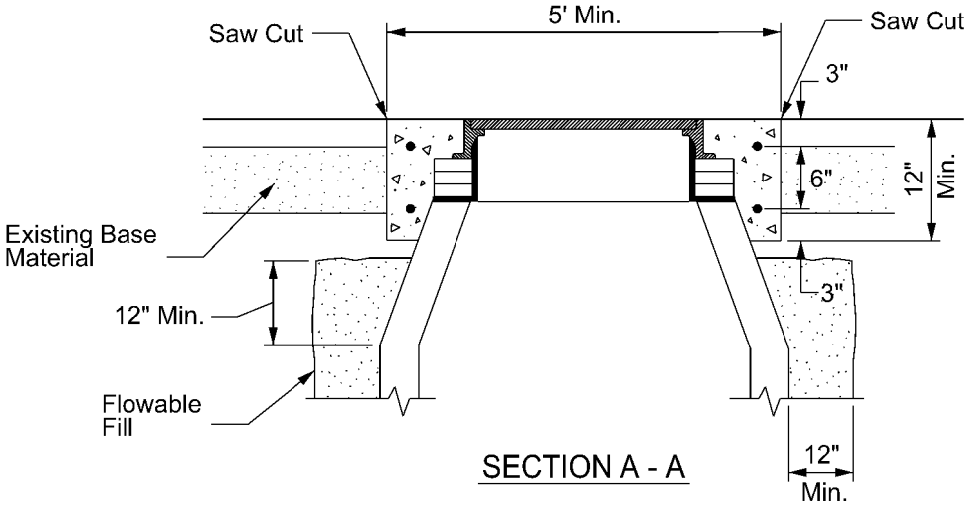
WATERTIGHT MANHOLE INSERT DETAIL



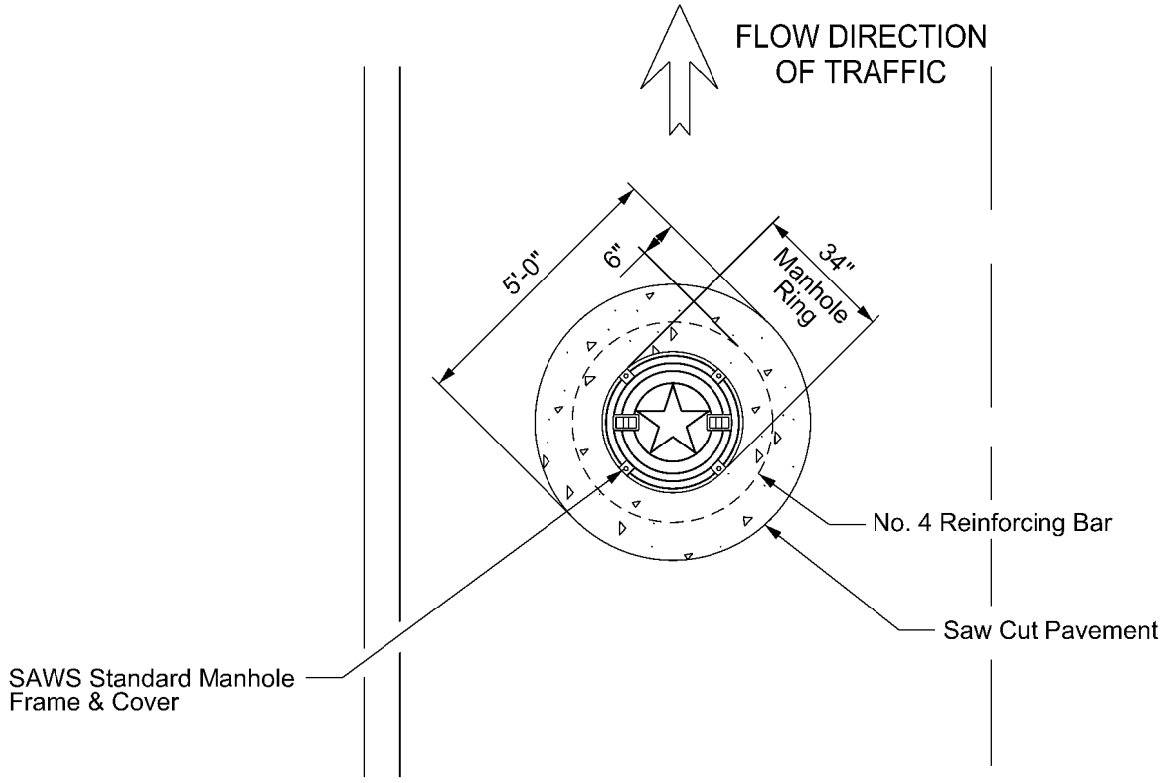
VENT HOLE DETAIL SECTION A-A

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

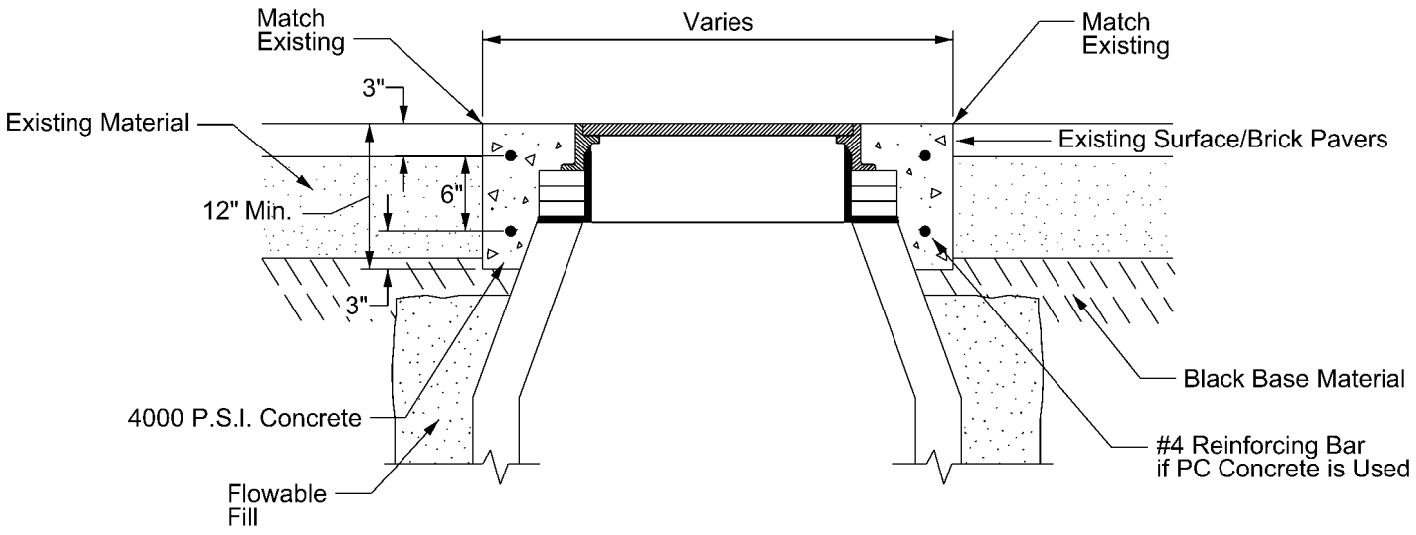


SECTION A - A

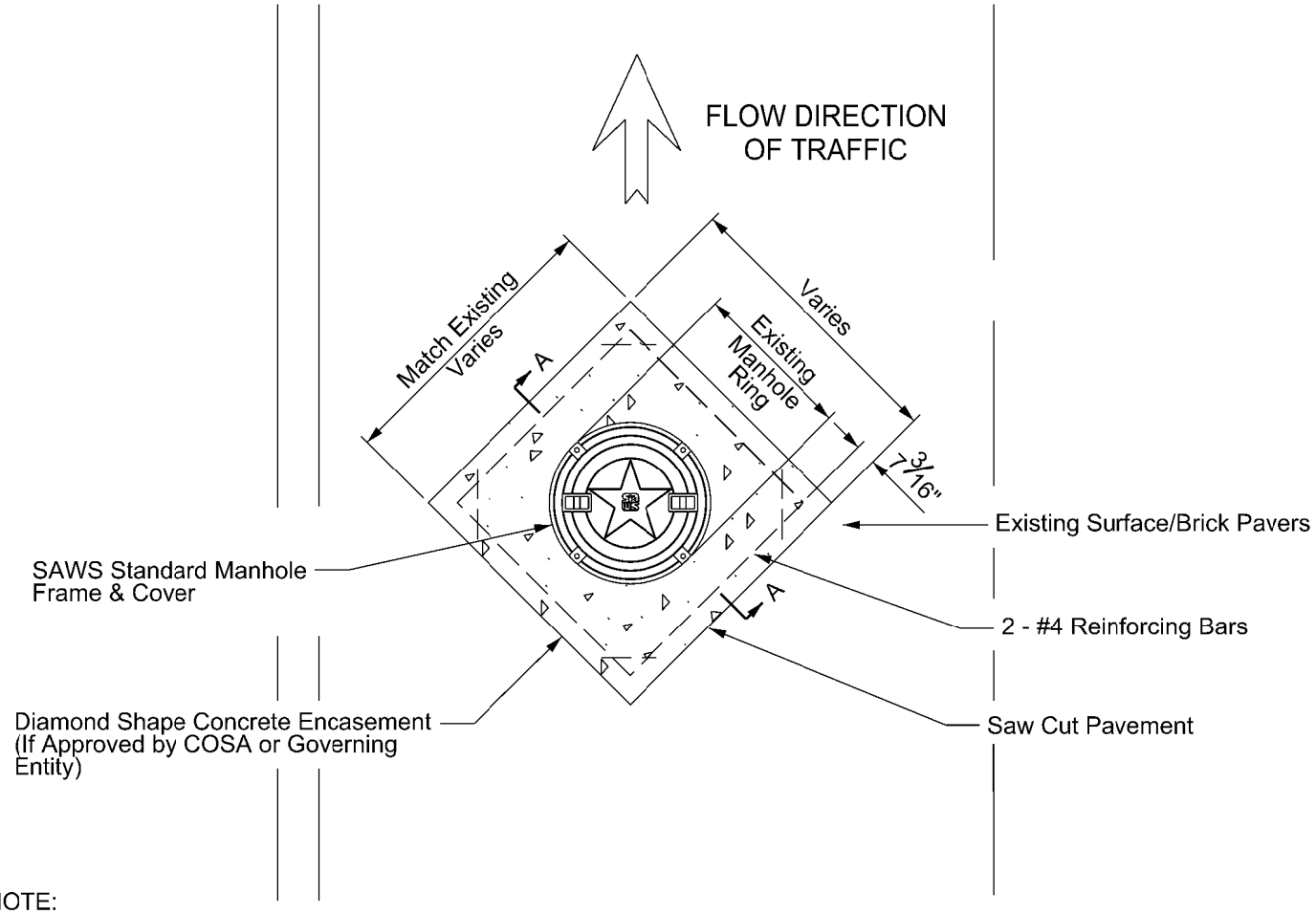


NOTE:
1. The Concrete Shall be 4000 PSI Minimum and Reinforced with No. 4 Bars as Shown.
2. The Concrete Shall Extend to Edge of Saw Cut Pavement.
3. Manhole Ring Encasement is Required on all Manholes.
4. Manhole Lid shall Open in the Direction of Traffic or Downstream in Parkway

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

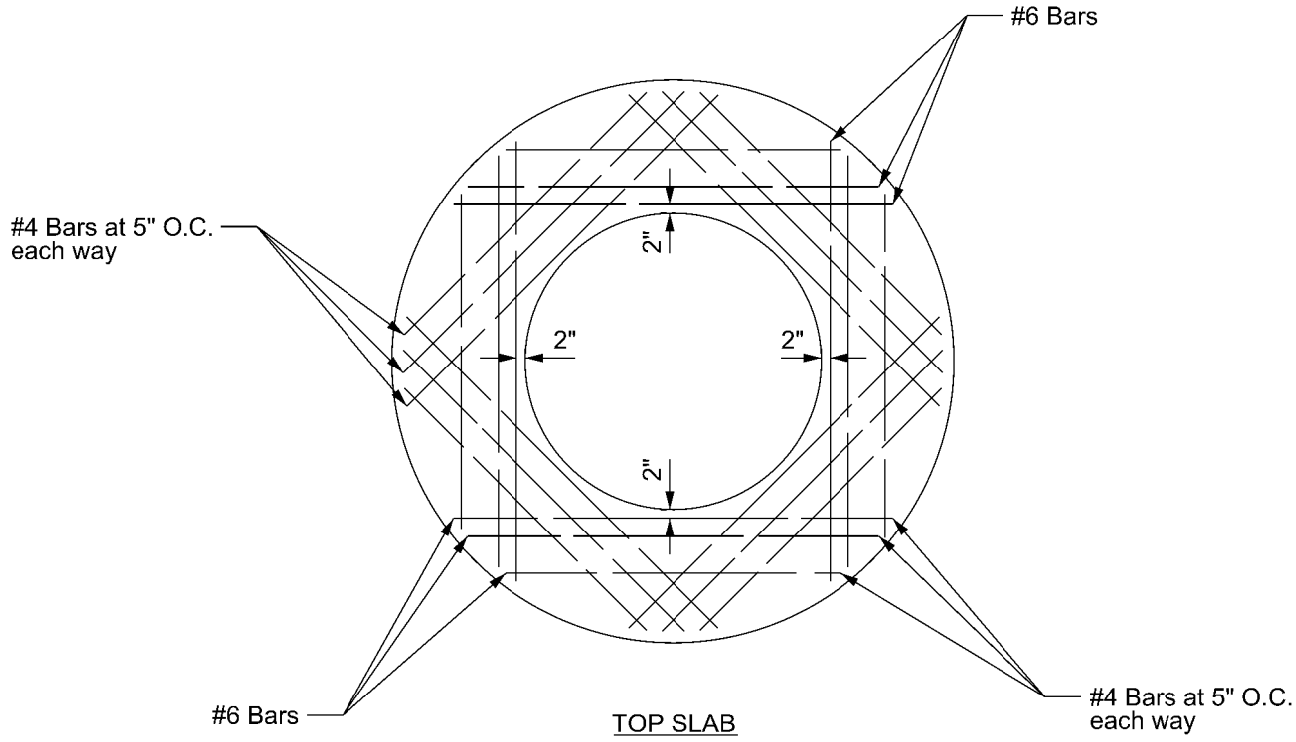


SECTION A - A

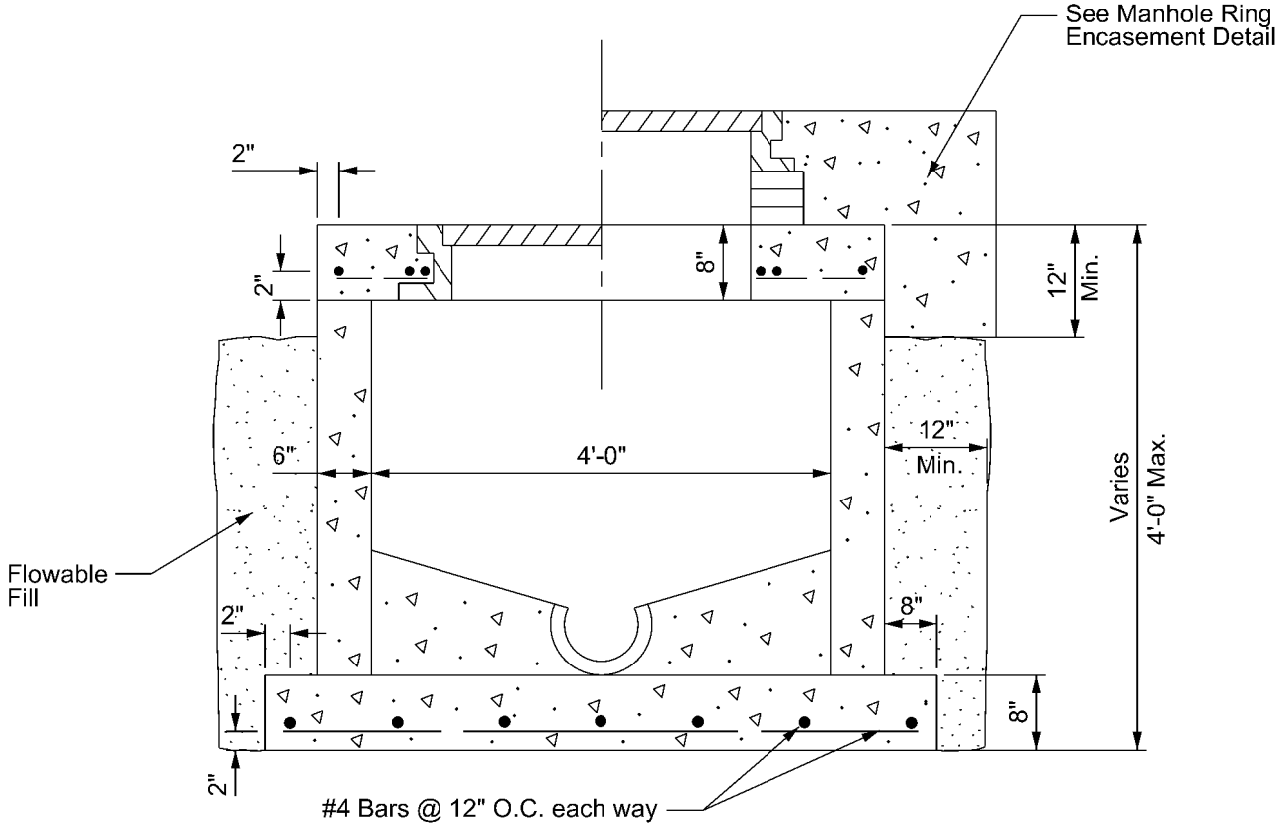


NOTE:
1. The Concrete Shall be 4000 PSI, Minimum and Reinforced with 2 - #4 Bars as Shown.
2. The Concrete Shall Extend to Edge of Saw Cut Pavement.
3. Manhole Ring Encasement is Required on all Manholes.
4. Manhole Lid Shall Open in the Direction of Traffic or Downstream in Parkway.

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

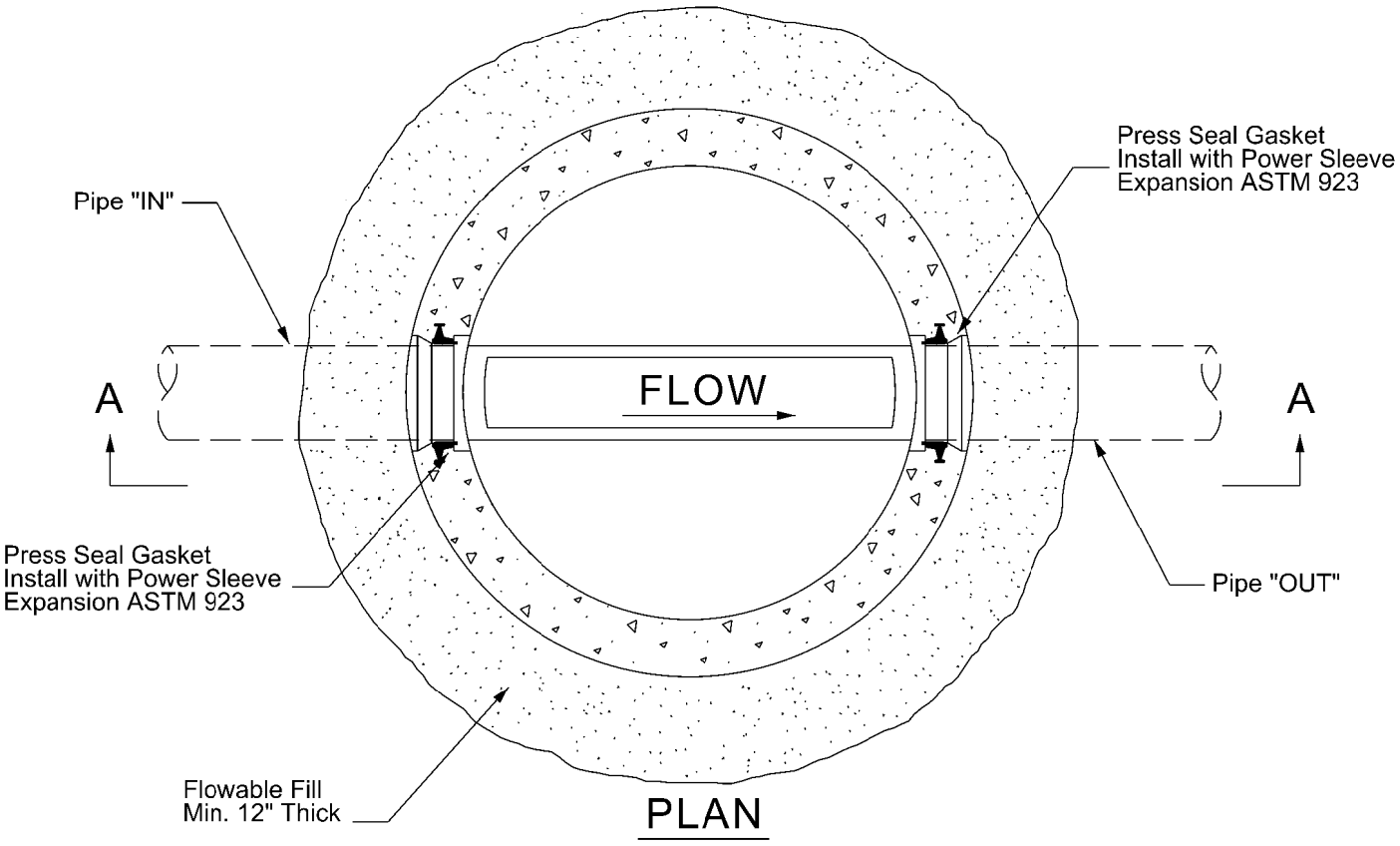


TOP SLAB

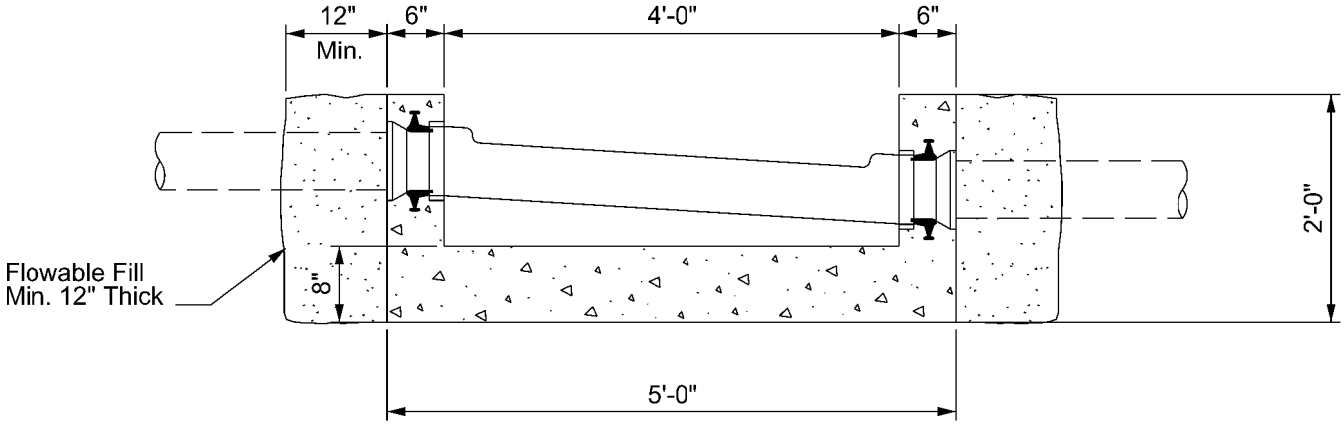


SHALLOW MANHOLE
PRECAST OR MONOLITHIC

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

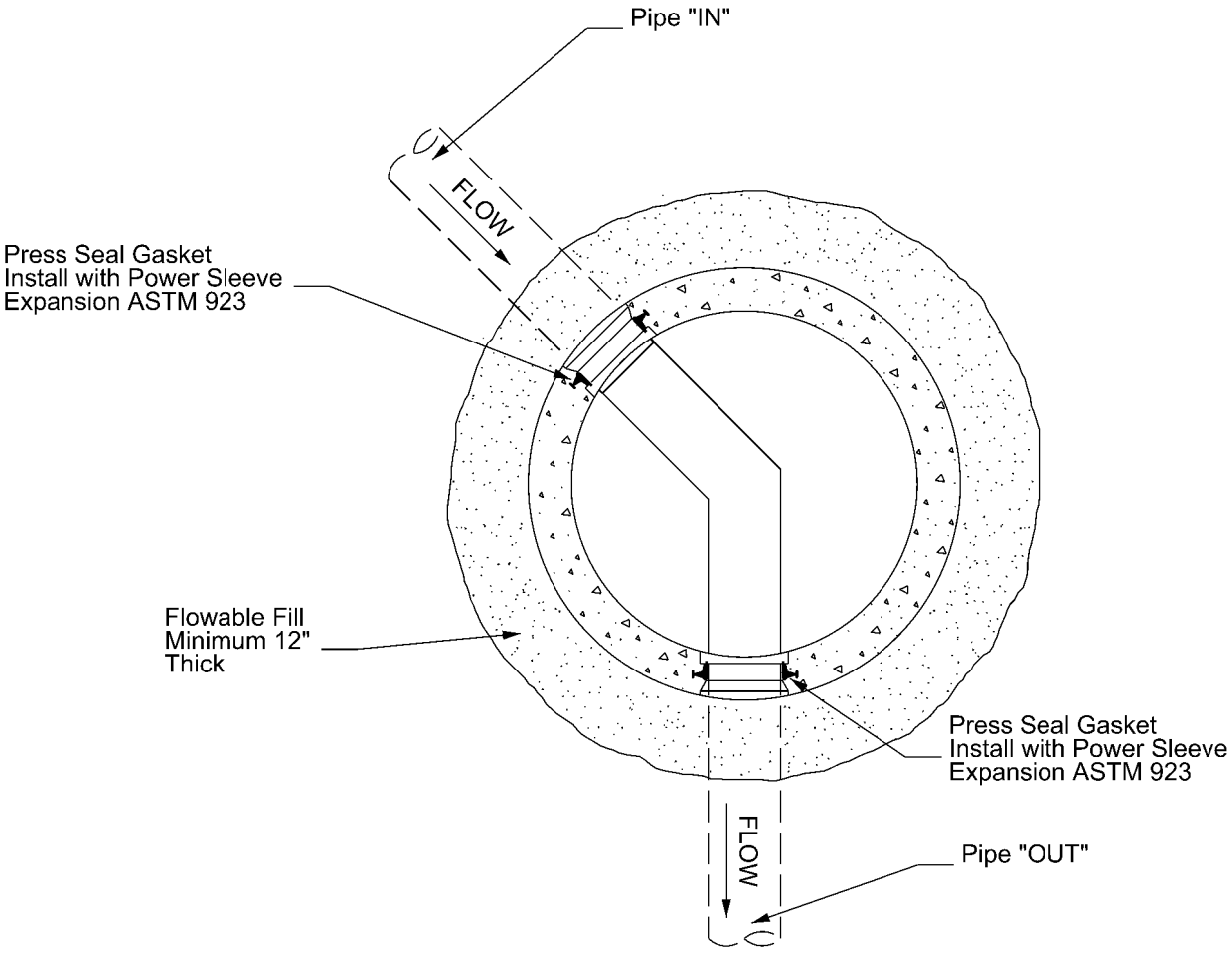


PLAN

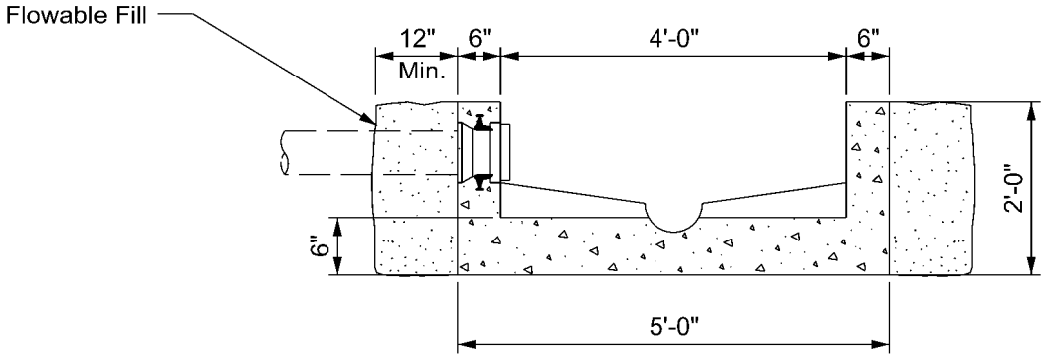


SECTION A-A

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

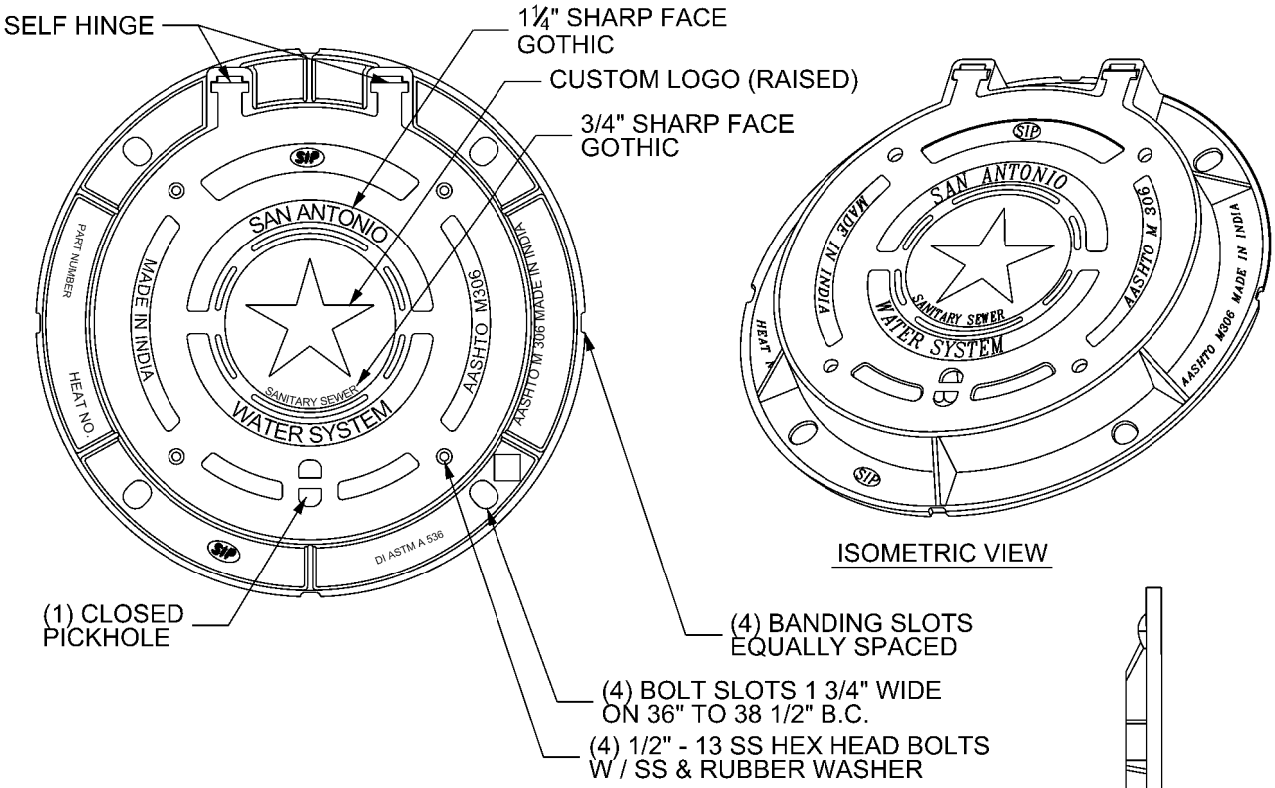


PLAN

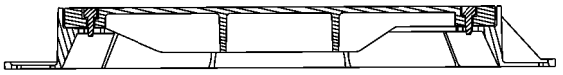


SECTION A-A

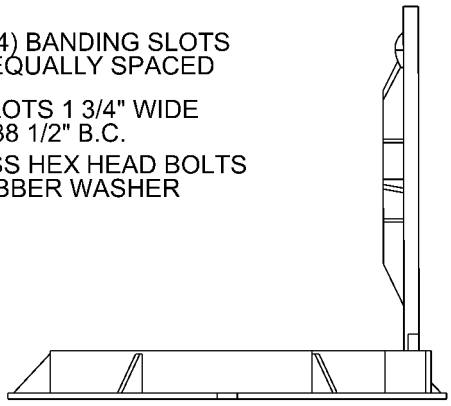
PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	PRECAST MANHOLE BASE 45° ANGLE	APPROVED MARCH 2008	REVISED AUG 2019
		DD-852-06	SHEET 1 OF 1



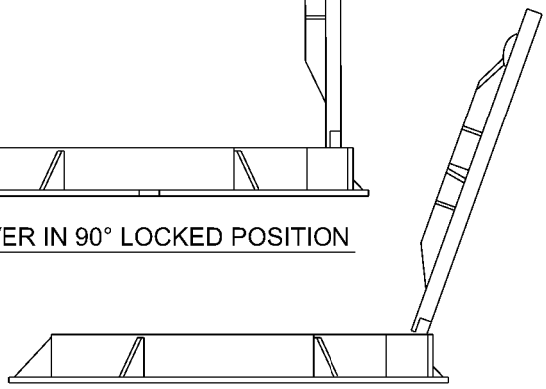
ISOMETRIC VIEW



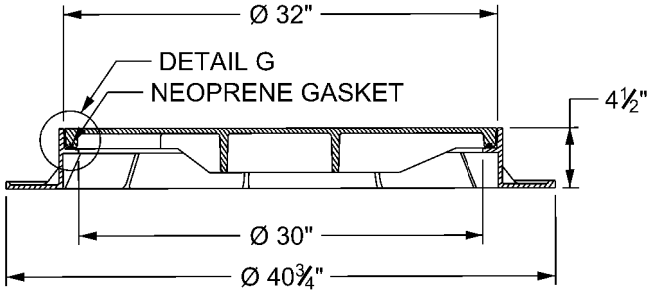
SECTION B-B (BOLTING DETAIL)



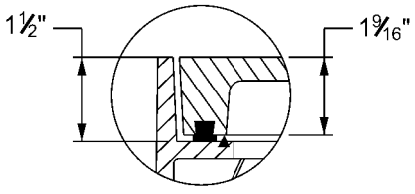
COVER IN 90° LOCKED POSITION



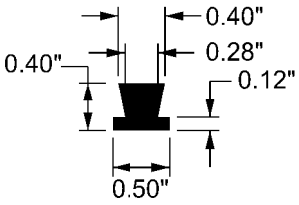
COVER IN 120° RESTING POSITION



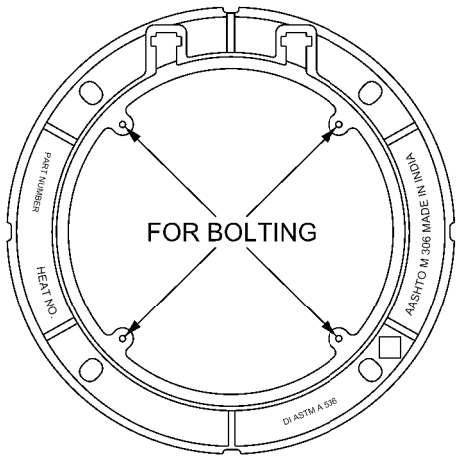
SECTION A-A



DETAIL G



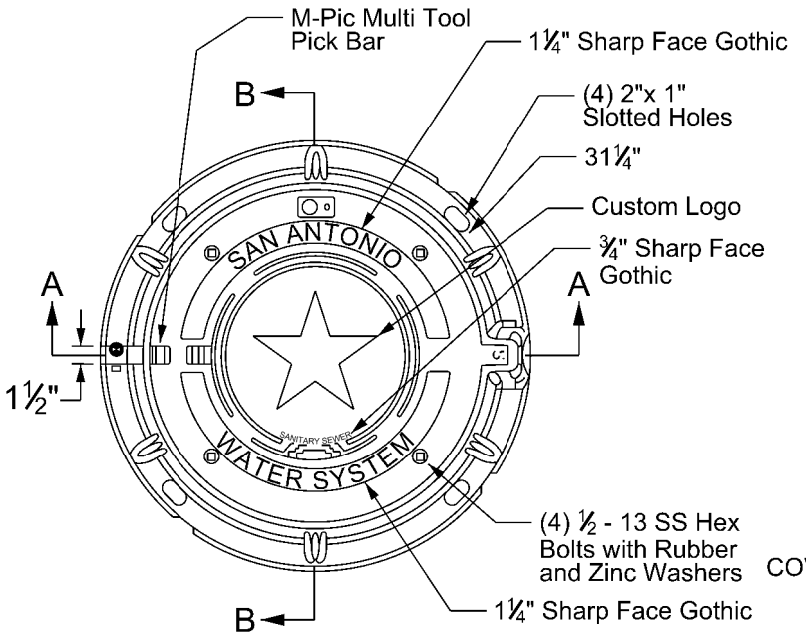
NEOPRENE GASKET DETAIL

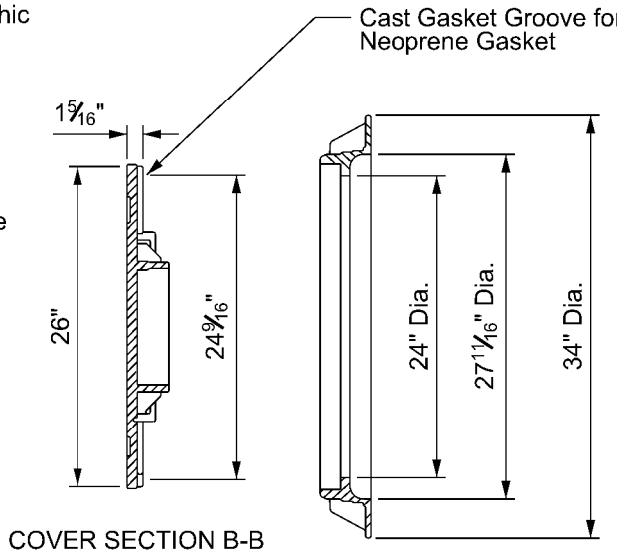


FRAME TOP VIEW

SIP Industries

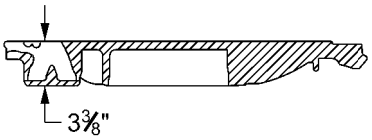
PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	30" MANHOLE RING AND COVER DETAIL	APPROVED	REVISED AUG 2019
		DD 852-07	SHEET 1 OF 5



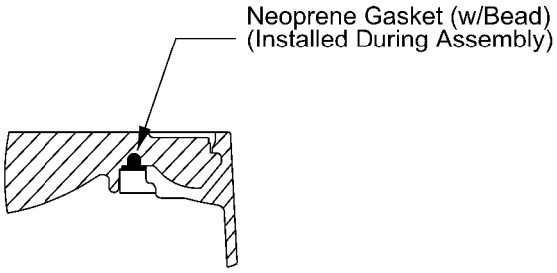


COVER SECTION B-B

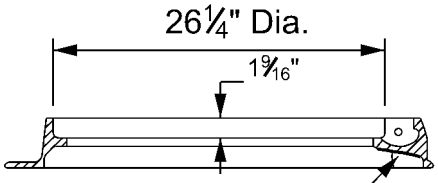
FRAME SECTION B-B



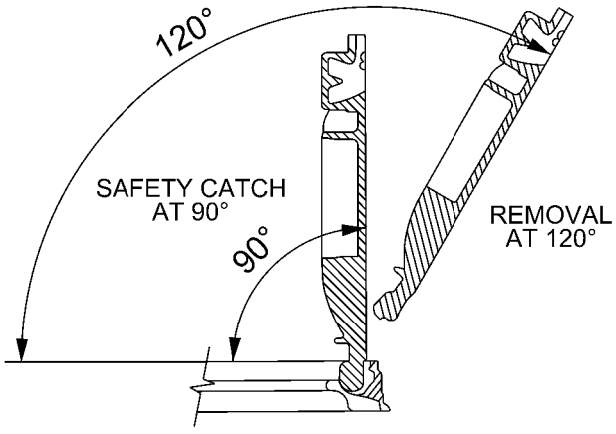
COVER SECTION A-A



HINGE & GASKET VIEW



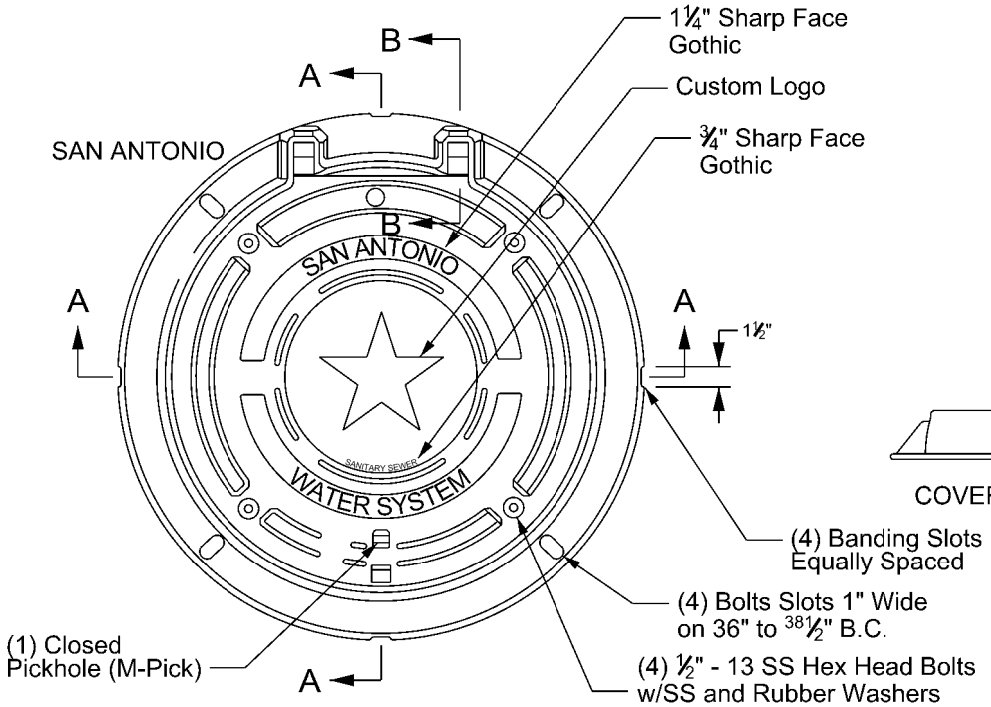
FRAME SECTION A-A

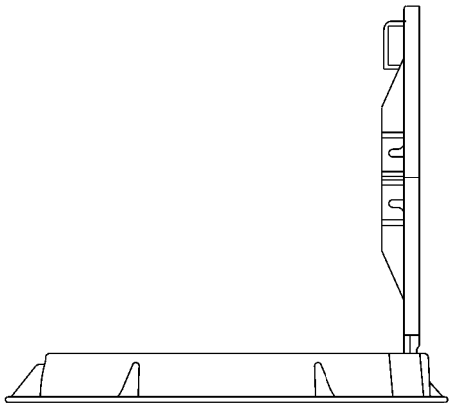


HINGE POSITIONS

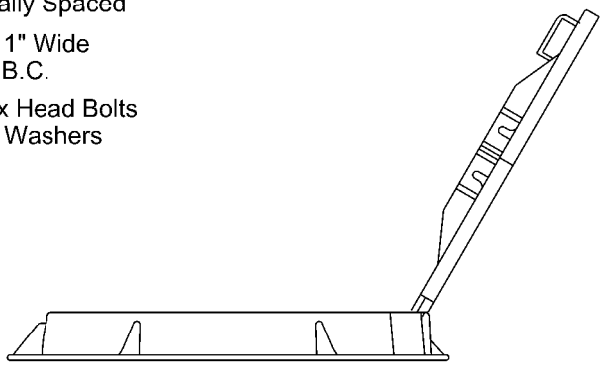
ERGO Assembly

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

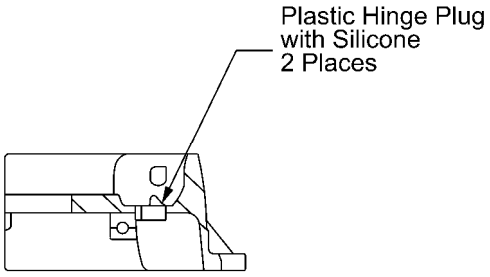




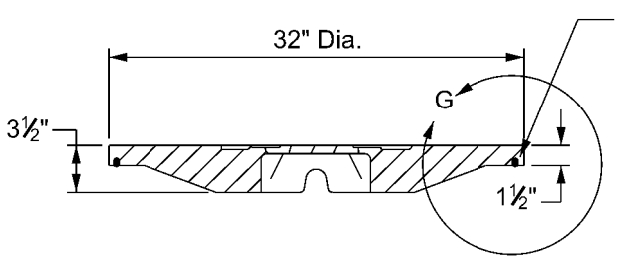
COVER IN 90° LOCKED POSITION

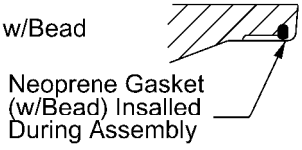


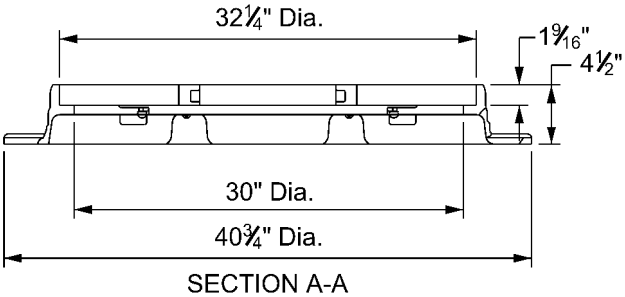
COVER IN 120° RESTING POSITION



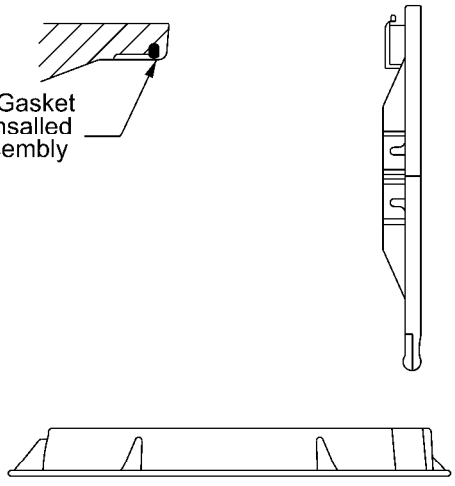
SECTION B-B







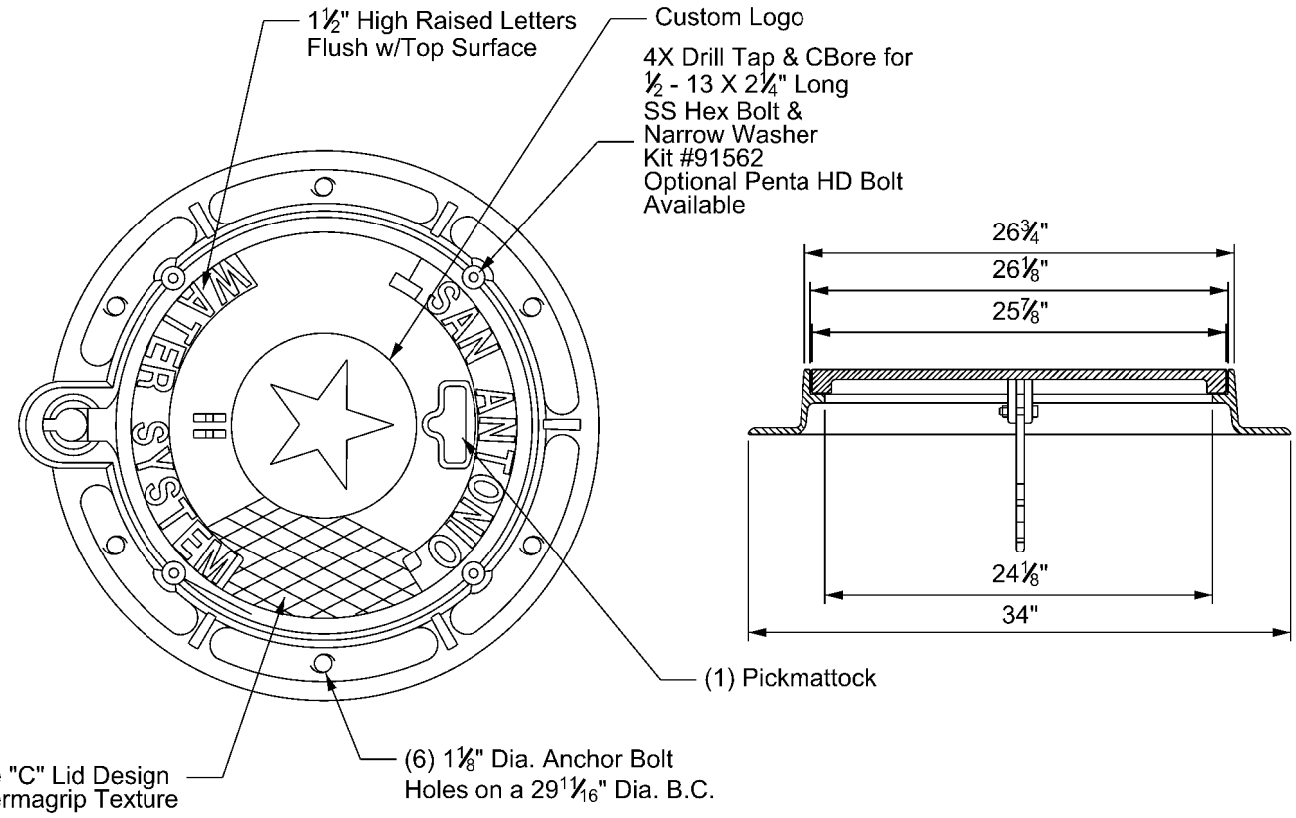
SECTION A-A

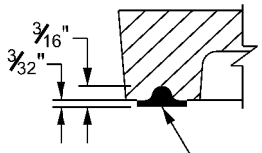


REMOVE LIFT ASSIST BOLT & REMOVE COVER @ 90°

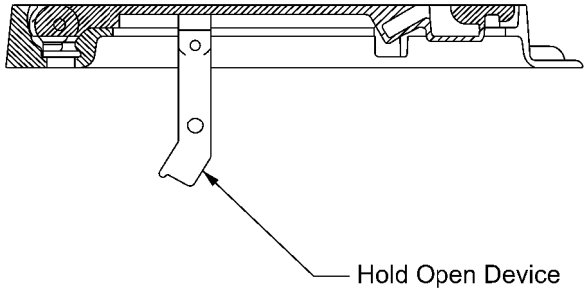
ERGO XL Assembly

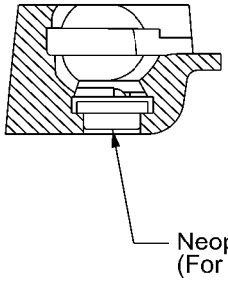
PROPERTY OF SAN ANTONIO WATER SYSTEM SAN ANTONIO, TEXAS	MANHOLE RING AND COVER DETAIL	APPROVED MARCH 2008	REVISED AUG 2019
		DD 852-07	SHEET 3 OF 5





"T-SEAL" GASKET DETAIL

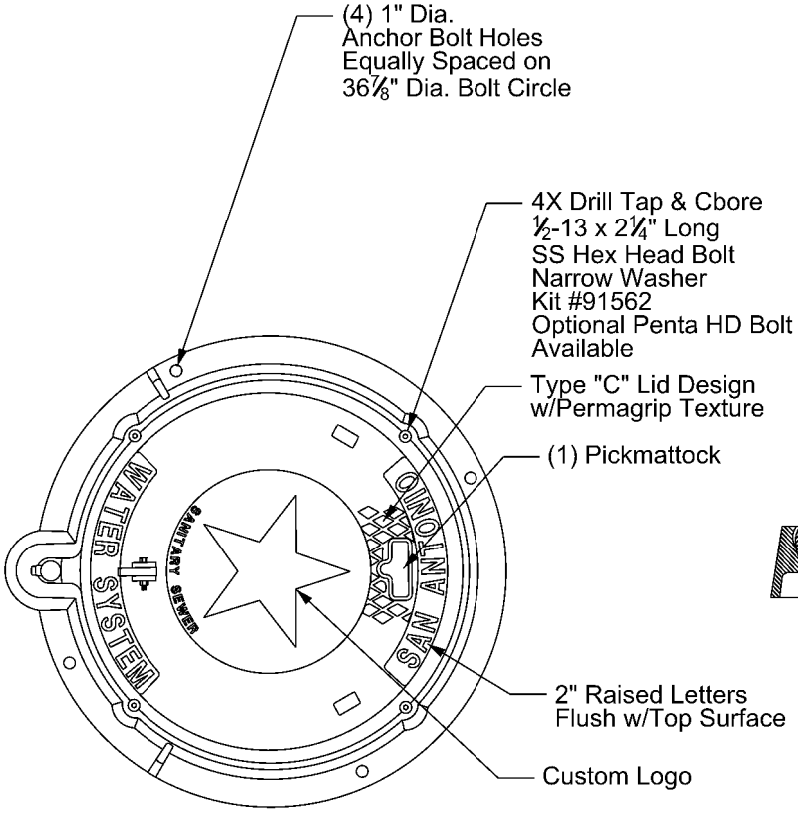


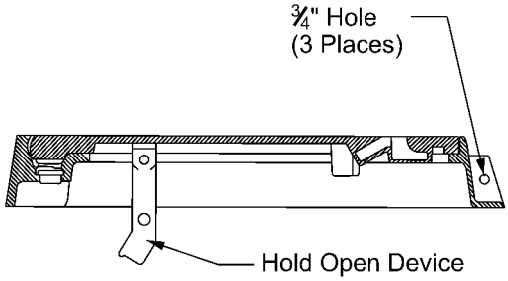


FRAME SHOWING HINGE PLUG

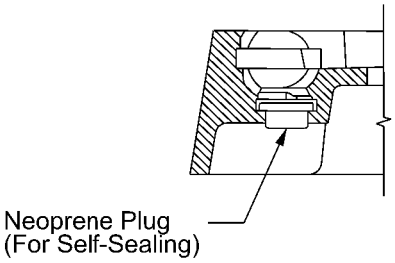
NEENAH FOUNDRY

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

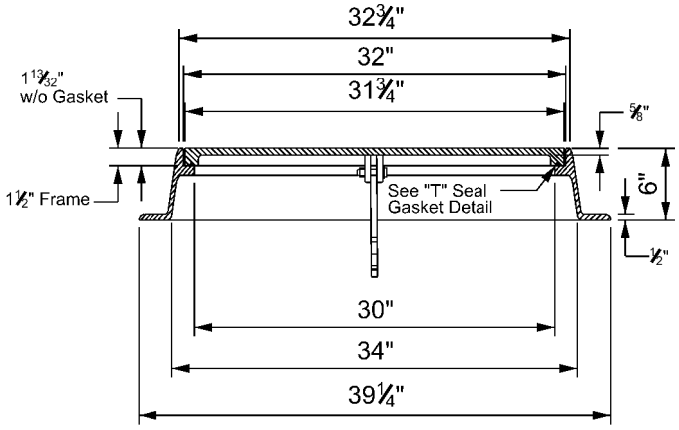




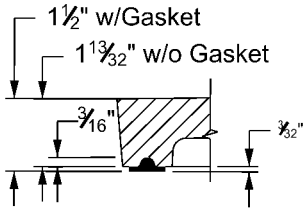
SECTION A - A



FRAME SHOWING
HINGE PLUG



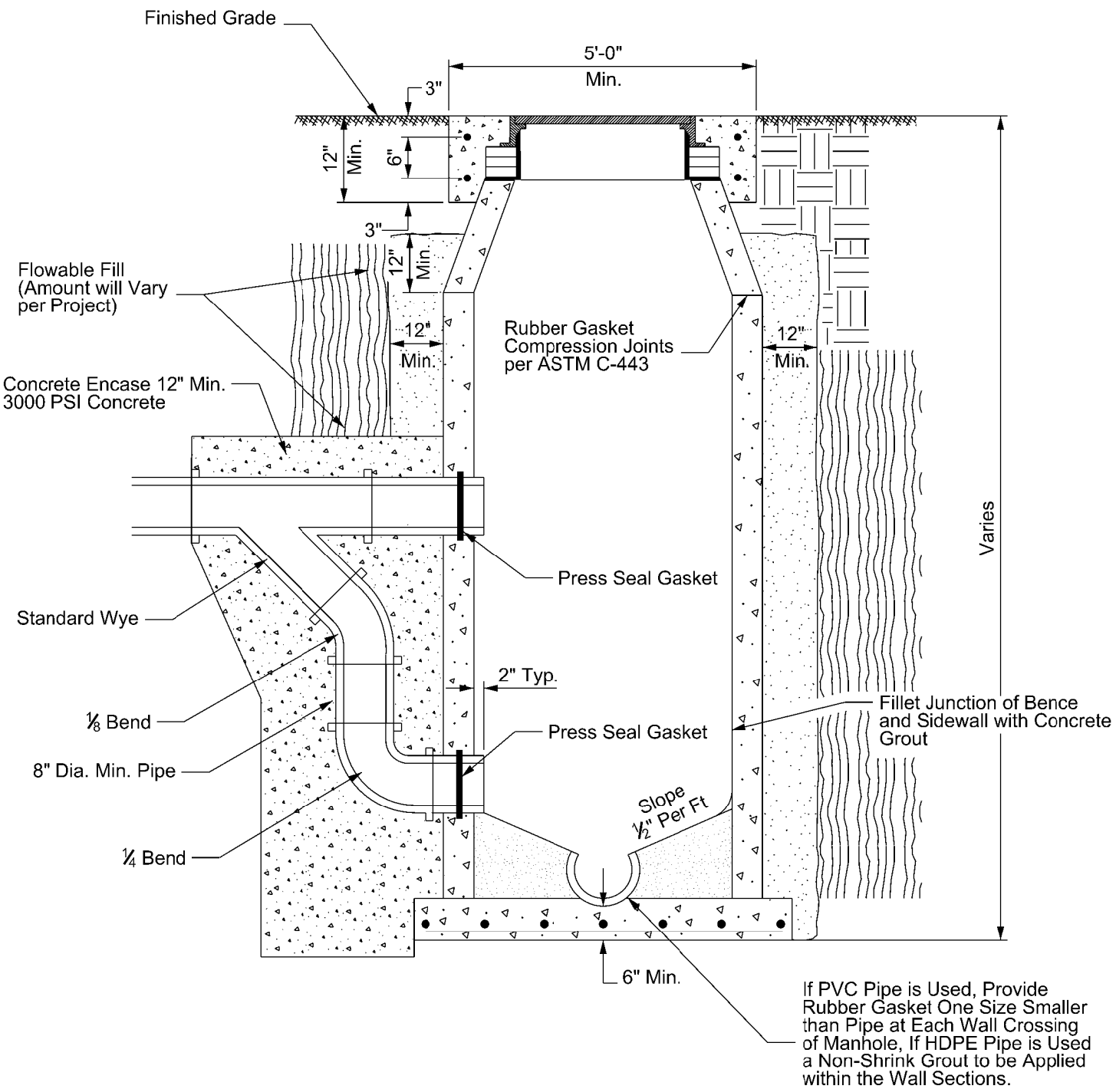
SECTION B - B



"T" SEAL GASKET DETAIL

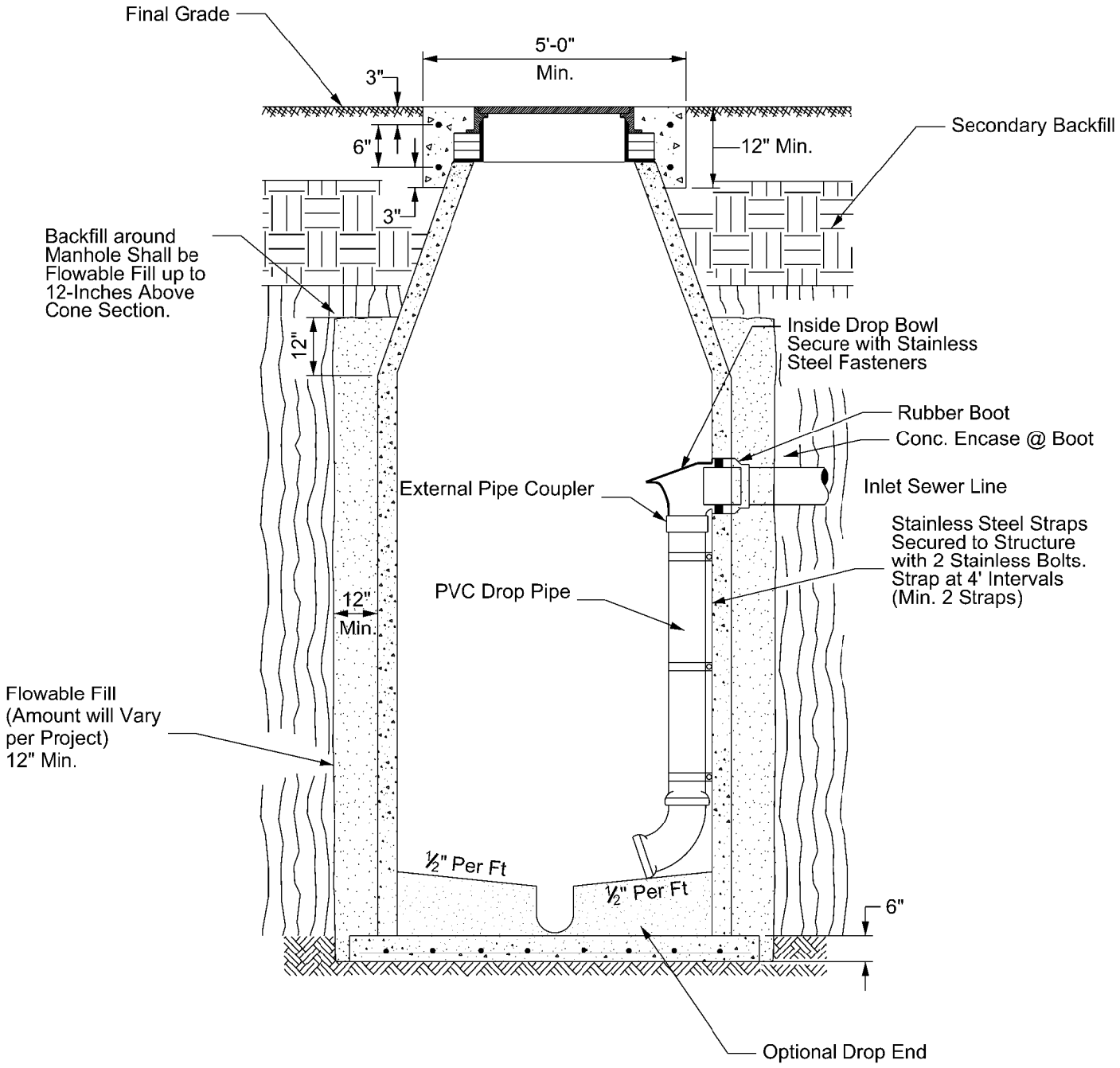
NEENAH FOUNDRY

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



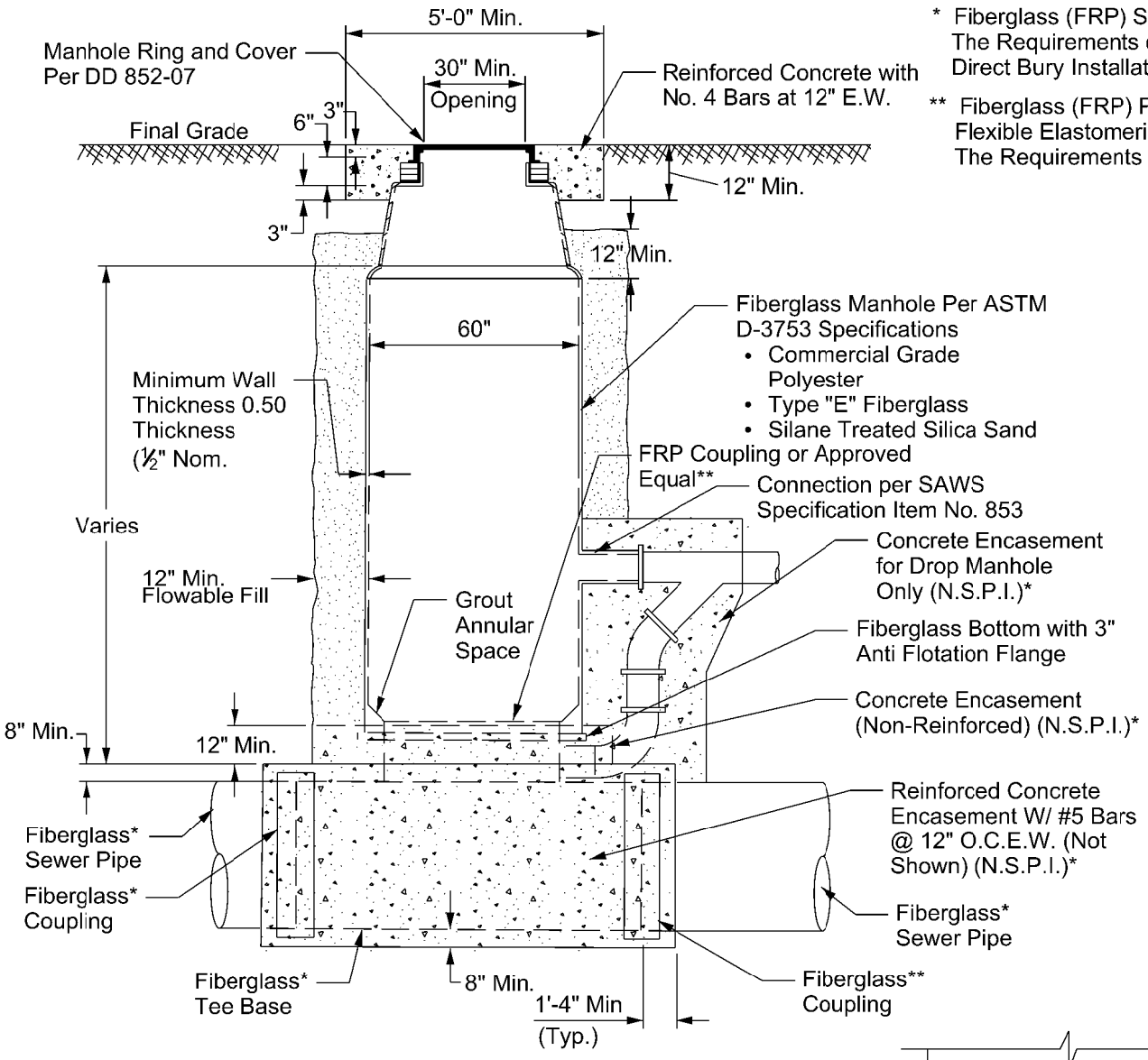
NOTE: Price for Drop Fittings and Encasement to be Included with the Price of Manhole.

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

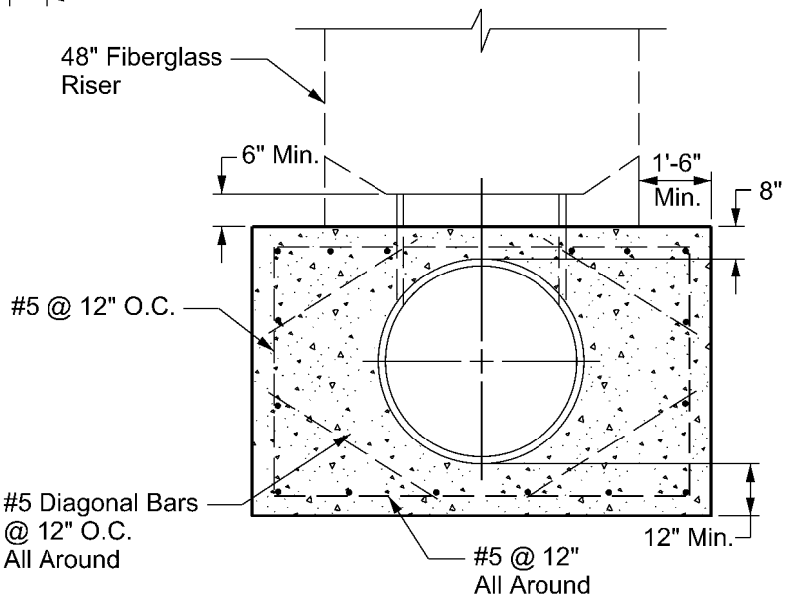
Notes:

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.

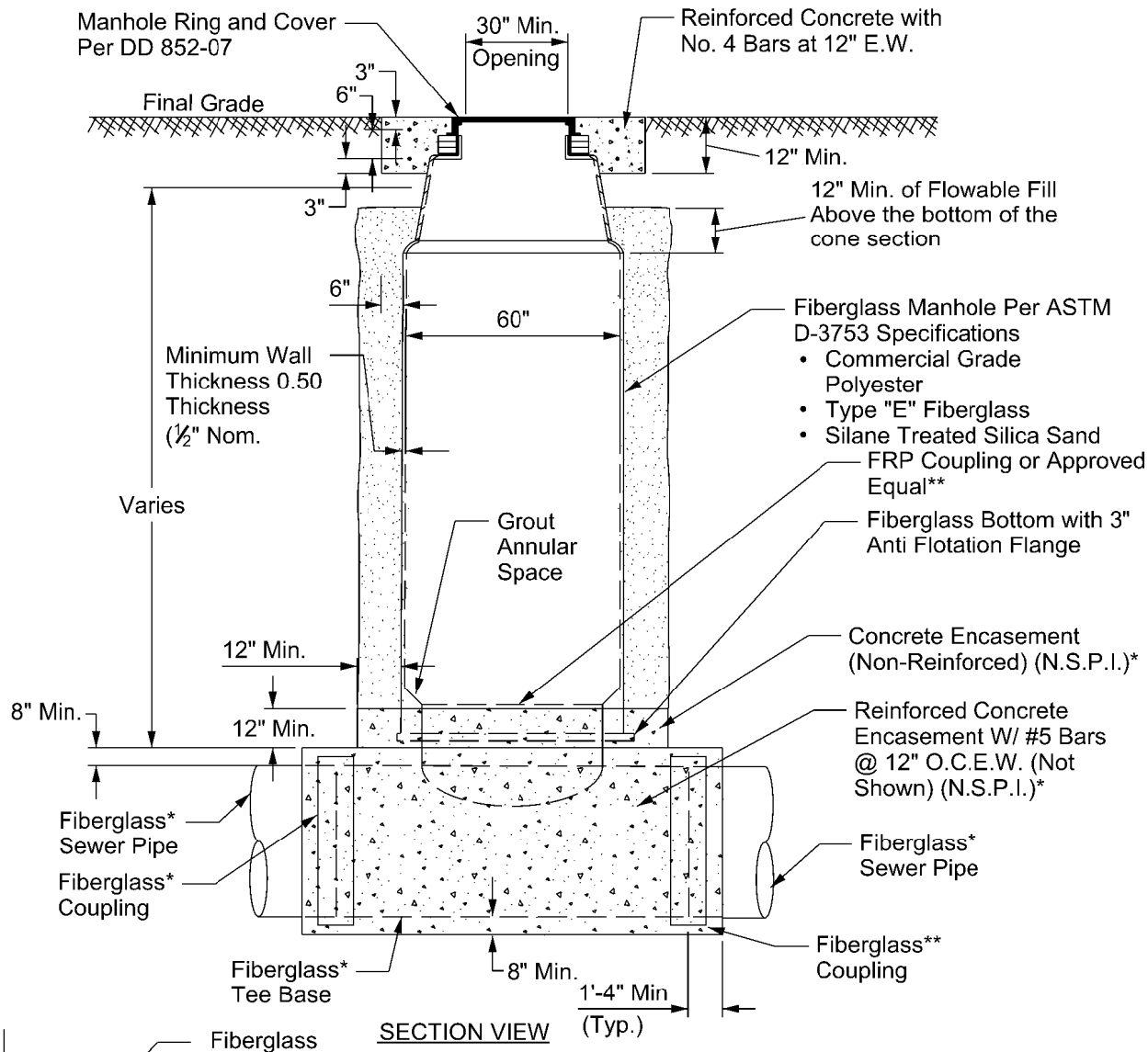
3. Backfill Around Manhole Shall be Flowable (low Strenght) with a Min. Thickness of 12-Inches and Fill Shall be Placed to within 12-Inches of Final Grade. This Cost Shall be Incidental to the Cost of the Manhole.

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.

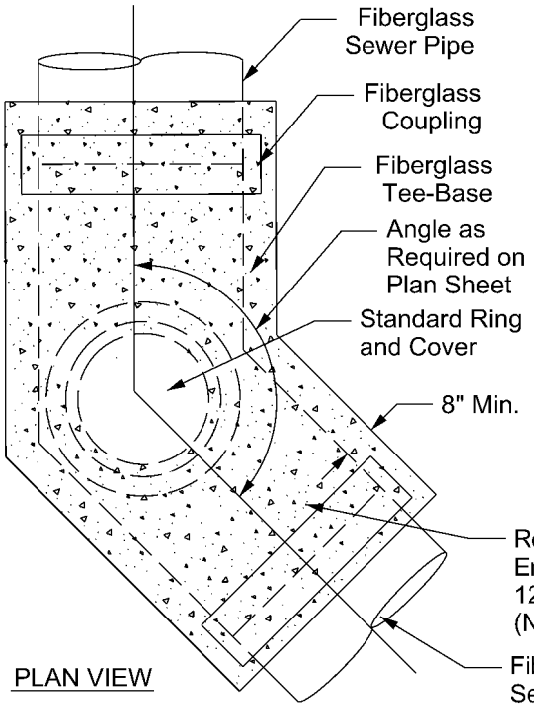


TEE BASE CONCRETE REINFORCEMENT SECTION THROUGH PIPE

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

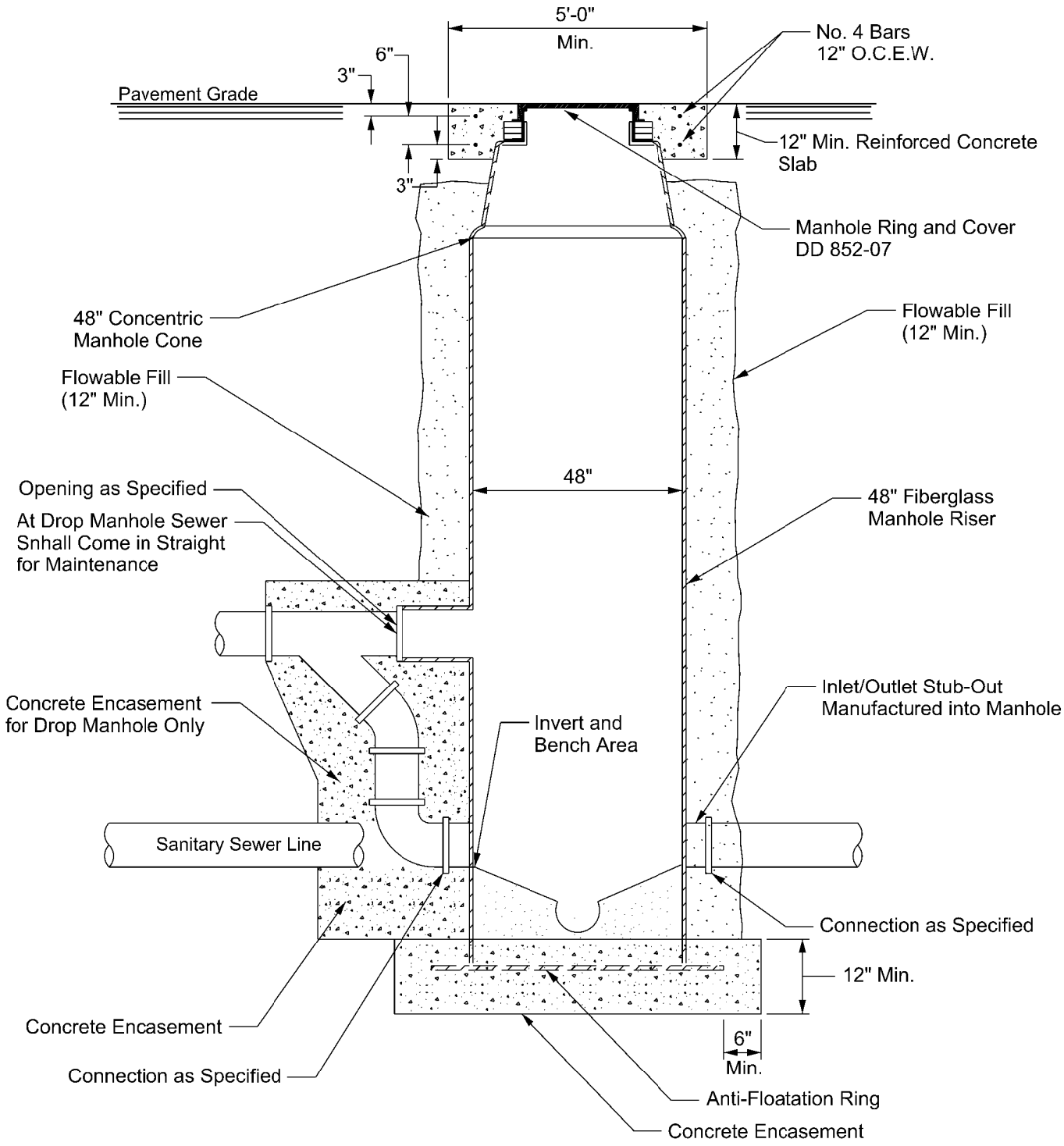
Notes:

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 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-

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 logged at the end of this Specification Item No. 1110, unless a date is specifically cited.

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. A preliminary schedule shall be submitted to the Inspector prior to, or immediately after, the Pre-Construction Conference, in bar graph form, based on the date of the Authorization to Proceed.
   b. The Contractor may submit to the Inspector a revised contractor phasing plan prior to the start of construction for review and approval. If the Inspector determines that the revised Contractor's Phasing Plan is not acceptable with respect to the best interest of SAWS, then the Contractor shall proceed with the work in accordance with the SAWS's Phasing Plan at no additional cost to the SAWS.
   c. Within 10 days after receipt of Authorization to Proceed, Contractor shall submit for SAWS's review, a detailed construction schedule, reflecting sequence of operations, milestones and commencing and completion dates of each item of work.
   d. Other work may be added to the progress schedule as requested or approved by the Inspector.
   e. 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.
   f. 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.
   g. Updated copies of the progress schedule shall be available at the established progress meetings for review.
   h. 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. Owner's Review:

   a. Within 10 days of submission of the schedule by Contractor, Contractor shall meet with the Inspector to participate in reviewing and revising the schedule as necessary. 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 Owner's review of the progress schedule, if the Contractor desires to make changes in his method of executing the work, he shall notify the Inspector 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 Inspector. 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 the Inspector 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: The narrative report shall include:

   a. Contractor's transmittal letter;
   b. Schedule narrative concerning completion and progress of all work according to the activity in the Contractor's construction schedule;
   c. Description of any problem areas;

d. Current and anticipated delays, cause, corrective action to be taken, and impact of the delay on other activities, on milestones, and on completion dates;
e. Status of pending items such as permits, Contract modifications, and time extensions;
f. Progress relative to schedule and other project or scheduling concerns;
g. 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.

1110.4 DELAYS AND RECOVERY:

1. If it is determined by the Inspector 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;
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;
b. 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.

1110.5 MEASUREMENT: There will be no measurement for payment of the Progress Schedule, as specified herein.

1110.6 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" stage of the pay estimate, the Contractor shall deliver a complete set of reviewable and approvable monthly record drawings to the Inspector. Place all letter-sized material in a 3 ring binder which is neatly indexed by process and division number. Bind Contract drawings and shop drawings in rolls of convenient size for ease of handling.
   b. Accompany the submittal with a transmittal letter in 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) Certification that each document as 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- And Post 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 written to a single storage device

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 logged at the end of this Specification Item No. 814, unless a date is specifically cited.

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. Database shall be submitted and uploaded onto SAWS CPMS or SAWS most current program management system

f. Log of the televised system for review shall be uploaded for review and approval by the Inspector.

g. Contractor to provide a pre and also maybe requested to provide a post construction video upon request.

h. Contractor is to coordinate the post-video procedures with the Inspector at completion of the project, and prior to close out.

1114.4 EQUIPMENT:

1. Equipment:
   a. The television unit shall have capability of displaying in color, on the video, surfacefeature 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. Equipment:
5. Television inspection shall be done one area at a time.

1114.5 MATERIALS: All videos shall be a SAWS compliant database, recorded in MPEG-1 format and uploaded onto SAWS Contracting and Project Management System (CPMS) or most current acceptable media. 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 or post 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 or post construction, as specified herein. Contractor is responsible for any features damaged.

End of Specification

ITEM NO. 01340 – SUBMITTALS

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. CONTRACTOR'S Responsibilities.

B. OWNER'S Duties.

C. Submittal Requirements.

D. Re-submittal Requirements.

E. Products.

F. Shop Drawings.

G. Manufacturer's Requirements.

H. Submittal Codes.

1.02 RELATED SECTIONS

Contractor shall be responsible for coordination of all equipment, work, etc. specified within this section to all related sections within the contract documents.

1.03 CONTRACTOR'S RESPONSIBILITIES

A. CONTRACTOR'S Responsibilities:

1. Review submittals prior to submittal.

2. Determine and verify following:

    a. Field measurements.

    b. Field construction criteria.

    c. Catalog numbers and similar data.

    d. Conformance with Specifications.

3. Coordinate each submittal with requirements of Work and Contract Documents.

4. Notify the ENGINEER in writing, at time of submittal, of deviations in

submittals from requirements of the Contract Documents. No deviation will be allowed without the written permission of the OWNER. If CONTRACTOR fails to notify OWNER of deviations, he shall pay for all cost for equipment replacement or removal to correct problem.

5. Begin no fabrication or work requiring submittals until return of submittals with the ENGINEER'S approval.

6. Designate in Construction Progress Schedule, dates for submittal and receipt of reviewed Shop Drawings and samples.

7. Submittals received but not required in Specifications shall be returned without review.

8. Submit As-built Drawings.

B. OWNER'S Duties:

1. Review submittals in accordance with schedule.

2. Affix stamp and signature, and indicate acceptance of submittal or further action required of CONTRACTOR.

3. Return submittals to the CONTRACTOR for distribution or for resubmittal per the Construction Services Contract.

1.04 SUBMITTAL PROCEDURES

A. All paper for the production of the O&M Manual Information shall be recycled paper with a weight of 20 lbs.

B. All paper for the production of the submittals to be recycled with a weight of 20 lbs.

C. Identify Contract, CONTRACTOR, Subcontractor and/or supplier; pertinent drawing sheet and detail and Specification section number, as appropriate.

D. Apply CONTRACTOR'S stamp, signed or initialed, certifying that review, verification of products required, field dimensions, adjacent construction work, and coordination of information, are in accordance with the requirements of the Work and Contract Documents.

E. All engineering submittals or calculations shall bear the stamp and signature of a Professional Engineer registered in the State of New Jersey.

F. Schedule submittals in accordance with the approved schedule.

G. Identify variations from Contract Documents and product or system limitations that may be detrimental to successful performance of the completed Work in the transmittal letter to the ENGINEER.

H. Provide space for the ENGINEER'S review stamp on each submittal front page.

I. Revise and resubmit submittals within fourteen (14) days. Identify all changes made since previous submittal. CONTRACTOR'S failure to obtain approval of submittals shall not be used by CONTRACTOR as a basis for delays in achieving Contract Completion Dates.

J. Provide a detailed schedule for the delivery of each required submittal within thirty (30) days of Notice to Proceed. Assign a submittal number to each submittal or partial submittal using the Specification number first, and a sequential number for each submittal within that Specification in accordance with the form provided by the OWNER.

K. Progress payments may be withheld if submittals, resubmittals or schedule updates are not presented to the ENGINEER in accordance with the project schedule as required.

L. An electronic file shall be submitted for all submittals and re-submittals. These electronic files shall be in electronic Adobe Acrobat PDF format or in another format acceptable to the ENGINEER. Electronic documents shall be full size of the original documents and shall be delivered by email.

M. For each item that is copyrighted, submit a copyright release allowing the OWNER/ENGINEER to make unlimited copies, to edit or otherwise revise documents, and to re-use for future operation, maintenance, and training associated with Owner's facilities.

1.05 PROPOSED PRODUCTS LIST

A. Proposed products shall be provided in accordance the General Conditions or, as otherwise specified in the Contract Documents.

B. Within thirty (30) days after Notice to Proceed, submit a complete list of products proposed for use, with Specification section number, name of manufacturer, trade name, and model number of each product.

C. For products specified only by reference standards, give manufacturer, trade name, model or catalog designation, and reference standards.

D. Specifically identify the products, the anticipated schedule for delivery and storage, and the estimated value thereof for materials that the CONTRACTOR intends to request approval for off-site storage and partial progress payment therefore.

1.06 SHOP DRAWINGS

A. Shop Drawings shall be in accordance with the GENERAL CONDITIONS or as otherwise specified in the Contract Document.

B. Within thirty (30) days after Notice to Proceed, submit a list of Shop Drawings indicating Specification section number, contents, proposed numbering system, and time schedule for preparation and submission for all Shop Drawings for the contract.

C. Submit Shop Drawings in the form of portable document format (PDF) for the ENGINEER.

1.07 PRODUCT DATA

A. Submit the number of copies that the CONTRACTOR and Subcontractors require, plus five (5) copies which will be retained by the OWNER.

B. Mark each copy to identify applicable products, models, options, and other data. Supplement manufacturers' standard data to provide information unique to this Project. Indicate project equipment number or tag number for which product is proposed.

1.08 SAMPLES

A. Samples shall be submitted in accordance Section GC GENERAL CONDITIONS, except as otherwise specified herein below.

B. Submit samples to illustrate functional and aesthetic characteristics of the product, with integral parts and attachment devices. Coordinate sample submittals for interfacing work.

C. Submit samples of finishes from the full range of manufacturers' standard colors, textures, and patterns for the OWNER’S selection.

D. Include identification on each sample, with full project information.

E. Submit the number of samples specified in individual Specification sections; one of which will be retained by the OWNER.

F. Reviewed samples that may be used in the work are indicated in individual Specification sections.

1.09 MANUFACTURER'S INSTRUCTIONS

A. Submit manufacturers' printed instructions for delivery, storage, assembly, installation, start-up, adjusting and finishing, in quantities specified under Product Data above.

B. Identify conflicts between manufacturers' instructions and Contract Documents.

1.10 MANUFACTURER'S CERTIFICATES

A. When specified in individual Specification sections, submit manufacturers' certificate to the OWNER for review, in quantities specified for Product Data.

B. Certify material or product conforms to or exceeds specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.

C. Certificates may be recent or previous test results on material or product, but must be acceptable to the OWNER.

1.11 WARRANTY

A. Submit all warranty information in accordance with individual specification sections and Section GC GENERAL CONDITIONS.

PART 2 – PRODUCTS

NOT USED

PART 3 – EXECUTION

NOT USED

END OF SECTION

ITEM NO. 02513

BITUMINOUS CONCRETE DRIVES

1. DESCRIPTION

This section includes the construction and/or reconstruction of bituminous concrete driveways where shown on the plans or as directed by the Engineer. For new bituminous concrete drives, or new portions of existing drives, it shall also include preparation of sub-grade.

2. MATERIALS

The paving materials shall be in conformance with the NJ Department of Transportation Standard Specifications, 2007 Edition. The job mix formulas, which shall be used, are those specified under "Permanent Pavement Repair".

3. METHODS OF CONSTRUCTION

Pavement repairs shall not be initiated until permission to do so is granted by the Engineer. Pavement repairs shall be made by excavating the trench area to the specified depth, neatly cutting the edges of existing pavements, consolidating or compacting the proposed subgrade (top of backfill) and placing the pavement as shown on the Standard Details and as described herein. The surface course shall not be applied until final acceptance of the bituminous stabilized base course installation has been given by the Engineer. The pavement section shall consist of 6" DGA, 6" bituminous stabilized base and 2" pavement surface course (FABC), as shown in the Standard Detail "Asphalt Driveway Pavement Detail".

4. QUANTITY AND PAYMENT

The quantity for which payment will be made will be the actual driveway area constructed as shown on the plans or as directed by the Engineer, measured in square yards. The area shall be measured by taking the width of the driveway excavation and multiplying it times its horizontal length.

Payment will be made for the quantity as determined above the unit price bid per square yard in the Proposal. This price shall include all labor, material and equipment, excavation, grading, preparation of the sub-grade, and construction of bituminous concrete base and wearing courses as shown on the detailed plans for bituminous concrete drives, and all else necessary for and incidental to this work.

END OF SECTION

DIVISION 2 – SITE CONSTRUCTION

SECTION 02657 - GLASS-FIBER REINFORCED POLYESTER (FRP) WETWELLS

1. DESCRIPTION

This specification shall govern for the furnishing of all work necessary to accomplish and complete the installation of glass-fiber reinforced polyester wetwells. Glass-Fiber Reinforced Polyester wetwells shall be a one-piece monolithic designed unit constructed of glass-fiber reinforced, supplier certified, unsaturated commercial grade polyester resin. FRP wetwells shall be manufactured in strict accordance with ASTM D-3753 "Standard Specification for Glass-Fiber Reinforced Polyester Manholes and Wetwells", as manufactured by Containment Solutions, Inc., Conroe, Texas, Fiberglass wetwells, or approved equal.

2. GOVERNING STANDARDS

Wetwells shall conform to the following design criteria:

A. ASTM D-3753: Standard Specification for Glass-Fiber Reinforced Polyester Manholes and Wetwells.

B. ASTM C-581: Practice for Determining Chemical Resistance of Chemical Thermosetting Resins Used in Glass-Fiber Reinforced Structures Intended for Liquid Service.

C. ASTM D-2412: Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel Plate Loading.

D. ASTM D-695: Test Methods for Compressive Properties of Rigid Plastics.

E. ASTM D-2584: Test Method for Ignition Loss of Cured Reinforced Resins.

F. ASTM D-790: Test Method for Flexural Properties of Unreinforced and Reinforced Plastics and electrical Insulating Materials.

G. ASTM D-2583: Test Method for Indentation Hardness of Rigid Plastics by means of a Barcol Impressor.

3. GENERAL DESCRIPTION: FIBERGLASS REINFORCED POLYESTER WETWELL DIAMETERS (I.D.): 3'- 0" through 20'- 0"

A. Dimensions: The wetwells shall be a circular cylinder, sized per the plans for the applicable stations. Wetwells shall be produced in per the length in the plans +/- ½". Nominal inside diameters shall be 36", 42", 48", 54", 60", 66", 72", 96", 120", 132", 168", 186", 192", 216", and 240". Tolerance on the inside diameter shall be +/- 1%. Other diameters as agreed upon between purchaser and the manufacturer are covered by this specification.

B. The manufacturer of the wetwell shall be able to show experience in the manufacture of FRP wetwells for more than five years.

C. Design Criteria:

1. Wetwells shall meet all requirements for pipe stiffness as required in ASTM D3753.

2. The wetwells, shall be suitable for use in typical environments including storm and sanitary sewers with a temperature range not to exceed 140°F.

3. Cylinders shall be designed and fabricated to provide sufficient strength for the following loading conditions:

    a. Resistant to buckling when empty and when the groundwater elevation is at grade.

    b. The anchoring wall structure at the embankment within the reinforced concrete base zone shall be designed to resist external hydrostatic water forces of an empty or full cylinder with the groundwater at grade elevation.

    c. Load Bearing Capacity: Properly installed wetwell shall be capable of withstanding AASHTO HS-20 dynamic loading (16,000 lbs.) applied vertically.

4. The FRP wetwells, shall be manufactured to the diameters and heights as shown in the plans and specifications. They shall be designed by the manufacturer to perform as underground structures at the depths required. The FRP structures shall be capable of supporting the top slab covers, frames, soil overburdens plus a live load equivalent to AASHTO HS-20 Loading.

5. All cutouts shown in the plans and details for each FRP wetwell shall be capable of maintaining the unit's structural integrity.

6. Wetwell FRP Tops and Hatch Openings: Resin and glass fiber reinforced wetwell tops and hatch openings may be provided upon Engineers request. Wetwells shall be provided with glass reinforced top designed to withstand backfill and concrete slab. Fiberglass Ribs or Fiberglass structural members may be utilized to meet the design criteria. Stiffeners shall be of non- corrosive materials encapsulated in fiberglass. FRP encapsulated wood or lumber shall not be permitted.

    - Hatch opening dimensions and position to be specified by Engineer.

    - Vapor barrier lip around hatch opening shall be 4" tall. It shall be shall be constructed of fiberglass pultruded structural shapes.

7. Wetwell FRP Bottoms: Resin and glass fiber reinforced wetwell bottoms may be provided upon Engineers request. Upon that request, wetwells shall be provided with

glass reinforced bottom section designed to withstand the hydrostatic head pressure, empty and water to grade. Fiberglass Ribs or Fiberglass structural members may be utilized to meet the design criteria. Stiffeners shall be of non-corrosive materials encapsulated in fiberglass. FRP encapsulated wood or lumber shall not be permitted. Bottoms sections shall be furnished with an intregal 3" wide anchoring flange.

8. Wetwell FRP bottom or top flanges: Resin and glass fiber reinforced wetwell flanges may be provided upon Engineers request. Flanges shall be 3" wide minimum.

D. Marking and Identification: All Wetwells shall be marked with the following information:

1. Manufacturers Identification

2. Manufacturers Serial Number

3. Wetwell Diameter & Length

4. ASTM Designation

3. MATERIALS

A. Resin: The resins used shall be unsaturated, supplier certified, commercial grade polyester resins. Mixing lots of resin from different manufacturers, or "odd-lotting" of resins shall not be permitted. Quality-assurance records on the resin shall be maintained. Non-pigmented resin is required to allow for light or "sand" color of wetwell surface in order to facilitate easy from grade interior inspection. UV Inhibitors shall be added directly to resins to prevent photodegradation.

B. Reinforcing Materials: The reinforcing materials shall be commercial grade "E" type glass in the form of mat, continuous roving, chopped roving, roving fabric, or both, having a coupling agent that will provide a suitable bond between the glass reinforcement and the resin.

C. Surfacing Material: If reinforcing material is used on the surface exposed to the contained substance, it shall be a commercial grade chemical-resistant glass or organic surfacing mat having a coupling agent that will provide a suitable bond with the resin.

D. Fillers and Additives: Fillers, when used, shall be inert to the environment and wetwell construction. Additives, such as thixotropic agents, catalysts, promoters, etc., may be added as required by the specific manufacturing process to be used to meet the requirements of this standard. However, calcium carbonate mixed by the fabricator shall not be permitted. The resulting reinforced plastic material must meet the requirement of this specification.

E. Laminate: The laminate shall consist of multiple layers of glass matting and resin. The surface exposed to the sewer/chemical environment shall be resin rich and shall have no exposed fibers.

5. MANUFACTURE

A. Wetwell cylinders, flat tops, and flat bottoms, shall be produced from glass fiber-reinforced polyester resin. Wetwell cylinders up to 72" ID X 20' length to be manufactured by "computer regulated mandrel process". For 72" diameter and depths greater than 20', as well as all diameters greater than 72" to be manufactured by "computer regulated steel mandrel process" utilizing structural rib design.

B. Assembly Joints: Product components, i.e., cylinders, tops, bottoms, and connectors, may be joined together to form a complete wetwell.

6. REQUIREMENTS

A. Exterior Surface: The exterior surface shall be relatively smooth with no sharp projections. Hand-work finish is acceptable if enough resin is present to eliminate fiber show. The exterior surface shall be free of blisters larger than 0.5" in diameter, delamination and fiber show. Gel-coat or paint or other coatings are not allowed.

B. Interior Surface: The interior surfaces shall be resin rich with no exposed fibers. Interior surface shall be smooth for improved corrosion resistance and reduced sludge build-up. The surface shall be free of crazing, delamination, blisters larger than 0.5" in diameter, and wrinkles of 0.125" or greater in depth. Surface pits shall be permitted up to 6/ft2 if they are less than 0.75" in diameter and less than 0.0625" deep. Voids that cannot be broken with finger pressure and that are entirely below the resin surface shall be permitted up to 4/ft2 if they are less than 0.5" in diameter and less than 0.0625" thick. Gel-coat or paint or other coatings are not allowed.

C. Repairs: Any wetwell repair is required to meet all requirements of this specification.

D. Wetwell Lengths: Wetwell lengths shall be per plan requirements +/- 2".

E. Stiffness: The cylindrical portion of the wetwell is to be tested in accordance with ASTM Method D 2412. The wetwell cylinder shall have the minimum pipe-stiffness values shown in the table below, when tested in accordance with ASTM 3753, Section 8.5, (note 1).

Wetwell Length (ft)	PSI
3 - 6	0.72
7 - 12	1.26
3 - 20	2.01
21 - 25	3.02
26 - 35	5.24

G. Chemical Resistance: Per ASTM C 581; (see ASTM 3753, Section 8.7), Flexural strength, flexural modulus, and barcol hardness are plotted versus time on log-log coordinates. The line defined by these points is extrapolated to 100,000 hours. The minimum extrapolation retention

allowed for any of these properties is 50%. Test samples used are actual pieces of wetwell or samples manufactured in a manner consistent in every way with the wetwell component construction.

I. Physical Properties:

Flexural Strength (pipe)	Hoop:	22.5 x 103 psi
	Axial:	14.3 x 103 psi
Compressive Strength:		8.9 x 103 psi

7. TEST METHODS

A. All tests shall be performed as specified in ASTM 3753, Section 8, Titled "Test Methods". See ASTM 3753, Section 8, Note 5, for test method D-790 and test method D-695.

8. QUALITY ASSURANCE/QUALITY CONTROL

A. Examination: Each FRP cylinder component part shall be examined for dimensional requirements, hardness, and workmanship.

B. Composition Control: Controls on glass and resin content shall be maintained for all manufacturing processes and for each portion of the FRP cylinder fabrication. Records shall be maintained of these control checks. Proper glass content may be shown by glass usage checks, by glass and resin application rate checks, in accordance with the material composition test in ASTM D 3753, Section 8.8.1.

C. All required ASTM D-3753 testing shall be completed and records of all testing shall be kept and copies of test results shall be presented to customer upon written request within a reasonable time period.

9. CERTIFICATION

A. When requested by the purchaser on his order, a certification shall be made the basis of acceptance. This shall consist of a copy of the manufacturer's test report or a statement by the supplier, accompanied by a copy of the test results, that the wetwell has been sampled, tested, and inspected in accordance with the provisions of ASTM 3753 and this specification, and meets all requirements. An authorized agent of the supplier or manufacturer shall sign each certification so furnished.

10. HANDLING AND STORAGE REQUIRMENTS

A. FRP wetwells shall be lifted by the installation of lifting lugs as specified by the manufacturer on the outside surface near the top of the wetwell. Wetwells may also be lifted in the horizontal position with two slings on a spreader bar.

B. FRP wetwells may be stored upright or horizontally, however, the wetwell vertical deflection shall not exceed 4% of the diameter. The wetwell shall not be dropped or impacted.

C. Additional handling and installation instructions shall be in accordance with the FRP manufacturer's instructions.

D. Each FRP section manufactured in accordance with the drawings shall be clearly marked to indicate the intended pump station installation location. The contractor shall be responsible for the installation of the correct FRP sections in their designated pump station locations.

11. INSTALLATION METHODS

A. The FRP manufacturer's written installation instructions shall be followed to ensure the wetwell will perform in accordance with the design requirements of the applicable specification.

B. Each excavation and backfill are to be done as part of the work under this section, including any necessary sheeting and bracing. The contractor shall be responsible for handling groundwater to provide firm, dry subgrade for the structure, shall prevent water from rising on new poured in place concrete within 24 hours after placing, and shall guard against flotation of other damages resulting from groundwater or flooding.

C. A minimum of 12-in. bedding shall be placed as a foundation for the wetwell base slabs.

D. Backfilling: Do not backfill until concrete base has hardened sufficiently to provide rigid support for both the wetwell and backfill. Add backfill evenly in 12" lifts all around wetwell to avoid uneven backfill loads.

D. The Cast-in-place concrete base, shall be placed on a thoroughly compacted sub-base. The bottom of the FRP sections shall be cast-in-place a minimum of 4 inches and shall be adjusted in grade so that the top slab section is at elevation specified in the contract or on approved drawings.

E. Pre-cast concrete bases are permitted with Engineer pre-approval for installation with the wetwell. If such bases are used and are to be set with the wetwell, all lifting shall be done on the base itself with Engineer approved lifting eyes or loops and not the wetwell structure.

F. The FRP manufacturer's written installation instructions shall be followed to ensure the wetwell will perform in accordance with the design requirements of the applicable specification.

G. Wetwell cutouts may be made in the FRP wetwell, using a circular saw, saber saw, hole saw, or similar equipment with a masonry type blade. Axes, hammers, chisels, or similar impact type tools may not be used.

H. Stubouts and Connections: All FRP inserts and FRP sleeves for piping shall be made as shown on installation drawings and in accordance with the manufacturer's FRP specifications for installation.Other methods of connections may be performed per Engineers request or as shown in the plans and specifications, i.e., Inserta-Tee fittings, pipe connectors which conform to

ASTM C-923 or PVC sewer pipe with FRP lay-up reinforcement installed per manufacturer's recommendation.

1. Inserta-Tee Fittings: Joints for sewer pipe line and drop connections sizes 4" - 15" shall be made by means of Inserta-Tee watertight compression connection. Installation shall be in strict accordance with manufacturer's written instructions utilizing installation equipment approved for use by the manufacturer of the Inserta-Tee fitting.

2. Pipe Stubouts

    a. Install rubber gasketed PVC sewer pipe stubouts to wetwell with resin and glass-fiber reinforced lay-up. Gaskets shall meet the same performance requirements of the sewer pipe to be installed unless otherwise directed by Engineer. Resin and glass shall be of the same type and grade as used in the fabrication of the FRP wetwell.

    b. Install PVC or FRP pipe stubouts for use with resilient pipe-to-wetwell connectors (boots) which conform to the performance requirements of ASTM C-923. PVC or FRP pipe stubouts may also be used by placing incoming service piping through stubout and sealing the annular space with expandable sealing mechanism.

12. INSPECTION

A. The quality of all materials, the process of manufacture, and the finished sections shall be subject to inspection and approval by the Engineer, or other representative of the owner. Such inspections shall be made at the place of manufacture, or at site of delivery, and the sections shall be subject to rejection on account of failure to meet any of the specification requirements as specified herein. Sections rejected after delivery to the job site shall be marked for identification and shall be removed from the job at once. All sections which have been damaged after delivery will be rejected, and if already installed shall be acceptable if repaired or removed and replaced at the contractor's expense.

B. At the time of inspection, the material will be examined for compliance with the requirements of this specification and the approved drawings.

END OF SECTION

ITEM NO. 02701 - VALVES

1. GENERAL

1.01 Work Included

The Contractor shall furnish, install, paint, adjust, and test all valves shown on the drawings and as listed in the valve schedules or as required to provide a complete installation ready to operate. Valves shall be installed complete with all necessary appurtenances including hangers and supports, extension stems, floor stands, hand and chain wheels, operating wrenches, indicators and special operators.

1.02 Related Work Specified Elsewhere

A. Sanitary Force Main.

B. Manholes and Chambers.

1.03 Submittals

Furnish and submit shop drawings, including operation and maintenance manuals to the Engineer. All materials delivered to the site shall be accompanied by certificates of conformance as required by the Supplementary Conditions.

1.04 Product Handling and Storage

Special care shall be exercised during delivery, distribution and storage of the materials to prevent damage. Damaged materials will be rejected and shall be replaced at the Contractor's expense. Storage of valves and appurtenances, prior to use, shall be in such a manner as to keep the materials clean and dry.

2. PRODUCTS

2.01 General

The valves and appurtenances shall be in the quantity, quality, types and sizes as indicated on the Contract Drawings, specified herein, or as otherwise required for the complete and operational installation.

2.02 Materials and Workmanship

All valves shall conform to all applicable provisions of AWWA, ASTM and ANSI Standard Specifications.

All similar valves shall be of the same manufacturer, unless otherwise approved by the Engineer.

Unless otherwise required, all valves 3 inches and larger and located in structures or above ground shall have flanged ends, and be outside screw and yoke valves, unless otherwise specifically indicated or approved by the Engineer. Valves smaller than 3 inches shall have screwed ends. Buried valves shall have mechanical joint ends and standard 2 inch operating nut, unless otherwise indicated.

Extended valve stems, stem guides and operating nuts and handwheel operators shall be provided as indicated or required. Wrenches or levers shall be provided where recommended by the valve manufacturer.

Cast iron parts of valves shall meet the requirements of ASTM Designation A126, "Standard Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings." Flanged ends shall be flat faced and drilled to either Class 125 or Class 250 as required and conform to ANSI: B16.1. Mechanical joints shall conform to ANSI: A21.11. All castings shall be clean and sound, without defects of any kind and no plugging, welding or repairing of defects will be permitted. All bolt heads and nuts shall be hexagonal of American Standard size. Non-ferrous alloys of various types shall be used for parts of valves where called for. Where no definite specification is given, the material shall be the best for that particular application as determined by the Engineer.

Valves shall open by turning hand wheel or operating nut to the left (counter-clockwise).

Non-rising stem gate valves shall be provided with "O" ring type packing. Rising stem gate valves shall be provided with packed boxes.

2.03 Gate Valves

General: Gate valves shall be as manufactured by Mueller Co. All valves shall be of the tight-closing, resilient-faced wedge type.

Valves shall be drop tight at rated pressure of 175 psi (3" - 12"), 150 psi (14" - 24") and shall be satisfactory for applications involving throttling service and/or frequent operation and for applications involving open/close valve operation.

Valve Bodies: Valve bodies shall be constructed of ductile iron ASTM A-536. Flanges shall be faced and drilled in accordance with ANSI B16.1, Class 125. Mechanical joint end bodies shall be in full compliance with ANSI A21.11.

Valve Wedge: The valve wedge shall be constructed of ductile iron ASTM A-536. The wedge shall have a synthetic rubber bonded to all surfaces except shaft and thrust bearing surfaces. The rubber compound shall be approximately 70 durometer hardness. The bond must withstand 75 lbs. pull under test procedure ASTM D-429, Method B.

Trunnion Bearings: Bearings shall be corrosion resistant and constructed of phenolic-backed or fiberglass-backed woven teflon fiber.

Packing: The valve bonnet or cover shall be fitted with a cavity to accommodate a packing set. The packing shall be self-adjusting chevron type replaceable without removing valve actuator.

Thrust Bearings: Thrust bearing shall be provided at the top of the stem. Thrust bearings shall be corrosion resistant.

Painting: All surfaces of the valve shall be clean, dry and free of grease before painting. The valve shall be evenly coated as specified.

Testing: All valves shall be subjected to a hydrostatic leak test at 150 psig (14" - 24") and 175 psig (3" - 12") and a body hydro test at 300 psi prior to shipment.

2.04 Check Valves

a. Shall be suitable for unscreened raw sewage and wastewater application.

b. A flanged check valve shall be installed on the discharge side of each pump and on emergency by-pass pumping assembly, followed by a full-closing isolation gate valve.

c. Shall provide clear unobstructed opening waterway when disc is in fully open position.

    1). Check valves installed inside of a wet well shall be prohibited.

d. Check valves shall be sized to assure they will not slam during pump starting, while pump operating and when stopping, when pump control is under full voltage starting method. The valve sizing shall also allow full opening to maintain full port open for passage of solid trash and fibrous debris.

e. Check valves shall be swing type with an external lever and weight, with minimum pressure rating as follow:

    1). 200-psi for sizes 2 to 12-inch, or 100-psi above operating pressure at Firm Pumping Capacity, whichever is greater.

    2). 150-psi for sizes 14-inch and larger, or 100-psi above operating pressure at Firm Pumping Capacity, whichever is greater.

f. Check valves shall be in compliance with ANSI/AWWA C508 standards.

g. Hinge pin shall be made of stainless steel 316.

h. Working parts shall be removable through the top of the valve.

    1). Top cover shall be equivalent to a blind flange conforming to ANSI/AWWA C110/A21.10 (ASME B16.1 Class 125). Top covers that are not compatible with ANSI/AWWA C110/A21.10 (ASME B16.1 Class 125) flanges shall be prohibited.

    2). Top cover shall be provided with a rubber reinforced gasket in conformance with ASTM D2000 AA 7008.

i. Tap bosses shall be available at both upstream and downstream of the disc.

j. Body shall be made of cast iron ASTM A126 CL B.

k. End process connections shall be ANSI/AWWA C110/A21.10 (ASME B16.1 Class 125) flanged.

   1). Bolt and nut set shall include flat and pressure washer on each side. All bolt sets shall be made of stainless steel 316.

l. Disc shall be of the rubber-faced type.

   1). Seat holder bolt shall be of stainless steel 304.

   2). Seat holder shall be ductile iron ASTM A536 Gr. 65-45-12.

   3). Disc seat ring shall be of rubber ASTM D2000 AA 7008.

Approved check valve manufacturers are Kennedy, Mueller, and American Flow Control or approved equal.

2.05 Plug Valves

General: Plug valves shall be as manufactured by Mueller Co. All plug valves shall be of the tight-closing, resilient-faced plug type and shall be of bi-directional eccentric seating such that the opening movement of the closing member (plug) results in the closing member rising off the body seat contact.

Valves shall be drop tight at rated pressure of 175 psi (3"- 12"), 150 psi (14"-24") and shall be satisfactory for applications involving throttling service and/or frequent operation and for applications involving open/close valve operation.

Valve Bodies: Valve bodies shall be constructed of ductile iron ASTM A-536. Flanges shall be faced and drilled in accordance with ANSI B16.1, Class 125. Mechanical joint end bodies shall be in full compliance with ANSI A21.11.

Valve Plug: The valve plug shall be constructed of ductile iron ASTM A-536. The plug shall have a cylindrical seating surface which is eccentrically offset from the center of the plug shafts. The plug shafts shall be integral. For 3" through 12" valves, the plug shall have a synthetic rubber bonded to all surfaces except shaft and thrust bearing surfaces. The rubber compound shall be approximately 70 durometer hardness. The bond must withstand 75 lbs. pull under test procedure ASTM D-429, Method B.

For 14" and larger valves, the plug sealing surface shall be covered by a rubber compound. The rubber compound shall be approximately 70 durometer hardness. The bond must withstand 35 lbs. pull under test procedure ASTM D-429, Method B.

Valve Seats: Valve body seats shall be corrosion resistant 300 Series stainless steel. Coated non-metallic materials shall not be acceptable.

Tru-union Bearings: Valves shall be fitted with sleeve type bearings. Bearings shall be corrosion resistant and constructed of phenolic- backed or fiberglass-backed woven teflon fiber.

Packing: The valve bonnet or cover shall be fitted with a cavity to accommodate a packing set. The packing shall be self-adjusting chevron type replaceable without removing valve actuator.

Thrust Bearings: Thrust bearings shall be provided at the top and bottom faced surfaces of the plug. Thrust bearings shall be corrosion resistant.

Painting: All surfaces of the valve shall be clean, dry and free of grease before painting. The valve shall be evenly coated as specified.

Testing: All eccentric plug valves shall be subjected to a hydrostatic leak test at 150 psig (14"-24") and 175 psig (3"-12") and a body hydro test at 300 psi prior to shipment.

Manual Actuators; Manual gear actuators shall be self-locking in all positions. Above ground actuators shall be equipped with handwheels or chainwheels as specified. Buried service actuators shall be equipped with a 2" operating nut and shall fully comply with the requirements of AWWA C504.

2.06 Air Release Combination Valves

Air Release Combination Valves shall be as shown on the drawings or approved equal.

2.07 Miscellaneous Small Valves

Contractor shall furnish and install miscellaneous small valves as shown on contract drawings, and specified herein. They shall be designed for 150 psi service pressure.

All valves and specialty items 2-1/2 inches and smaller shall be as manufactured by Walworth, Jenkins, Clow, Pratt, Crane, Nibco, or approved equal. They shall be furnished and installed as required to fulfill the intent of the Drawings and Specifications.

All valves shall be true union, full port, constructed of brass or bronze and suitable for use in sanitary systems.

2.08 Back Flow Preventer: shall be installed in locations shown on the plans. The back flow preventer shall be a Watts Series 909 Reduced Pressure Zone with Air Gap fitting and test cocks, or approved equal. The back flow preventer shall be installed inside of an insulated heated enclosure, Watts Model WB-1, or approved equal when it will be exposed to freezing temperatures. The back flow preventer and its enclosure shall be installed in accordance with manufacturer recommendations with all necessary provisions to allow periodical testing of the device.

3. EXECUTION

3.01 Inspection

All valves shall be manually opened and closed prior to installation, and the interior of the valves if required shall be cleaned by the Contractor.

3.02 Installation

A) Valves shall be installed as nearly as possible in the positions indicated on the Drawings consistent with conveniences of operating the handwheel or wrench. All valves shall be carefully erected and supported in their respective positions free from all distortion and strain or appurtenances during handling and installation. All material shall be carefully inspected for defects in workmanship and material, all debris and foreign material cleaned out of valve openings and seats, all operating mechanisms operated to check their proper functioning, and all nuts and bolts checked for tightness. Valves shall be packed and adjusted prior to field tests and shall be left in good condition. Valves and other equipment which do not operate easily or are otherwise defective shall be repaired or replaced at the Contractor's expense. Valves shall not be installed with stems below the horizontal.

B) Valves shall be set plumb and supported adequately in conformity with instructions of the manufacturer. Valves mounted on the face of concrete shall be shimmed vertically and grouted in place. Valves in the control piping shall be installed so as to be easily accessible. All valves shall be painted to match color code of adjoining piping.

C) All valves, including buried valves, shall be installed in such a manner as to make it possible to remove bonnets or heads and gates or plugs without destruction of any surrounding installation(s) or work in place. All valves shall be installed so as to be completely accessible for operation and free from interference when operated.

D) Valves shall be provided with extension stems where required for convenience of operation. Extension stems shall be provided for buried valves and elsewhere so that the operating wrench does not exceed 8' in length. Buried valves shall be equipped with an extension stem terminated with standard 2" operating nut and shall be set truly plumb with valve boxes directly over the valves. After being correctly positioned for line and grade, the earth fill shall be carefully tamped around the valve box. Top of box shall be 3" above ground encased as indicated in the drawings. Valve box cover shall be painted the same color as required by color code for the pipe service.

E) Operators on extended bonnet, stems and support brackets shall be set so that the stems shall run smoothly in true alignment. Extended bonnet shall be anchored firmly to concrete. Distances from the centerlines of valves to the operating level shall be checked by the Contractor and adjusted if necessary to suit the actual conditions of installation.

3.03 Valve Testing

All valves shall be factory tested as hydrostatic pressure equal to twice the working pressures. The manufacturer shall furnish the Engineer with certified copies of the test reports. All valves shall operate smoothly and to the specifications during field tests.

3.04 Valve Identification Marks

All valves shall have the size of the opening, the name of the manufacturer and the working water pressure for which they are designed, cast in raised letters upon the body of the yoke. All operating floorstands and bench stands for valves and gates shall have the name of the manufacturer and the part number cast in raised letters in a readily identifiable and prominent location.

END OF SECTION

ITEM NO. 02703 - SANITARY FORCE MAIN

1. DESCRIPTION

This section includes the construction of force mains and appurtenances at the location shown on the plans, as specified or required and shall include performing all operations in connection with the installation of all pipe, fittings, adapters, valves, valve boxes and chambers, connections to existing and new piping, thrust blocks, plastic, encasement, concrete encasement, bedding, trenching, backfilling, accessories, appurtenances, miscellaneous work, and testing of the entire new system.

2. MATERIALS

The quality of all materials, manufacturing procedures, and the finished pipe shall be subject to inspection and approval of the Engineer. Such inspection may be made at the place of manufacture and/or at the work site after delivery, and the pipe shall be subject to rejection at any time on account of failure to meet any of the specification requirements, even though sample pipes may have been accepted as satisfactory at the place of manufacture.

2.01 High-Density Polyethylene (HDPE)

1. Pipes: HDPE force main pipe shall be pressure rated DIPS, as shown specified or required, conforming to ANSI/AWWA C906, ASTM D3035, ASTM D3350 and ASTM F714 and other ASTM standards as applicable. Polyethylene material shall meet the requirements for PE 4710 resin cell classification 445574C or E per ASTM D3350.

PE 4710 ASTM D3350 CELL CLASSIFICATION OF PE445574C/E

Property	Standard	Typical Value
Cell Classification	ASTM D3350	445574C (Black)
Density	ASTM D1505	0.960 g/cc (Black)
Melt Index	ASTM D1238	0.08 g/10min
Flexural Modulus	ASTM D790	>110,000 <160,000 psi
Tensile Strength	ASTM D638	>3,500 psi
SCG (PENT)	ASTM F1473	> 500 hours
HDB @ 73 ºF	ASTM D2837	1,600 psi
Color; UV Stabilizer	ASTM D3350	Black/Green w/UV Stabilizer
Linear Thermal Expansion	ASTM D696	$8x10^{-5}$ in/in/ºF
Elastic Modulus	ASTM D638	>175,000

Pipe shall be manufactured with UV stabilizer to maximum protection. Pressure class/DR rating shall be as shown on the drawings. Pipe shall be clearly marked on the exterior at indicating production date (day, month, year) manufacturer's name and location, nominal size, material code,

DR, Pressure Class, AWWA C906, and ASTM F714. Pipe shall be as manufactured by JM Eagle or equal.

The force main material must withstand the pressure generated by instantaneous pump stoppage due to power failure under maximum pumping conditions. For the purpose of complying with this requirement, the effect of using surge relief valves with or without any combination of soft starters or variable frequency drives shall not be considered for this analysis

The minimum rated working pressure of force mains pipes, joints and related fittings shall be either 50 pounds per square inch greater than the maximum expected surge pressure when operating at firm pumping capacity, or 160 pounds per square inch; whichever is greater. The use of pipes, joints or fittings rated at a working pressure of less than 160 pounds per square inch is strictly prohibited.

The color code of the force main pipe shall be permitted to be black or grey, but shall have three continuous green stripes along the pipe separated at 120 degrees.

2. Joints: Joints shall be of a heat fusion joining system. Pipe and fittings shall be thermal butt fusion in accordance with ASTM F2620 and the manufacturers recommended procedures. Electrofusion couplings shall be utilized where indicated.

At the point of fusion, the outside diameter and minimum wall thickness of the fitting shall match the outside diameter and minimum wall thickness per applicable ASTM specifications for the same size pipe.

Installation of the pipes and fittings shall be performed in accordance with ASTM D-2774. Depending upon the installation requirements and site location, joining shall be performed within or outside the excavation. Joints of the pipe sections shall be smooth on the inside and internal projection beads shall not be greater than 3/16 inch.

Electrofusion couplings where shown shall be HDPE Electrofusion couplers sized and rated the same as the pipe they are joining conforming to ASTM F1290 and AWWA C906 as provided by Ferguson, or equal.

The tensile strength at yield of the fusion joints shall not be less than the pipe.

The manufacturer shall provide fusion training to on-site personnel as necessary. The contractor and the onsite joint inspector shall be trained by the manufacturer or manufacturer's authorized representative.

The fusion equipment and operator shall be required to demonstrate successful field experience. The fusion equipment shall be proven for a period of five years and the fusion operator shall have experience in the same size pipe on this project for five years or longer.

3. HDPE Fittings: All HDPE fittings shall be provided as indicated on the plans. All fittings shall be restrained in accordance with AWWA M55 guidelines. HDPE Fittings shall be C906 of the same material and pressure rating as the pipe they are being joined to. HDPE Elbows, tees, and

wyes shall be manufactured by mitered fabrication in the shop, field manufacture will not be acceptable. The manufacturer shall have a written specification for all standard mitered fittings, which establishes Quality Control criteria and tolerances. The manufacturer may be required to demonstrate its ability to produce product required by this specification.

Fabricated fusion HDPE fittings shall be AWWA C906, EDR the same as the pipe they are being joined to manufactured in accordance with ASTM F2206 with mitered fusion joints using parent stock pipe at least 20% thicker wall then pipe to which they will be joined. Fusion fittings shall be as manufactured by the Harrington Corporation of Bellingham WA or equal. Field fabricated fittings shall not be utilized.

Mechanical joint C906 adapter fittings (Powerseal 3501 with a Powerseal 3530 type 304 stainless steel stiffener, or equal) shall be used to transition from ductile iron to HDPE and from HDPE to PVC as necessary. The fitting shall be stronger than the pipe in that when it is subjected to tensile stress the pipe will pull apart before the fitting will pull out and the pipe will blow before the fitting ruptures under pressure.

The MJ Adapter shall have a pre-installed stainless-steel stiffener, in accordance with Plastic Pipe Institute (PPI) recommendations, to neutralize point-loading, ACQ, creep and loss of gasket seal due to diameter contraction. The stiffener shall be engineered sufficiently thick to avoid redial buckling due to gasket pressure.

The MJ Adapter requires longer bolts and shall be sold with the modified longer bolt kit to avoid construction crew delays or improper installation with too short bolts.

All fittings for force mains or pressure rated fittings shall be rated according to the manufacturer's written specifications, and clearly labeled on the fittings as such.

4. Installation: The installation shall conform to the requirements of the manufacturer, AWWA Standards, and as indicated on the plans and specified herein.

5. Marking and Certification: Each length of HDPE sanitary sewer shall be clearly marked with the Manufacturer's Name, Tradename or Trademark, Nominal pipe size, Pipe Stiffness, Production Code/Extrusion Code, Material Cell Class Designation and ASTM number.

The pipe manufacturer shall provide certification that the stress regression testing has been performed on the specific product. The said certification shall include a stress live curve per ASTM D-2837. The stress regression testing shall have been performed in accordance with ASTM D-2837, and the manufacturer shall provide a product supplying a minimum Hydrostatic Design Basis of 1,600 psi as determined by ASTM D-2837. This certification shall also state that the pipe was manufactured from one specific resin in compliance with these specifications. The certificate shall state the specific resin used and its source.

2.02 Ductile Iron Pipe (DIP)

All ductile iron pipe shall be centrifugally cast pipe conforming to the American National Standard

for Ductile Iron Pipe, Centrifugally Cast in Metal Molds or Sand Lined Molds for Water or Other Liquids, ANSI/AWWA Designation A21.5/C-151, latest revision. The pipe sizes shall be as shown on the contract drawings with a thickness class of 52 unless otherwise included on Plans. All pipe fittings shall have joints with body thickness and radii of curvature conforming to latest ANSI/AWWA Designation A.21.10/C-110.

Joints shall employ a single, elongated gasket of such size and shape as to provide an adequate compressive force against the spigot and socket after assembly to affect a positive seal under all combinations of joint and gasket tolerances. Gaskets shall be vulcanized natural or vulcanized synthetic rubber, resistant to common ingredients of sewage, industrial wastes, including oils and groundwater. Gaskets shall be free of porous areas, foreign materials, and visible defects.

The lubricant shall be suitable for lubricating the parts of the joint assembly. The lubricant shall be non-toxic and shall not support the growth of bacteria and shall have no deteriorating effects on the gasket material. Joints shall be U.S. Pipe and Foundry Company's "Tyton" joint, Griffin Pipe Products Company's "Super Bell-Tite" joint, or equal conforming to the latest edition of American National Standard for Rubber Gasket Joints for Cast Iron and Ductile Iron Pressure Pipe and Fittings, ANSI/AWWA Designation A21.11/C-111.

Where flexible restrained joints are called for on the plans, TR Flex pipe and fittings as manufactured by U.S. Pipe or equal shall be installed. Fittings shall conform to the applicable requirements of ANSI/AWWA Designation A21.10/C-110.

All ductile iron pipe shall be externally coated with a uniform thickness (approximately 1 mm thick) of hot-applied coal tar coating. The finished coating shall be neither brittle when cold, nor sticky when exposed to the sun, and shall be strongly adherent to the pipe. The inside lining shall be Protecto 401 ceramic epoxy or equal. Cut or damaged portions of the pipe shall be sealed with Protecto 401 or equal. Sealant utilized shall be by the same manufacturer as the interior coating.

All pipe and pipe fittings to be installed within vaults shall be Ductile Iron and shall have flanged type of joints unless connecting to a Dresser Coupling.

1. Flanged pipe shall be centrifugally cast, ductile iron, complying with ANSI/AWWA A21.51/C115 and Class 53 thickness.

2. Flanges shall be cast iron class 125 or 250 as indicated on the Plans and shall comply with ANSI B16.1.

3. Pipe and flanges shall be threaded and suitable thread sealant applied before assembling flange to pipe.

4. Flange gaskets shall be 1/8” thick neoprene Flange-Tyte gaskets as manufactured by US Pipe, or approved equal, and shall comply with requirements of ANSI/AWWA A.21.11/C-111.

4. Bolt holes shall be in angular alignment within 1/2 degrees between flanges. Flanges shall be faced with a gasket finish having concentric grooves a minimum of 0.01 inch deep by

approximately 0.03 inch wide, with a minimum of three grooves on any given surface spaced a maximum of 1/4 inch apart.

Pipe and fittings shall be as manufactured by U.S. Pipe and Foundry Company or approved equal.

2.03 Compression - Sleeve Coupling A.K.A Dresser Style Coupling

Coupling shall be designed to couple plain end piping by compression of a ring gasket at each end of the adjoining pipe sections. The coupling shall consist of one middle ring flared or beveled at each end to provide a gasket seat; two follower rings; two resilient tapered rubber gaskets; and bolts and nuts to draw the follower rings; two resilient tapered rubber gaskets; and bolts and nuts to draw the follower ring toward each other to compress the gaskets. The middle and the follower rings shall be true circular sections free from irregularities, flat spots, and surface defects; the design shall be such as to provide for confinement and compression of the gaskets.

Compression sleeve couplings shall conform to the latest edition of ANSI/AWWA Designation 21.107/C-110. Bolts shall be corrosion resistant and conform to ANSI/AWWA Designation 21.11/C-111, latest edition. The inside surface shall Protecto 401 or equal epoxy coated and the outside surface shall be coated with hot coal tar coating. Mechanical joint solid sleeves shall be U.S. Pipe Mechanical Joint Solid Sleeves, or equal. Dresser style ductile iron coupling rated the same as the pipe shall be considered equal. All couplings shall be restrained with suitably sized stainless steel rods.

2.04 Cast/Ductile Iron Fittings

All cast/ductile iron fittings shall be Class 250 suitable for use with the pipe specified above conforming to the latest edition of American National Standard for Gray Iron and Ductile Iron Fittings, 3" through 48" for Water and Other Liquids, ANSI Designation A21.10. Fittings shall be externally coated with a uniform thickness of hot applied coal tar coating and the inside shall be epoxy coated and only mechanical joint fittings shall be used. End plugs shall be setscrew type, as manufactured by the United States Pipe and Foundry Company, or equal. Bolts and gaskets shall conform to the latest edition of ANSI/AWWA Designation A21.11/C-111.

2.05 Valves

Valves shall be installed, as indicated on the Plans, and as specified in Section 02701 of these Specifications.

2.06 Force Main Manholes/Chambers

Force main manholes and chambers shall be installed, as indicated on the Plans, and as specified in Section 02657 of these Specifications.

2.07 Plastic Pipe Encasement

Plastic pipe encasement for use with ductile iron pipe shall be polyethylene 8 mil. thick either in tube or sheet form with 2" wide polyethylene adhesive tape used to secure the film to the pipe.

2.08 Concrete Pipe Encasement

Concrete encasement work shall include the construction of non-reinforced structures used for encasement or plugging purposes, as indicated in the contract documents, and/or as directed by the Engineer.

Concrete shall have a minimum twenty-eight (28) day compressive strength of 3,000 lbs. per square inch. All materials shall conform to the applicable provisions of the latest edition of the American Concrete Institute Standards (ACI Standard 318, Building Code Requirements for Reinforced Concrete).

2.09 Concrete Thrust Blocks

Concrete for thrust blocks shall have a minimum 28-day comprehensive strength of 3,000 lbs per square inch. All materials shall conform to the applicable provisions of the latest edition of the American Concrete Institute Standards (ACI Standard 318, Building Code Requirements for Reinforced Concrete).

2.10 Mechanical Joint Retainer Glands

Mechanical joint retainer glands must meet the specifications of AWWA C-111 (ANSI A21.11) American Standard for rubber gasket joints, latest edition. Glands shall be ductile iron.

2.11 Detectable Metallic Underground Tape

Detectable warning tape shall be of a nominal 4.5 mil (0.0045") thickness, with a solid aluminum foil core and 3" wide. The tape shall be green (a standard APWA Uniform Color Code color for sanitary sewer buried installation) with black letters "Caution Buried Sewer Line Below" and shall have reflective surfaces.

The tape shall be manufactured in accordance with requirements of ASTM D-882.

Detectable Metallic Underground Tape shall be used above HDPE and any other non-metallic pressure sewer pipe in all locations the force main is scheduled to be installed.

3. METHODS OF CONSTRUCTION

3.01 Cutting and Removing Pavement

The line between the trench and existing pavement to remain shall be cut with a saw, pneumatically operated spade, or approved equal, so as to leave a smooth, straight, and vertical edge. The existing pavement may be bituminous, brick, block non-reinforced concrete, reinforced concrete, etc. The

excavated pavement shall be broken up and removed to a site approved by the Engineer.

Where excavations are to be made on concrete roads, the existing concrete shall first be saw cut and removed. All protruding reinforcing roads shall be cut off and removed. Any loose or broken longitudinal portions of adjacent existing lanes shall be removed and replaced as directed by the Engineer.

3.02 Underground Utilities

The Contractor is responsible to verify utilities shown on the Plans.

Whenever a utility line is crossed or in any way exposed during this construction, the Contractor shall brace the utility line in accordance with the Standard Detail "Support of Utilities" and/or to the satisfaction of the Owner of the utility. The utility line shall be supported as the existing soil support is removed and until the trench is backfilled.

Contractor shall provide submittals indicating the number of, material of construction and location of temporary supports with structural calculations to show that said supports can adequately support the utility while exposed.

3.03 Excavation

Excavation shall be in accordance with the plans and specifications.

3.04 Excavation Support

The Contractor shall furnish, put in place, and maintain such excavation support as necessary to support the sides of the excavation and to prevent any movement of earth other than that intended to be accomplished by the excavation which may otherwise injure or delay the work or endanger adjacent structures.

Excavation support shall be constructed as necessary for the protection of the work and for the safety of personnel and shall comply with the safety precautions outlined in the Federal Register as required by the Federal Occupational and Safety Health Act of 1970 (OSHA). The Contractor shall be responsible for the adequacy of all trench support used on the work.

The Contractor is to provide support for all excavations in excess of 5' in depth, or as required, all in accordance with OSHA requirements.

3.05 Dewatering of Trench

All pipes shall be laid on a solid, dry foundation. The Contractor shall furnish all equipment, material and labor necessary to keep all trenches free from water that is above or below ground. Any pipe laid in water or wet trenches must be removed and reinstalled at the Contractor's expense.

The Contractor shall provide, maintain and operate such drains, percolation stone, trenches, sumps,

pumps, hoses, piping, well-pointing systems, and other approved methods and equipment as may be necessary to keep the excavations free from water during all stages of the construction operations and course of work. The Contractor shall provide such dikes, ditches, sumps and pumping that may also be required to prevent the flow of surface waters into excavated areas and into any and all areas where construction or installations are in progress. All water pumped from the excavation shall be discharged in such manner as shall not cause injury to work completed, damage to property, health hazards or impediment to traffic. All costs for dewatering shall be included in the prices bid.

Water shall be completely removed from all excavations promptly and continuously throughout the progress of the work, and the Contractor shall keep excavations absolutely dry at all times until the force mains have been properly joined and bedded and backfilled. Precautions shall be taken to protect uncompleted work from flooding during storms or from other causes.

3.06 Installation

Care shall be taken not to damage any materials in handling or installation of pipe, fittings, etc., and no smaller pieces or other materials of any kind shall be placed in the large pieces for transportation at any time. Any material found to have inherent defects upon delivery or to have been damaged in transportation will be rejected.

All pipe, fittings, adapters, valves and appurtenances shall be cleaned of foreign matter before being lowered into the trench and shall be kept clean during the laying operations by plugging or other approved means. Cutting of pipe shall be done in a neat and workmanlike manner with an approved type of mechanical cutter without damage to the pipe or lining so as to leave a smooth end at right angle to the axis of the pipe.

All pipes shall be laid on a solid, dry foundation. The Contractor shall maintain an average 4' of ground cover over the pipe line, excepting the following circumstances:

1. Connections to cleanout, blow-off, air release, and air vacuum manholes may require varying depths of cover, as indicated on the Standard Detail.

2. When a lateral separation of 10' or more cannot be maintained between the proposed sanitary force main and existing water mains, the force main shall be laid a minimum of 18" below the bottom elevation of water main(s).

Unless specifically indicated, there shall be no high points in the force main. The pipe shall be laid with the bell ends upstream when used. Each section of pipe shall rest upon the pipe bed the full length of its barrel and for a minimum of one-half its diameter with recesses excavated to accommodate bells and joints. Any pipe which has its grade or joints disturbed after laying shall be taken up and re-laid at the Contractor's expense. The Contractor shall close the ends of all unconnected pipe with a waterproof stopper. Bedding shall be in conformance with the details and specifications.

All joints of piping, couplings, fittings, valves, specials, etc., shall be installed in accordance with the manufacturer's printed recommendations. When the requirements contained in this specification

exceed the manufacturer's specifications, the specifications contained herein shall govern.

All gaskets and mating surfaces shall be thoroughly cleaned and lubricated in accordance with the manufacturer's specifications. The pipe shall be aligned with the previously installed pipe and, with gasket in place, put together. After pipes are put together, the joint shall be inspected to verify that gasket is properly positioned and that the joint has been properly made and is tight. If, while making the joint, the gasket becomes loose or misplaced, the pipe shall be removed and the joint remade to the satisfaction of the Engineer. Joints shall be made watertight.

Voids under joints shall be filled with proper bedding material compacted.

Concrete thrust blocks, or other acceptable restraint shall be provided at all tees, bends, and dead ends.

When tie rods are used with steel bands around the pipe barrel for pipe restraint, only one (1) rod shall be attached to each band and the band shall be cocked to prevent slippage along the pipe barrel. A band placed behind a bell may be used with two (2) rods. For mechanical joint pipe, tie rods may be threaded through the bolt holds in the flange and secured by nuts. All rods and bands shall be made of corrosion-resistant material or coated to prevent rust or deterioration.

Restraint may be necessary for more than one (1) length of pipe on each side of any change in direction, or at any dead end or tee. See standard details for required joint restraint system.

Valves and valve boxes shall be set plumb with a 6" minimum base of bedding. Valve boxes shall be centered on the valves and the box cover shall finish flush with the surface of the pavement or ground.

Methods of construction for concrete encasement work shall conform to all applicable requirements of the American Concrete Institute Standards, ACI Standard 318.

At all areas where ductile iron pipe is exposed to corrosive soil condition, runs parallel to cathodically protected utility lines on the same side of the road or where utility lines cross, or when using composite borrow excavated material consisting of sand/ash/ pozzolon for road restoration, the force main shall be protected by encasing the pipe with plastic. Polyethylene film shall be applied loosely but continuously to the pipe with joints in plastic made by polyethylene adhesive tape. Care shall be taken in the installation and backfilling operation to prevent tearing the plastic and exposing the pipe.

3.07 Connections to Existing Manholes

Where new pipe is to be connected to an existing manhole, the Contractor shall perform all cutting, patching, channel reconstruction, and all else necessary to install and seal the new pipe. Any damage to the existing manhole caused by the construction operations shall be repaired by the Contractor to the satisfaction of the Engineer. All exterior concrete work shall receive two coats of bitumastic 8 mil/coat. All connections shall be watertight. All cost for this work shall be included in the unit price bid for the connecting pipe.

3.08 Special Crossings

Bridge, stream, highway and other special crossings shall be constructed in accordance with the contract drawings, details and these specifications. The Contractor shall pay attention to environment protection, protection of structures and perform all required procedures to the satisfaction of the Engineer, and the authoritative agency.

3.09 Backfilling and Compaction

Unless otherwise approved by the Engineer, the Contractor shall backfill all trenches at the end of each working day with suitable material from the trench excavation or temporary stockpile. Backfill shall be brought to elevations which allow construction of temporary paving specified elsewhere in these specifications. If, in the opinion of the Engineer, the native material is unsuitable, select off-site material shall be provided as described in the item "Borrow Excavation". Bedding material shall be deposited and mechanically compacted to a minimum 95% Modified Proctor Density in layers not exceeding 6" in depth (loose measure) to a point 12" above the top of the pipe. From this point, all backfill shall be mechanically compacted in maximum 12" lifts, unless otherwise approved by the Engineer, to obtain a minimum 90% Modified Proctor Density to a point 3' below the road surface. From this point, a minimum 95% Modified Proctor Density is required. Smaller lifts shall be required if this density is not obtained. The backfill material shall be wet or dried as required to obtain the required density.

The only methods of compacting the backfill material permitted shall be mechanical compaction in lifts as specified. Consolidation will not be acceptable as a method to achieve the soil densities specified.

The Engineer, at his discretion, may perform, or have performed soil density checks at randomly chose lifts. Density testing will be performed at the completion of the compaction effort. Compaction requirements will be strictly enforced.

When the trench is not in or across a dedicated street, right-of-way, or any other place where pavement is to be constructed, backfill shall be compacted to obtain a minimum 90% Modified Proctor Density.

The densities referred to above shall be based upon the latest Standard Test Methods for Moisture-Density Relations of Soil and Soil Aggregate Mixtures Using 10 lb. Hammer and 18" Drop, ASTM Designation D-1557. Density control in the field shall be based on the latest Test for Density of Soil in Place by the Sand/Cone Method, ASTM Designation D-1556. The Owner may retain and, except as otherwise specified, pay for the services of an independent testing laboratory to do such sampling and to make such tests as the Owner or Engineer may deem necessary to verify that work conforms to the requirements of the specifications.

3.10 Detectable Underground Metallic Tape Installation.

After trench is backfilled and prior to installation of pavement and/or topsoil, the Contractor shall

install a detectable metallic tape over the entire HDPE force main pipe alignment. The tape shall be at 4 to 6 inches under surface of the finished grade. The tape shall be installed in such a way that an unbroken conductivity is achieved, wherever tape breaks occur a minimum 6" overlap shall be made.

The tape shall be installed in presence of the Engineer's representative. No separate payment will be made for installation of detectable underground tape. The cost of this work shall be included in all applicable bid items scheduled in the Proposal.

3.11 Pavement Repair

After satisfactory completion of backfilling and compaction and within 24-hours of completion of this work, bituminous stabilized base shall be constructed as specified, shown or required. If cold weather has shut-down asphalt plants or if backfill and compaction efforts are inadequate, the Contractor shall install "Temporary Pavement Repair".

3.12 Temporary Pavement Repairs

The Contractor shall use temporary pavement repair only with permission of the Engineer. Temporary pavement repair is intended to be used only if cold weather has shut-down asphalt plant prohibiting the use of bituminous stabilized base. If compaction method has not achieved the specified soil densities, the Engineer may require the Contractor to place temporary pavement at no cost to the Owner.

During the interval between the completion of backfill and the time of placement of permanent paving, all pavement and drives shall be maintained in a safe and satisfactory condition. The Contractor shall install all temporary pavement repair in accordance with these specifications.

Temporary pavement repair shall consist of 2" minimum (compacted measure) of bituminous concrete patch (cold patch) on all Municipal roads and 6" (compacted measure) of cold patch on County and State Roads. Prior to placing of cold patch, the trench shall be thoroughly cleaned of all loose and foreign material. It shall not be applied when surface is wet or dusty. Application shall be made only when the condition of the surface is acceptable to the Engineer.

The Contractor shall continuously maintain temporary paving for the entire period it remains in place; shall inspect trenches at such intervals as may be necessary, including but not limited to immediately following rainstorms, winter thaws, and similar occurrences which may cause settlement, erosion, or other problems; and shall promptly make necessary repairs to maintain trenches in a satisfactory condition. In the event the Contractor fails to make such repairs, the Owner may make such repairs as are deemed necessary and Contractor shall pay for the cost of this work.

The Contractor is required to repair all areas that are damaged by his actions during construction. If the damaged areas are outside the maximum trench width shown in the detail, additional costs of restoring the damaged areas shall be borne by the Contractor.

The Engineer, giving one week's notice, may direct the Contractor to remove the bituminous concrete patch surface and replace it with the permanent base course (bituminous stabilized base). It is the intention of the Engineer to require the placement of the permanent base course in lieu of bituminous concrete patch provided weather conditions allow and it is demonstrated that the Contractor's compaction method has achieved the specified soil densities within the 24-hour time limit for the placement of temporary pavement repair. If specified soil densities are not achieved within this time limit, the Contractor will be required to place bituminous concrete patch as specified. The placement of bituminous concrete patch should not be construed as relieving the Contractor from any of the requirements of the backfilling operations.

The Contractor shall not receive compensation for placement of temporary pavement repair due to inadequate backfill and compaction efforts.

3.13 TESTING

All pipelines shall be pressure and leakage tested prior to construction of permanent pavement repair, a minimum of seven days after the last concrete thrust block has been cast if constructed with normal Portland cement. All testing operations shall be witnessed by the OWNER'S authorized representative.

All materials and equipment required for testing shall be supplied by the Contractor including at a minimum test equipment, temporary valves, plugs, caps, bulkheads, or other water control equipment and materials. No materials shall be used which would be injurious to the construction or its future function.

The CONTRACTOR shall furnish and install all means and apparatus necessary for getting the air or fluid into the pipeline for flushing and testing including pumps, compressors, gauges, and meters, any necessary plugs and caps, and any required blow-off piping and fittings, etc., complete with any necessary reaction blocking to prevent pipe movement during the flushing and testing.

Hydrostatic testing of ductile iron pipe shall conform to AWWA Standard C-600.

Flushing and retesting any section or portion of a pipeline shall be performed, if required to resolve questionable results.

The CONTRACTOR shall provide water for all flushing and testing of liquid conveying pipelines.

The pressure test shall be performed by increasing the hydrostatic pressure to a specified value and maintaining that pressure for a period of one hour. Any pipe, fittings, or valves found defective shall be replaced. Prior to performing the test, all air pockets and bubbles must be eliminated. Hydrostatic test pressure shall be 2 times the working pressure of the system at the point of testing or 150 psi, whichever is greater.

The leakage test shall be performed concurrently with the pressure test and shall be accomplished by increasing the hydrostatic pressure to a specified value and maintaining that pressure for a period of two hours. Leakage is the quantity of water that must be supplied into the newly laid pipe, or any

valved section thereof, to maintain the specified leakage test pressure after the air in the pipeline has been expelled. The test pressure shall be 2 times the working pressure of the system at the point of testing or 150 psi whichever is less. The leakage from each portion of the pipeline being tested shall not exceed 11.65 gallons per inch of internal diameter per mile of pipe per day. If any test of pipe laid discloses a greater leakage than specified, the Contractor shall, at his own expense, locate and repair the defective joints until the leakage is within the specified allowance.

Hydrostatic testing of HDPE pipe shall conform to ASTM F2164.

Flushing and retesting any section or portion of a pipeline shall be performed, if required to resolve questionable results.

The CONTRACTOR shall provide water for all flushing and testing of liquid conveying pipelines.

Based on ASTM F2164, the contractor shall slowly fill and then thermally stabilize the pipeline with no air entrapment. The pipe section being tested shall then be pressurized to 110 psi adding water as needed to maintain the pipeline at test pressure for 4-hours. The contractor shall then slightly reduce the pressure to 100 psi, and then observe the pressure for one hour to remain essentially constant (within 5% variation) to achieve an acceptable test. The Plastic Pipe Institute's Handbook of Polyethylene Pipe further describes general hydrostatic testing, based on ASTM F2164.

3.14 CLEANING AND FLUSHING

Upon completion of construction, testing and approval of the installation, all dirt and other foreign materials shall be removed from pipelines and their appurtenances, and all pipelines shall be cleaned, flushed and temporarily plugged until the system is to be placed into operation.

3.15 APPROVALS

The Contractor shall furnish shop drawings, catalogs, specification sheets and other manufacturer's literature for all equipment and materials he proposes to furnish. Such items should not be ordered until the Engineer's approval of the material submitted is obtained.

In addition, the Contractor shall submit to the Engineer, copies of purchase orders, delivery tickets and/or invoices for all materials delivered and installed.

END OF SECTION

ITEM NO. 05500

–MISCELLANEOUS METAL WORK

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. The CONTRACTOR shall provide all labor, materials and equipment required to furnish, fabricate, deliver and erect miscellaneous metal work.

B. The extent of the miscellaneous metal work is shown.

C. Types of products required but not limited to include the following:

1. Ladders.

2. Ladder safety cages.

3. Bollards

4 Steel pipe sleeves.

5 Shelf angles.

6 Extruded aluminum stair nosings.

7 Hatch covers, miscellaneous structural shapes.

8. Items to be embedded in concrete or masonry shall be furnished under this section but installed under Section 03300 CAST-IN-PLACE CONCRETE or Section 04200 UNIT MASONRY.

1.02 RELATED SECTIONS

Contractor shall be responsible for coordination of all equipment, work, etc. specified within this section to all related sections within the contract documents.

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Codes: Comply with applicable requirements of applicable codes.

B. Reference Standards: Comply with applicable provisions and recommendations of the following except as otherwise shown or specified.

1. ASTM A 36, Structural Steel.

2. ASTM A 123, Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strip.

3. ASTM A 153, Zinc Coating (Hot-Dip) on Iron and Steel Hardware

4. ASTM A 240, Heat Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Fusion-Welded Unfired Pressure Vessels.

5. ASTM A 276, Standard Specification for Stainless Steel Bars and Shapes.

6. ASTM A 386, Zinc Coating (Hot-Dip) on Assembled Steel Products.

7. ASTM A 992, Standard Specification for Structural Steel Shapes.

8. ASTM B 211, Aluminum-Alloy Bars, Rods and Wire.

9. ASTM B 221, Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes and Tubes.

10. ASTM F 593, Standard Specification for Stainless Steel Bolts; Hex Cap Screws, and Studs.

11. ASTM F 594, Standard Specification for Stainless Steel Nuts.

12. ASTM F 1554, Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.

13. ANSI A14.3, Safety Requirements for Fixed Ladders.

14. AWS D1.1, Structural Welding Code.

15. AISI Standards for Stainless Steel.

1.04 SUBMITTALS

A. Show drawings, brochures, and samples shall be submitted for all items to be furnished in accordance with the provisions of Section 01340 SUBMITTALS, shall include at least the following:

1. Fabricator’s quality control procedures.

2. Copies of welding certificates for welding procedures and personnel.

3. Shop Drawings showing materials, sizes, finishes, locations, attached hardware and fittings, and details for manufactured items and fabricated metalwork, including grating span charts, field erection details showing cuts, copes, connections, holes, thread fasteners and welds. Indicate welds, both shop and field, by symbols conforming to AWS standards. Indicate coatings or other protection against corrosion.

4. Sample of the proposed stair nosing indicating finish.

5. Setting diagrams, erection plans, templates and directions for installation of backing plates and anchors.

6. Certificate of conformance stating that all materials, finishes and load requirements conform to Contract Specifications and Drawings.

1.05 QUALITY ASSURANCE

A. Welding of steel shall be in accordance with the Structural Welding code, current edition, as formulated by the American Welding Society and Section 15018 WELDING.

PART 2 - PRODUCTS

2.01 GENERAL PROVISIONS

A. Standard products meeting the requirements of the Specifications may be accepted as the equivalent of those specified, if approved by the OWNER and in accordance with Article 6 of the General Conditions.

B. Gauges for iron sheets and steel are U.S. Standard; for non-ferrous products are Brown & Sharpe; and for wire is Unites States Steel Wire.

C. Steel W-shapes shall conform to ASTM A992 (50 ksi, yield strength). Structural steel for S, M, and HP Shapes and channels shall conform to ASTM A 572, Grade 50, unless otherwise indicated. Other steel shapes, and plates and bars shall conform to the requirements of ASTM A36.

D. Steel pipe columns shall conform to ASTM A53, Grade B.

E. Structural tubing columns shall conform to ASTM A500, Grade B.

F. Cast iron shall conform to ASTM A48.

G. Aluminum items shall be fabricated from bars, plates, pipes, rolled and extruded shapes conforming to the following alloy designation unless otherwise indicated or specified.

1. Standard structural shapes shall be rolled 6061-T6 conforming to ASTM B308.

2. Rolled rod and bar shall be 6061-T6 conforming to ASTM B211.

3. Sheets, plates, checkered plates, etc., shall be 6061-T6 conforming to ASTM B209.

4. Bolts shall be 2024-T4; nuts shall be 6061-T6; and washers shall be Alclad 2024-T4.

H. Stainless Steel items shall be Type 316 unless otherwise specified herein and/or as shown on the Contract Drawings. Stainless steel bolts and nuts shall meet the requirements of ASTM F 593 and ASTM F 594 for Type 316, condition CW.

2.02 STAIR NOSINGS

A. Shall be a 4-inch width abrasive aluminum for use on all concrete stairs except inside and outside stairs in the Sodium Hypochlorite Facility, which shall be bronze. Nosings shall stop 6 inches from each end of tread and be anchored with wing type anchors in accordance with manufacturer's recommendations. Stair nosings shall be installed under Section 03300 CAST-IN-PLACE CONCRETE.

B. Product and Manufacturer: Provide one of the following:

1. Style 801 with cross hatched surface as manufactured by American Safety Tread Company.

2. Type 101 Alumogrit as manufactured by Wooster Products, Incorporated.

3. Type AX as manufactured by Safe-T-Metal.

2.03 ALUMINUM LADDERS

A. Shall be formed of alloy 6061-T6 1½-inches diameter pipe side rails and alloy 6063-T5 aluminum 1-inch square corrugated or other approved skid-proof rungs. Rails shall be bracketed to the wall at not over four feet centers so that center of the rung is 7 inches from the face of the wall. Ladders shall be provided where shown on the Contract Drawings. All ladders shall be equipped with cable fall prevention devices, including cable, harness, brackets, guide sand sleeves. Ladder, Safety Cages and cable fall prevention devices shall conform to all requirements of ANSI A14.3 and OSHA regulations.

2.04 LADDER SAFETY POST

A. Provide a ladder safety post at all ladders accessed by hatches and at other locations shown on the Contract Drawings. The ladder safety post shall be pre-assembled from the manufacturer.

B. Performance characteristics:

1. Tubular post shall lock automatically when fully extended.

2. Safety post shall have controlled upward and downward movement.

3. Release lever shall disengage the post to allow it to be returned to its lowered position.

4. Post shall have adjustable mounting brackets to fit ladder rung spacing up to 14” on center and clamp brackets to accommodate ladder rungs up to 1-3/4” in diameter.

C. Post: Shall be manufactured of high strength square tubing. A pull up loop shall be provided at the upper end of the post to facilitate raising the post.

D. Material of construction: Aluminum.

E. Balancing spring: A stainless steel spring balancing mechanism shall be provided to provide smooth, easy, controlled operation when raising and lowering the safety post.

F. Hardware: All mounting hardware shall be Type 316 stainless steel.

G. Finishes: Factory finish shall be mill finish aluminum.

2.05 HATCH COVERS

A. Shall be of the styles, types and sizes indicated on the Contract Drawings. All hatch covers shall be of the same manufacturer. Manufacturer shall guarantee proper operations against defects in material or workmanship for a period of 5 years.

B. Manufacturer:

1. Bilco Company.

2. Babcock-Davis Associates, Incorporated.

3. Halliday Products Company.

C. Single leaf and double leaf, respectively, watertight, self-draining type. Door leaf shall be of 1/4-inch thick aluminum diamond pattern plates reinforced with aluminum stiffeners as required and capable of withstanding a live load of 300 pounds per square foot. Channel frame shall be a 1/4-inch thick aluminum with anchor flange around the perimeter. Each door leaf shall be equipped with a minimum of two hinges, with stainless steel pins, compression spring operators enclosed in telescopic tubes to afford easy operation, and an automatic hold-open arm with release handle. A snap lock with removable handle and safety chains shall be provided on each hatch. A 1½-inch drainage coupling shall be located in the front right corner of the channel frame. Hardware shall be stainless steel and factory finish shall be mill finish with bituminous coating applied to exterior of frame.

D. Buried and underground vault access doors shall be designed to withstand an AASHTO H-20 wheel load with a maximum deflection of $1/150^{th}$ of the span. Provide H-20 access doors where shown and in sizes as shown on the Drawings. Material of construction, accessories and appurtenances shall be in accordance with 2.05.C.

E. Hatches not shown connected to a drainage system shall be provided with extensions to the drainage coupling to allow drainage to the area below.

F. Hatch covers shall be installed in accordance with the recommendations of the manufacturer and as approved by the OWNER.

2.06 METAL STAIRS: Refer to Section 05510 ALUMINUM STAIRS.

2.07 MISCELLANEOUS STRUCTURAL STEEL ITEMS

A. All miscellaneous structural steel items, galvanized angles, relieving angles, plates, channels, headed concrete anchors, and all required fastenings shown on the Contract Drawings shall be fabricated as detailed and furnished under this section. They shall be installed under the applicable section of the Specifications. Miscellaneous items shall be galvanized as indicated and as specified herein.

B. Steel frames for miscellaneous openings shall be fabricated from structural shapes and plates of the sizes indicated. Frames shall be accurately squared, mitered, butted, or coped as necessary and shall be fully welded, welded flush and ground smooth. Stops, where required, shall be plug-welded and ground smooth. Joints exposed to weather shall be seal welded.

C. Bollards:

1. Provide 6-inch diameter, double extra strength, galvanized steel pipe, 4-foot 0-inches above grade, with conical top. Fabricate recessed base and surface mounted bollards as shown on plans.

D. Anchor bolts shall be of the sizes indicated, threaded, headed and made of ASTM F1554, Grade 36 steel and galvanized except where stainless steel is noted. Plates shall be furnished as indicated. Stainless steel bolts shall be used in attaching aluminum to masonry and shall include stainless steel nuts and washers. In general, anchor bolts to be supplied under this section will only be for the other items supplied under this section which requires them.

E. Aluminum gratings and frames shall be of the types and sizes shown on the Contract Drawings.

F. Weirs and Baffles shall be fiberglass and/or aluminum construction (including plates, angles, straps, bracing, channels) and shall be fabricated and installed in accordance with the details shown and approved by the OWNER. Stainless steel bolts, nuts, and washers shall be provided, where shown. Aluminum weirs and baffles shall be aluminum alloy 6061-T6. Welding shall be in accordance with the requirements as specified herein.

G. Loose Stainless Steel Lintels: Provide loose structural lintels of Type 304 stainless steel for openings and recesses in masonry walls and partitions as shown. Where not shown provide loose stainless steel lintels as specified. Continuously weld adjoining members together to form a single unit. Grind welds smooth and finish all faces, where exposed in the finished Work with a 180-grit mechanical finish. Provide not less than 8 inches continuous bearing at each side of openings, unless otherwise specified. Unless otherwise shown size loose lintels as follows: 5-inches x 5-inches x 3/8-inches.

H Shelf Angles:

1. Provide stainless steel 5-inches x 5-inches x 3/8-inches shelf angles for attachment to concrete construction. Provide vertical slotted holes to receive 3/4-inch diameter bolts, spaced not more than 6-inches from ends and not more than 24-inches on centers, unless otherwise shown.

2. Provide stainless steel 5-inches x 5-inches x 3/8-inches shelf angles for attachment to masonry construction. Provide holes to receive 5/8-inch diameter adhesive anchors, spaced not more than 6-inches from ends and not more than 24-inches on centers, unless otherwise shown.

3. Furnish wedge-type concrete inserts, complete with fasteners, as specified in Section 03252 ANCHORAGE IN CONCRETE for attachment of shelf angles to cast-in-place concrete.

4. Furnish 5/8-inch diameter stainless steel adhesive anchors with 5-inch minimum embedment as specified in Section 03252 ANCHORAGE IN CONCRETE for attachment of shelf angles to masonry construction. Drill holes in grouted cores only.

I. Large Diameter Pipe Sleeves:

1. Provide 3/16-inch thick stainless steel escutcheon plate and sleeve as shown. Provide holes to receive 3/8-inch diameter adhesive bolts, spaced as shown.

J. Aluminum wide flange beams, aluminum angles, plates, tubes, channels and bars shall be of the sizes shown and shall be aluminum alloy 6061-T6. Furnish and install aluminum beams, angles, plates, tubes, and channels at locations indicated and in accordance with the details shown. Provide stainless steel expansion bolts as shown.

2.08 SHOP COATINGS

A. Interior Service. All ferrous metal items which will be in interior service shall be cleaned in accordance with SSPC Specification SP-6 for commercial blast cleaning and shall be prime painted compatible with the finish paints as specified in Section 09900 PAINTING, for interior service. Stainless steel shall not be painted.

B. Immersion Service. All ferrous metal items which will be in submerged service shall be cleaned in accordance with SSPC Specification SP-10 for near white blast cleaning and shall be prime painted compatible with the finish paints as specified in Section 09900 PAINTING, for immersion service.

C. Dissimilar Material:

1. Where aluminum surfaces come in contact with metals other than stainless steel or metals not compatible with aluminum, aluminum surfaces shall be kept from direct contact with such parts by painting the dissimilar metal with a coating of zinc chromate paint or use a good grade caulking or non-absorptive tape between dissimilar metals.

2. Similarly, when aluminum comes in contact with concrete, or masonry byproducts of these materials, the aluminum shall be given a coat of bituminous paint. Steel to be welded or encased in concrete shall not be painted.

D. Galvanizing. All items specified as galvanized shall be coated by the hot-dip process in accordance with ASTM A123, ASTM A153, ASTM A386, and ASTM A525 as applicable in molten zinc, producing a continuous coating of uniform thickness of weight required by the referenced Specifications.

1. Coating shall be of best commercial quality, free from injurious defects, flux and uncoated spots, and of such quality as will endure without penetration of the coating not less than four immersions in copper sulfate, conforming to ASTM A239.

2. A stamp showing galvanizer's name, the weight of the coating and ASTM Specification compliance shall identify galvanized items.

PART 3 - EXECUTION

3.01 WORKMANSHIP

A. Materials and workmanship shall be subject to the approval of the OWNER. Built-up work shall be assembled in sections in the shop so far as practicable, accurately finished and the separate sections marked for field erection.

B. Where necessary, pertinent measurements shall be made before fabrication of the items so that work herein included shall properly fit the construction.

3.02 INSTALLATION

A. Work shall be installed at the proper time and as rapidly as the condition of the supporting work will allow. Sections shall be installed in the most substantial manner, reinforced with steel shapes where necessary, using bolts, screws, or other necessary fastenings. All bolts projecting beyond the nuts, in exposed work shall be cut off close to the nuts and ground smooth.

B. All cutting, fitting, drilling and tapping required to install the work and to make proper connections with adjoining supporting work, and all anchors, sockets, pipe sleeves, and fastening devices required for the proper and secure installation of the work shall be included.

END OF SECTION

ITEM NO. 09900 – PAINTING

PART 1 GENERAL

1.01 Work Included

The Contractor shall provide all labor, materials and equipment necessary to prepare and paint all surfaces. The work shall include, but not be limited to, painting of all new and existing building construction, piping, equipment and appurtenances as shown on the Plans or as specified herein.

Surface preparation and shop painting of the structural steel, miscellaneous metal items, wood, concrete, masonry and other miscellaneous materials are included under this Section. Wherever possible, all shop and field coatings shall be made with paints of the same manufacturer. Where this is not possible, the manufacturer, paint material and mil thickness of shop prime coatings used shall be submitted to the Engineer for approval. All shop prime coatings shall be made with paints equivalent to those specified herein. In instances where another paint manufacturer's prime coat is used, modifications to these specifications concerning preparation and painting may be necessary at no additional cost to the Owner.

It is the intent of this Specification to provide a completely painted or coated system for the items mentioned, but the absence of any item or coating from the said schedules shall not relieve the Contractor from painting such item completely as if it had been mentioned.

1.02 Work Not Included

The following items are not required to be painted, except as noted in this Specification or on the Contract Drawings: concealed copper and brass piping; concealed galvanized surfaces; acoustic tile ceilings; non-slip stair nosing; aluminum work, including trench, stair and platform gratings, railings, louvers, and windows; curtain wall members; stainless steel and reinforced plastic; and items furnished with a factory finish equivalent to those specified herein.

1.03 Inspections and Certifications

At the time the Contractor furnishes the name of the paint manufacturer to the Engineer for approval, he shall also submit the manufacturer's detailed program of technical and inspection services incorporating the requirements specified herein.

1.03 Inspections and Certifications

There shall be two (2) inspections held at the job site. The Contractor shall be responsible for arranging all of these, and shall notify in advance of each meeting/inspection, his painting subcontractor or painting foreman, the manufacturer's expert technical representative, and the Engineer, each of whom shall be present at each meeting/inspection.

At the first inspection, all conditions pertinent to surface preparation and painting shall be discussed with the Contractor. At this time an inspection of all surfaces to be painted shall be made and recommendations concerning preparation and painting shall be made by the manufacturer's representative.

The final inspection shall be held at the completion of all of the painting work. This inspection shall incorporate the checking and inspection of all coated surfaces. The Contractor shall correct all deficiencies found at this time in accordance with the paint manufacturer's recommendations and the Specifications in this section all work to meet the Engineer's approval.

At the conclusion of all the painting work as approved by the Engineer, the Contractor shall furnish a written manufacturer's certificate stating that the materials applied were found to meet the dry mil thicknesses and other requirements of this Specification.

PART 2 MATERIALS

2.01 General

All paint and accompanying materials shall be delivered in original unopened containers bearing the manufacturer's label and all special markings and directions thereon. All paint and accompanying materials shall be used strictly in accordance with the manufacturer's recommendations, except as directed and approved in writing by the Owner or his representative. The paints and paint shall be products of MAB Paints, Pennsylvania, Sherwin Williams Co., Cleveland, OH, or approved equal.

2.02 Painting Schedule

The schedule which follows includes the various items and surfaces required to be painted, the associated Finish Numbers, the types of painting materials to be used for prime, intermediate and finish coats and minimum dry film mil thickness required per coat. In general, the first material mentioned in any given painting system is a prime coat, which for prefabricated and shop-fabricated items should be applied at the shop. The remaining materials are normally field applied finish coats.

The intent of the Schedule is to provide a completely painted or coated system for all of the work as shown on the Drawings and specified herein, but the absence of any item or surface from the Schedule shall not relieve the Contractor from the responsibility for preparing and painting such item or surface as if it had been so included in the Schedule.

The Painting Schedule is divided into three sub-schedules: Painting for Building Construction; Painting for Equipment and Piping; and Painting of Process Tanks, Manholes, Chambers, etc. The Painting Schedule is a general or standard schedule and all items presented may not be applicable.

PAINTING SCHEDULE

PAINTING FOR BUILDING CONSTRUCTION

SURFACE OR ITEM	MATERIALS	MIN. DRY FILM THICKNESS IN MILS PER COAT
Exterior Exposed Concrete, Precast Concrete, Concrete Block and Brick	1 Coat Siloxane 20	90-145 SF/Gal/Coat
Exterior Exposed Non-Submerged Ferrous Metals, Metal Doors and Frames	1 Coat Rust-O-Lastic Primer 073-444 1 Coat Rust-O-Lastic Primer 073-217 1 Coat Rust-O-Lastic Silicone Alkyd 069	2.0 1.5 2.0
Exterior Exposed Wood	1 Coat Sea-Shore Latex Primer 056-958 2 Coats Sea Shore Latex Trim 024	1.5 1.5
Exterior and Interior Redwood Plywood	1 Coat Walman's F+P Natural	As recommended by manufacturer
Interior Exposed Concrete, Precast Concrete	2 Coats Ply-Mastic 650 Epoxy 065	3.0
Interior Exposed Concrete Block	1 Coat 2000 Block Kote 064-140 2 Coats Ply-Mastic 650 Epoxy 065	50-75 SF/Gal./Coat 3.0
Interior Exposed Cinder Block	1 Coat 2000 Block Kote 064-140 2 Coats Ply-Mastic 650 Epoxy 065	50-75 SF/Gal./Coat 3.0
Concrete Floors	2 Coats Ply-Mastic 650 Epoxy 065 Incorporate any Anti-skid product in First Coat where non-slip qualities are required at the rate of pound per gallon.	4.0
Interior Exposed Plaster or Gypsum Wallboard	1 Coat Rich Lux Latex Undercoater 037-154 2 Coats Rich Lux Wal Shield 041	1.5 1.25
Exposed Interior Structural Steel,	1 Coat Anti-Corrosive Primer 073-444 1 Coat Anti-Corrosive Primer 073-217	2.0 2.0

Misc. Ferrous Metals	1 Coat Rust-O-Lastic Alkyd 074	1.5
Interior Exposed	1 Coat Rich Lux Latex Undercoater 037-154	1.5
Lumber and Millwork,	2 Coats Rich Lux Semi-Gloss Latex	1.25
Wood Doors	Enamel 023	
Interior Metal	1 Coat Rich Lux Latex Undercoater 037-154	1.5
Doors and Frames	2 Coats Rich Lux Semi-Gloss Latex	1.25
	Enamel 023	
Exposed Interior	1 Coat Anti-Corrosive Primer 073-444	2.0
Miscellaneous	1 Coat Anti-Corrosive Primer 073-217	2.0
Sheet Metal	1 Coat Rust-O-Lastic Alkyd 074 to match	1.5
	adjacent wall surface	
Aluminum Embedded in	1 Coat Ply-Mastic 650 Epoxy 065	2.0 – 3.0
Concrete or Masonry	2 Coats Targuard	8.0

PROCESS TANKS, MANHOLES, CHAMBERS

STEEL TANKS, CHAMBERS		
OR PUMP STATIONS		
	1 Coat Ply-Tile Zinc One 073280/073294	2.0 – 4.0
Exterior Below Grade	1 Coat Ponamid Epoxy Sand 65	5.0 - 6.0
	1 Coat Ponamid Epoxy White 54	5.0 - 6.0
	1 Coat Ply-Tile Zinc One 073280/073294	2.0 – 4.0
Interior Submerged	1 Coat Ponamid Epoxy Sand 65	5.0 - 6.0
	1 Coat Ponamid Epoxy White 65	5.0 - 6.0
	1 Coat Ply-Tile Zinc One 073280/073294	2.0 – 4.0
Interior Non-Submerged	1 Coat Ponamid Epoxy Sand 65	5.0 - 6.0
	1 Coat Ponamid Epoxy White 65	5.0 - 6.0
	Or	
	1 Coat Ply-Tile Zinc One 073280/073294	2.0 – 4.0
	2 Coats Ply-Mastic 650 Epoxy 065	4.0 - 6.0
Exterior Above Grade	2 Coats Ply-Mastic 650 Epoxy 065	4.0 - 6.0

CONCRETE WATER, OR WASTE-
WATER PROCESS TANKS,
PRECAST/POURED/BLOCK
MANHOLES, CHAMBERS, OR

WET WELLS

Exterior Below Grade	1 Coat Ponamid Epoxy Sand 65	5.0 - 6.0
	1 Coat Ponamid Epoxy White 65	5.0 - 6.0
	(or)	
	2 Coats Targuard	8.0
Exterior Above Grade	2 Coats Ply-Mastic 650 Epoxy 065	4.0 - 6.0
	(or)	
	1 Coat Ponamid Epoxy Sand 65	5.0 - 6.0
	1 Coat Ponamid Epoxy White 65	5.0 - 6.0
Interior (Submerged)	2 Coats Targuard	8.0
	(or)	
	1 Coat Ponamid Epoxy Sand 65	5.0 - 6.0
	1 Coat Ponamid Epoxy White 65	5.0 - 6.0
Interior Non-Submerged	1 Coat Ponamid Epoxy Sand 65	5.0 - 6.0
	1 Coat Ponamid Epoxy White 65	5.0 - 6.0

PAINTING FOR EQUIPMENT AND PIPING

Exposed Metallic Pipe, Pipe Hanger and Supports	1 Coat Anti-Corrosive Primer 073-444	2.0
	1 Coat Anti-Corrosive Primer 073-217	2.0
	1 Coat Rust-O-Lastic Silicone Alkyd 069	2.0
Exposed Valves and Special Fittings	1 Coat Anti-Corrosive Primer 073-444	2.0
	1 Coat Anti-Corrosive Primer 073-217	2.0
	1 Coat Rust-O-Lastic Silicone Alkyd 069	2.0
Exposed Plastic Pipe, Valves, and Special Fittings	1 Coat Ply-Mastic 650 Epoxy 065	3.0
	1 Coat Rust-O-Lastic Universal Lacquer Resistant Primer 073-424	1.5
	Rust-O-Lastic Alkyd 074 (Number of Coats as required for coverage)	
Top of Valves Boxes	1 Coat Anti-Corrosive Primer 073-444	2.0
	1 Coat Anti-Corrosive Primer 073-217	2.0
	1 Coat Rust-O-Lastic Silicone Alkyd 069	2.0
Exposed Pipe Insulation	1 Coat Rust-O-Lastic Hydro-Prime 073-189	1.5
	2 Coats Rust-O-Lastic Alkyd 074	1.5

Aluminum Control/ Highway Box	1 Coat Ply-Mastic 650 Epoxy 065	3.0
	2 Coats Rust-O-Lastic Silicone Alkyd 069	2.0
Valve and Gate Stands	1 Coat Anti-Corrosive Primer 073-444	2.0
	1 Coat Anti-Corrosive Primer 073-217	2.0
	1 Coat Rust-O-Lastic Silicone Alkyd 069	2.0
Pumps, Motors, Engines, Generators and Maintenance Elevator (Manlift)	1 Coat Anti-Corrosive Primer 073-444	2.0
	2 Coats Anti-Corrosive Primer 073-217	2.0
	1 Coat Rust-O-Lastic Silicone Alkyd 069	2.0
Meters and Strainers	1 Coat Anti-Corrosive Primer 073-444	2.0
	1 Coat Anti-Corrosive Primer 073-217	2.0
	1 Coat Rust-O-Lastic Silicone Alkyd 069	2.0
Aluminum, Galvanized Metal w/o Clear Coat and Other Non-ferrous Metals	1 Coat Rust-O-Lastic Hydro Prime II 073-189	1.0 - 1.5
Interior	2 Coats Rust-O-Lastic Alkyd 074	1.5
Exterior	2 Coats Rust-O-Lastic Silicone Alkyd 069	2.0
Pipes (Metallic)	1 Coat Anti-Corrosive Primer 073-444	2.0
(Above Water)	1 Coat Anti-Corrosive Primer 073-217	2.0
	1 Coat Rust-O-Lastic Silicone Alkyd 069	2.0
(Below Water)	2 Coats Epoxy Tar Coating 796-998/999	8.0
Pipes (Metallic with Bitumastic Coating)	1 Coat Rust-O-Lastic Hydro Prime II 073-189	1.0 - 1.5
(Above Water)	2 Coats Rust-O-Lastic Silicone Alkyd 069	2.0
(Below Water)	2 Coats Targuard	8.0
	(or)	
	1 Coat Ponamid Epoxy Sand 65	5.0 - 6.0
	1 Coat Ponamid Epoxy White 65	5.0 - 6.0
Hydrants	1 Cost Anti-Corrosive Primer 073-444	2.0
	1 Coat Anti-Corrosive Primer 073-217	2.0
	1 Coat Rust-O-Lastic Silicone Alkyd 069	2.0

Hoists (Steel)	1 Coat Anti-Corrosive Primer 073-444	2.0
	1 Coat Anti-Corrosive Primer 073-217	2.0
	1 Coat Rust-O-Lastic Silicone Alkyd 069	2.0
Electric Switchgear, Control Centers, etc., not provided with a factory finish	1 Coat Anti-Corrosive Primer 073-444	2.0
	1 Coat Anti-Corrosive Primer 073-217	2.0
	1 Coat Rust-O-Lastic Silicone Alkyd 069	2.0
Heating and Ventilating Equipment (Pre-treat Surface as Required)	1 Coat Anti-Corrosive Primer 073-444	2.0
	1 Coat Anti-Corrosive Primer 073-217	2.0
	1 Coat Rust-O-Lastic Silicone Alkyd 069	2.0
Submerged Ferrous Metal	2 Coats Targuard	8.0
	(or)	
	1 Coat Ponamid Epoxy Sand 65	5.0
	1 Coat Ponamid Epoxy White 65	5.0
Non-Submerged Ferrous Metal Subject to Moisture and Condensation - Especially on below-grade surfaces which will be constantly wet.	2 Coats Targuard	8.0
	(or)	
	1 Coat Ponamid Epoxy Sand 65	5.0 – 6.0
	1 Coat Ponamid Epoxy White 65	5.0 – 6.0
Ferrous Metal Surfaces in vicinity of, or adjacent to chlorine delivery, storage and evaporation facilities, manhole, drain inlet castings.	1 Coat Ponamid Epoxy Sand 65	5.0 - 6.0
	1 Coat Ponamid Epoxy White 65	5.0 – 6.0

NOTE: In general, and only with approval of the Engineer, ferrous metal surfaces shop primed by another manufacturer with an equivalent coating shall receive one (1) coat of Rust-O-Lastic Universal Lacquer resistant Primer 073-424, 2.0 mils thick.

The shop primer coating and Rust-O-Lastic Universal Lacquer resistant Primer 073-424, shall replace the specified one (1) coat of Anti-Corrosive Primer 073-444, 2.0 mils thick and one (1) coat Anti-Corrosive Primer 073-217 2.0 mils thick. Rust-O-Lastic Universal Lacquer resistant Primer 073-424 shall be followed by the appropriate finish coats as specified herein. The applicator shall apply sufficient finish coatings to achieve the required protective and decorative finish.

When priming blasted steel use Rust-O-Lastic Universal Lacquer resistant Primer 073-424 in lieu of Anti-Corrosive Primer 073-444.

PART 3 GENERAL

3.01 Workmanship, Safety and Clean-up

All work shall be done in a workmanlike manner so that the finished surfaces will be free from runs, drops, ridges, waves, laps, and unnecessary brush marks. All coats shall be applied in such a manner as to produce an even film of uniform thickness completely coating all corners and crevices. All painting shall be done by thoroughly experienced workmen. Succeeding coats of the same type and/or color of paint shall vary sufficiently from the color of the preceding coat to permit ready identification. Primers and intermediate coats shall be retouched before applying the succeeding coat.

The application of paint or surface drainage coating to any surface shall signify the acceptance by the Contractor of the surfaces to be finished, and any defects in the finished painting work due to defects in the surface to be painted or finished shall be corrected by the Contractor at no additional expense to the Owner.

The Contractor shall use particular care in preparing and painting those surfaces of metals which are subject to submergence or intermittent submergence, but which are not easily accessible or visible after erection or placement.

Proper safety precautions shall be taken at all times in enclosed areas as well as open areas. Masks for painters may be necessary and forced ventilation inside tanks and enclosed areas must be provided, not only to protect the painters from prolonged breathing of the volatile solvents but also to facilitate the proper setting and hardening of the paint coatings. All safety precautions necessary, including those required by law, shall be included under this Section and are the responsibility of the Contractor.

After the painting work is completed and dry, the Contractor shall go over all doors and sash and loosen any that may have become stuck, leaving same and all other work free from any defects caused by the painting. All paint spots, daubs, etc., shall be removed from glass, hardware, piping equipment, etc., which may have become spotted as a result of the painting work. Upon completion of the painting and finishing work, all surplus materials, empty packages, debris and the like, shall be removed from the building and the premises.

3.02 Rates of Application

On metal surfaces, the painter shall 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. In other words, one gallon of paint as originally furnished by the manufacturer must not cover a greater square foot area when applied by spray gun than when applied unthinned by brush. Deficiences in film thickness and/or the continuity of the coatings shall be corrected by

application of an additional coat(s) of paint.

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.

All thicknesses referred to in the painting schedule are dry mil measurements. Mil thickness shall, in all cases, take precedence over number of coats to obtain proper coverage.

3.03 Painting Restrictions During Bad Weather, Low Temperature and Other Atmospheric Conditions

No paint shall be applied when the surrounding air temperature, as measured in the shade, is below 40°F (50°F for two-component epoxies including coal tar epoxies; for emulsions, follow manufacturer's instructions on containers). Paint shall not be applied in rain, snow, fog or mist, or when the relative humidity exceeds 85%. No paint shall be applied when it is expected that the relative humidity will exceed 85% or that the air temperature will drop below 40°F within 18 hours after the application of the paint. Dew or moisture condensation should be anticipated, and if such conditions are prevalent, painting shall be delayed until midmorning to be certain that the surfaces are dry. Further, the day's painting should be completed well in advance of the probable time of day when condensation will occur, in order to provide an appreciable drying time prior to formation of moisture.

3.04 Drying Times

Drying time shall be construed to mean "under normal conditions." Where conditions are other than normal because of the weather or because painting must be done in confined spaces, longer drying times will be necessary.

Additional coats of paint shall not be applied, nor shall units be handled, moved, or put into service until paints are thoroughly dry.

3.05 Storing and Mixing

All materials used in paint application shall be stored and mixed in a single well-ventilated place and in a manner to prevent spontaneous combustion and contamination by extraneous materials. No plumbing fixture or pipe shall be used for mixing or for disposal of any waste paint, solvents, or other refuse material. Waste rags, etc., shall be removed daily. All materials shall be stored, mixed and used at the temperatures recommended by the paint manufacturer. Paint and solvent containers shall be kept tightly closed when not being actually used and shall remain unopened until required for use. Paint which was livered, gelled, or otherwise deteriorated during storage shall not be used. All containers of paint shall be clearly labeled to show paint identification, date of manufacture, batch number, order number and special instructions, all legible at the time of use.

3.06 Surface Preparation - General

All surfaces to be painted shall be thoroughly cleaned by removing dirt, rust scale, loose rust, loose mill scale, welding alux and slag, oil, tar asphalt, grease, laitance, loose paint and other detrimental matter which may interfere with the proper adhesion of the coating to be applied. All surfaces shall be free from wetness, dampness, frost and ice before any coating is applied. Surfaces shall be thoroughly dry before painting. No painting shall be done until the surface to which paint is applied has been approved by the Engineer.

Hardware, accessories, equipment, piping, machine surfaces, plates, lighting fixtures, and similar items in place prior to cleaning and painting, and not intended to be painted, shall be removed or masked during painting operation and repositioned upon completion of each area or shall otherwise be protected.

Cleaning and painting shall be so programmed that dust and other contaminates from the cleaning process will not fall on wet, newly painted surfaces. The Contractor shall not only protect his work at all times, but shall also protect all adjacent work and materials during the progress of his work. Upon completion of work, he shall clean-up all paint spots, oil and stains from floors, glass, hardware, etc.

3.07 Surface Preparation for Ferrous Metals

A. General

All ferrous metal surfaces shall be thoroughly cleaned of all rust, scale, slag, flux, grease, oil and other foreign substances by the methods described in (B) or (C) below.

The following preparation procedures shall be applied before any painting is done in the shop and in the field, both before and after erection and setting. All sharp corners, weld seams and surface projections that might protrude through the paint film shall be ground smooth or otherwise removed. All re-entrant angles and corners and areas around rivet heads, bolt heads and nuts shall be scraped clean and thoroughly wire-brushed. Welds and weld marks shall be completely cleaned. Surfaces to be finished which are not in perfect condition, cannot be cleaned or smoothed, or which have defects which cannot be removed by sanding or leveling up, shall be otherwise repaired by the Contractor in an approved manner before painting. The intent of this specification is to produce all surfaces completely cleaned and in satisfactory condition to receive the paints to be applied as scheduled.

Cleaned metal shall be prime painted as soon as practicable after cleaning, preferably immediately thereafter. In any case, the prime painting shall take place before any rusting or other deterioration of the surface takes place. Whenever possible, cleaning and priming shall be done in the fabricating shop or place of manufacture, prior to delivery to the job site. Before applying any finish coats, all scars, blemishes, loose paint and damaged areas of previously primed surfaces (whether primed in shop, field or both) shall be cleaned as specified herein and shall be spot primed with the schedule prime coating.
No motors, engines, drives, gears or similar machinery shall be blast cleaned, and all such equipment shall be completely covered and protected before connecting any blast cleaning

procedures in the vicinity of or adjacent to such items.

B. Ferrous Metal Surfaces Subject to Constant or Intermittent Submergence, Spraying or Exposure to Damp, Wet or Corrosive Environments

All ferrous metal surfaces subject to constant or intermittent submergence, spraying, or exposure to damp, wet or corrosive environments shall be blast cleaned in accordance with Steel

Structures Painting council surface preparation specification SSPC-SP10 for Near White Metal Blast Cleaning. After delivery to the job site and field erection, all weld areas, all areas which, in the opinion of the Engineer, have been improperly shop cleaned and all areas which have not been previously blast cleaned or pickled as described above shall be field blast cleaned in accordance with SSPC-SP10, Near White Metal Blast Cleaning.

C. Other Ferrous Metal Surfaces

All other ferrous metal surfaces not falling into the category described in (B) above shall be cleaned in accordance with Steel Structures Painting Council surface preparation Specification SSPC-SP6 for Commercial Blast Cleaning.

3.08 Surface Preparation for Galvanized and Non-Ferrous Metals

All non-ferrous metals, whether to be shop or field primed, shall be cleaned with an approved solvent prior to the application of the pretreatment and/or primer. In addition, galvanized surfaces which are to receive Black Mastic as the finish coats shall be sandblasted to provide a profile or "tooth".

3.09 Surface Preparation for Concrete

All concrete surfaces, before application of any paints, shall be thoroughly cleaned by approved methods of all laitance, dust, form oil, curing compounds and other foreign matter.

The following procedures shall be followed in cleaning and preparing concrete floors which will be painted:

1. Thoroughly wet surface with a 15% solution of muriatic acid.

2. After all bubbling stops, scrub all surfaces, then thoroughly flush and rinse with clean water to remove all of the salts and acid residue. No acid shall be allowed to dry on surfaces. After rinsing, allow to dry thoroughly.

If, in the opinion of the Engineer, the above etching does not provide a roughened and clean surface satisfactory for receiving and bonding the coating, the etching procedures (steps 1 and 2, above) shall be repeated.

No concrete shall be painted until at least 60 - 90 days after form removal, or if no forms are used, for at least 60 - 90 days after placement.

3.10 Surface Preparation for Wood

Wood surfaces shall be thoroughly cleaned and free of all foreign matter with cracks and nail holes and other defects properly filled and smoothed. Wood trim shall be sandpapered to a fine finish and wiped clean of dust.

Before priming, two (2) thin coats of orange shellac shall be applied on all knots, pitch and sapwood. After the priming coats on woodwork has dried, all nail holes, cracks, open joints and other small holes shall be filled neatly with approved putty.

All lumber that could be subject to dry rot, such as roof, curbs, or lumber built into masonry or concrete work shall be pressure treated with preservative material. Treatment shall consist of "Penta", having a 6.0 pounds per cubic foot minimum net retention, or "Wolmanizing", having a 0.3 pounds per cubic foot minimum net retention or the preservative material.

Heavy timber for underwater or permanent subsurface use shall be creosoted.

3.11 Protection

All finished work and equipment, machinery and apparatus shall be properly protected from damage or defacement, and all damage or defacement thereto shall be made good by the Contractor in an approved manner, at no additional expense to the Owner. Floors, equipment, machinery, apparatus and similar items shall be covered with heavy building paper or cloth properly secured in place. The various rooms and spaces of the building where painting and finishing is going on shall be protected against dust, as far as practicable, until the freshly painted surfaces have thoroughly dried. At the time of acceptance of the buildings and facilities the painting and finishing work must be in a neat and undamaged condition.

COVERAGE AND DRYING TIMES CHART

The estimated coverages shown are in square feet per gallon per coat, and based on the minimum dry film thickness required per coat; allow for normal waste factors. Information on this chart applies only to the products designated. Drying times, in general, refer only to drying times between coats. See manufacturer's complete directions for other drying times and curing conditions.

PRODUCT	COVERAGE	MIN. DRY FILM THICKNESS IN MILS PER COAT	HOURS DRYING TIME BETWEEN COATS
2000 Block Kote 064-140	50-75	---	8
Rust-O-Lastic Alkyd 074	546	1.5	18-24
Rich Lux Latex Undercoater 037-154	426	1.5	4-6
Ply-Mastic 650 Epoxy 065	346	3.0	4
Epoxy Targuard	145	8.0	8
Siloxane 20	90-145	---	4
Rust-O-Lastic Primer 073-217	300-350	2.0	18-24
Rich Lux Semi-Gloss Latex 023	266	1.5	4-6
Anti-Corrosive Primer 073/444	350-400	2.0	18-24
Rust-O-Lastic Silicone Alkyd 069	385	2.0	18-24
Sea Shore Latex Trim 024	440	1.5	6
Rich Lux Wal Shield 041	400	1.5	4-6

NOTE: Follow manufacturers label instructions exactly for re-coating, drying, curing and surface preparation.

Colors

Paint colors shall be as selected by the Owner and/or Engineer and will not necessarily conform to the standard color of any manufacturer.

END OF SECTION

ITEM NO. 15162 - WET PIT SUBMERSIBLE PUMPS FOR WASTEWATER

PART 1. GENERAL

1.01 This specification shall govern for all work necessary for furnishing, installing and placing into initial operation the submersible pumps, accessories, and control panel for the Lift Station.

1.02 GENERAL DESCRIPTION

The 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.

1.03 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 10 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 be available within 160 miles of the project site for immediate repairs should repairs become necessary. Unless it can be demonstrated that parts and service have been available at a service center within 160 miles of the project site through the same financially sound firm on a continuing basis for at least 10 years, the spare parts listed in these specifications must be furnished with the pumps at no additional cost to the City.

1.04 PERFORMANCE (Operating Conditions)

A.	One pump running duty point	736 gpm @ 61.4’ tdh
B.	Two pumps running duty point (Total Flow)	1,010 gpm @ 80.3’ tdh

D.	Min. Shutoff Head	125.0 Ft.
E.	Min. Hydraulic Efficiency	
	1. One pump running duty point	60.7 %
	2. Two pumps running duty point	70.4 %
F.	Max. Active Motor Input Power	
	1. Design duty point	15.8 Kw
	2. Two pumps running duty point	14.7 Kw
G.	Max. Total Motor Input Power	
	1. One pump running duty point	20.0 HP
	2. Two pumps running duty point	20.0 HP
H.	Max pump speed	1755 rpm
I.	Max NPSHR	
	1. One pump running duty point	13.61 Feet
	2. Two pumps running duty point	20.0 Feet
J.	Min. motor rating @ 40 degrees C	20.0 HP
K.	Voltage/Cycle/Phase	460/60/3
L.	Motor design Type	NEMA B
M.	Motor Service Factor	1.15
N.	Motor Insulation	Class H
O.	Max. Motor pole number	4 Pole
P.	Max. Rated current (FLA)	26 Amps
Q.	Min. Rated power factor	83%
R.	Max. Locked rotor current	148 Amps
S.	Max. NEC Code Letter	G
T.	Min. Pump discharge size	4 Inches

1.05 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 shipment from the factory or other manufacturer approved point in time but no later than startup and beneficial use of pumping system.
   a. 0 – 24 months warranty is 100%.
   b. 25 – 39 months warranty is 50%
   c. 40 – 60 months warranty is 25%

PART 2. PRODUCTS

2.01 PUMPS

A. Manufacturers

1. Pumps shall be the product of Xylem Flygt Products
2. Engineer pre-approved pump manufacturer.

B. Design

1. General
   a. Major pump components shall be of gray cast iron, Class 35, with smooth surfaces devoid of blowholes and other irregularities.
   b. Exposed nuts and bolts shall be AISI type 304 stainless steel or brass construction.
   c. All surfaces, other than stainless steel, shall be factory sprayed with alkyd primer and synthetic resin enamel rubber paint finish.
   d. All mating surfaces where watertight sealing is required shall be machined and fitted with Nitrile or Viton rubber o-rings.
   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 gray cast iron, Class 35B, 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 have induction hardened, screw shaped leading edges and shall be capable of handling solids, fiberous 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. Impellers shall be trimmed to specifically meet the conditions of operation.
3. Insert Ring
   a. A hardened, replaceable insert ring 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.
4. Volute
   a. Pump volutes shall be single piece gray cast iron, Class 35B, non concentric design with smooth passages large enough to pass any solids that may enter the impeller. Minimum inlet and discharge size shall be as indicated herein.
   b. Minimum inlet and discharge size shall be as indicated herein.
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, water tight chamber.

b. The stator windings shall be insulated with moisture-resistant Class H insulation for 180 degrees C. The motor shall be designed for continuous duty capable of fifteen (15) evenly spaced starts per hour. Automatic reset, normally closed thermal sensors shall be imbedded in each phase of the motor windings to provide overheating protection.
c. 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%.
d. The motor shall be designed for continuous duty while handling pumped media of up to 104 degrees F.
e. 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.
f. The motor service factor shall be 1.15. The motor shall have a voltage tolerance of +/- 10%.
g. 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.
h. Motor horse power shall be sufficient so that the pump is non-overloading throughout its entire performance curve, from shut-off to run-out.
i. Motor shaft shall be one-piece, extending through the pump and motor. Extension couplings shall not be acceptable. Shaft shall be ASTM A572 Grade 50 carbon steel shaft material. If shaft is exposed to the pumped media it shall be constructed of 431 stainless steel. Shaft sleeves shall not be acceptable.
j. The power cable entry seal design shall preclude specific torque requirements to insure a watertight seal and shall allow simple field changing of power and pilot cables without affecting pump or motor warranty. The cable entry assembly shall consist of a seal flange designed and machined to provide precise compressions of cylindrical elastomer grommets flanked by stainless steel washers all having a close tolerance fit against the outside diameter of the cable and the inside diameter of the entry body. Cable sizing shall conform to NEC requirements for portable power use.
k. A separate junction chamber shall be provided inside the pump for connection of power and pilot 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.
l. Power shall be multi-conductor externally jacketed with oil resistant chloroprene rubber. Internal tinned copper conductor's insulation shall be ethylene propylene rubber and shall be color coded to identify each power lead.

6. Mechanical Seal
   a. The upper seal shall contain one stationary and one positively driven rotating corrosion and abrasion resistant tungsten-carbide seal ring. The rotating seal ring shall have small back-swept grooves laser inscribed upon its face to act as a pump as it rotates, returning any fluid that should enter the dry motor chamber back into the lubricant chamber.
   b. The lower seal shall act as the primary unit to prevent entry of pumped liquid to the oil chamber. The upper seal shall act as a secondary unit to prevent pumped

liquid or oil from entering the stator housing. The seal system shall allow continuous pump operation with the motor exterior totally dry.

c. Each seal unit shall consist of a positive driven rotation ring, a stationary ring and an independent spring to maintain interface contact. The upper and lower seals for all pumps shall have tungsten carbide rotation and stationary rings.

7. Bearings
   a. The pumps shall be equipped with grease lubricated bearings with a minimum L_{10} bearing system life of 50,000 hours at any point along the pump curve at maximum speed.
   b. The upper bearings shall be roller bearings.
   c. The lower bearings shall be one or two angular contact ball bearings and one roller bearing.
   d. The lower bearing housing shall include an independent thermal sensor to monitor the bearing temperature. If a high temperature occurs, the sensor shall activate an alarm and shut the pump down.

8. Pump protection devices
   a. The pump manufacturer shall provide a pump monitoring system which shall consist of pump protective devices and monitoring unit mounted on a dead front door or back plate of control panel.
   b. Pump protective devices
      1). Three thermal switches in the stator coils.
      2). A leakage sensor shall be provided in the stator housing to detect water intrusion.
   c. Monitoring and Status Unit
      1.) The Monitoring and Status unit shall be designed to mount on the back plate or switch outdoor of the control panel
      2.) All monitoring devices shall connect to the control and monitoring unit.

9. 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 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. See specification for access cover requirements.
   d. Guide rail system shall consist of no less than two bars. Each bar shall be Schedule 40 wall thickness pipe to assure future availability for replacement. Guide bars shall be 2 or 3 inch as indicated on the Plans. Guide bars spanning 20 feet or less between upper and lower supports shall not require intermediate bracing. Guide bar material shall be stainless steel, type 316.

10. Testing
    a. a. A certified factory performance test shall be performed on each pumping unit in accordance with Hydraulic Institute Standards, Level A, latest edition. Tests shall be sufficient to determine the curves of head, input horsepower, and efficiency relative to capacity from shutoff to 150% of design flow. A minimum of six points, including shutoff, shall be taken for each test. At least one point of the six shall be taken as near as possible to each specified condition.
    b. Results of the performance tests shall be certified by a Registered Professional Engineer and submitted for approval before final shipment.

2.02 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 two years after startup and beneficial use by the Owner.

B. Access Covers:
   1. To insure compatibility the supplier of the submersible pumps shall supply all access covers in structures containing submersible pumps.

C. Guide Rail Brackets:
   1. Dual rail upper guide rail brackets shall be provided by the pump supplier for each pump. Each bracket shall have two 3/16" hooks for supporting pump power cables and lifting assemblies. The upper guide rail bracket shall be constructed of 316 stainless steel.
   2. 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 mid point of guide rail span. The intermediate guide rail bracket shall be constructed of 316 stainless steel.

D. Float Cable Racks:
   1. Level sensor floats shall be suspended in the wet well from a cable rack bolted to the access opening or cover frame. Each rack shall be provided with six, 3/16" minimum diameter hooks over which the level sensor cables shall be looped. The cable rack shall be 316 stainless steel.

E. Power Cable Supports:
   1. A stainless steel or non-metallic 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.

F. Lift Station Hardware:
   1. All nuts, bolts, washers, anchor bolts or any attachment hardware used inside the wet well shall be constructed of 316 stainless steel.

2.03 Electrical Control Panel:

1.0 The Pump Manufacturer shall provide and be responsible for proper electrical protection and control operation. The Pump Supplier shall supply the pump control panel in order to assure unit responsibility for equipment selection, component compatibility, startup and operational checks and future service. Electrical equipment supplied must comply with all requirements of Division 17 Instrumentation and with the Electrical Drawings.

PART 3.0 EXECUTION

3.01 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 is shown on the construction drawings. The location of the pumps, access covers, and discharge connection are approximate. The precise placement and alignment of anchor bolts, discharge assembly, guide rails, access cover and associated connections shall be in accordance with the supplemental construction details provided by the pump manufacturer. The manufacturer shall check alignment during start up field testing. Improper alignment shall be corrected by the Contractor prior to continuation of testing.

3.02 Startup and Field testing

A. After the pumps have been completely installed and wired, the Contractor shall remove the pumps to the wet pit 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

B. After initial inspection, the Contractor shall lower the pumps into place in the wet pit and provide water for an initial 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 representative 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

C. On completion of initial inspection and operational checks, the pump manufacturer shall furnish the 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 bear the stamp and signature of a Registered

Professional Engineer employed or retained by the pump supplier to indicate engineering review and approval of field test data. A copy of the report shall be included in the operation and maintenance manuals.

SECTION 15163 – ODOR CONTROL AND AERATION SYSTEM EQUIPMENT

GENERAL

The system shall be a Reliant Water Technologies Wet Well Wizard, or approved equal. It shall consist of at least three major parts, with specific fitting hardware, for the purpose of aerating and vigorously agitating sewer or lift station wet wells, or similar applications, on a continuous basis.

THE AIR SOURCE

The air source must be a side channel, two stage, low volume, high pressure regenerative blower with an air release valve, IP65 motor protection, plumbing for one or more wet well aeration ejectors, and a weather-proof pressure gauge for the purpose of aerating and agitating the liquid in a sewer or lift station wet well. The blower motor and flywheel specifications must be sized to accommodate the necessary pressure and air volume to properly aerate and agitate the water in a specific wet well, taking into consideration the well surface area, altitude, and water depths, including low water and high water depths. The wet well water agitation must be aggressive enough to continuously cause wave surges across the entire wet well surface. A single blower must be capable of supplying enough air volume and pressure for enough aeration ejectors to completely affect the entire surface of the wet well. It is important that no air from the air source can reach the intakes of underwater pumps in the wet well.

A magnetic motor control starter in a NEMA 4X enclosure must be supplied to receive the primary power to the blower. The starter must be prewired to the blower.

The air source with have a stainless steel manifold with the necessary number of air outlet ports to supply air to the required number of aeration ejectors identified in this specification. Each port will utilize stainless steel cam lock hose connectors to accommodate the required number of air feed hoses. There will be an Inches of Water gauge located on the primary manifold feed pipe, and stainless steel intake plumbing and filter hood.

THE AIR FEED HOSE

A 1" OD, ¾" ID, reinforced, double walled, PVC and polyurethane hose of variable lengths for the connection of the regenerative blower to each ejector tube in the wet well. Each end of the air feed hose must terminate with a mating stainless steel cam lock fitting for the air source manifold and the aeration tube or tubes.

THE AIR FEED HOSE CONNECTING HARDWARE

All nipples and cam lock fittings for the hose between the regenerative blower and the aeration ejector in the wet well are to be made of either stainless steel or brass.

THE AREATION EJECTOR

An 18" HDPE tube fitted to a stainless steel support 6" atop a 5" diameter stainless steel base weighing no less than 10 lbs. The interior of the ejector tube will be fitted with no less than 4 circular bubble cleaving disks made of HDPE with 1 flat edge each, situated in an antipodal manner as to cleave and spin large bubbles as they rise through the tube. The reinforced,

double walled hose, (noted above) must enter the ejector from the dorsal end and pass through each cleaving disk, ending below the bottom disk in such a way as to terminate with a brass outlet nipple held in place with a stainless steel clamp. All hardware holding the antipodal cleaving disks in place must be stainless steel and welded to the cleaving disks. The ejector tube must be positioned in a vertical orientation in the wet well and there will be no holes in the tube other than at the dorsal and bottom ends of the tube. No air entering the tube can escape the bottom end of the tube near the intakes of pumps situated in the bottom of the wet well. No air escaping the ejector will be in a fine bubble configuration. The ejector is strictly a coarse bubble ejector.

WARRANTIES

The equipment manufacturer must provide against defective or deficient equipment, workmanship and materials under normal use, operation and service. This warranty shall end one (1) year from accepted start-up or eighteen months from delivery, whichever is longest. The warranty shall be in printed form and shall apply to all units.

TECHNICAL SPECIFICATIONS
FOR

VIDA SAN ANTONIO LIFT STATION

PREPARED BY

CLEARY ZIMMERMANN ENGINEERS, LLC

1344 SOUTH FLORES, SUITE 101
SAN ANTONIO, TEXAS 78204
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TBPE FIRM NO. F-9357

Conner B. Sturdivant, P.E., P. ENG.
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TBPE LICENSE No.
January 23, 2024
ISSUE DATE
CLEARY ZIMMERMANN ENGINEERS, INC.
TEXAS REGISTERED ENGINEERING FIRM NO. F-9357

TABLE OF CONTENTS

DIVISION 16 – ELECTRICAL

DIVISION 17 – INSTRUMENTATION

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

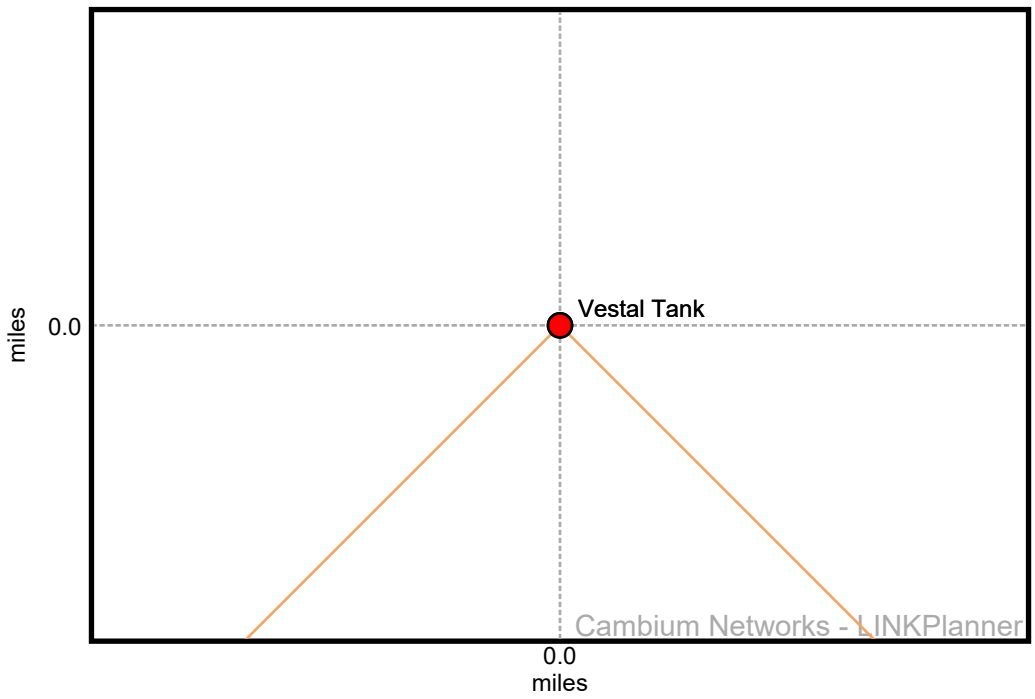
LINKPlanner PMP Installation Report

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™

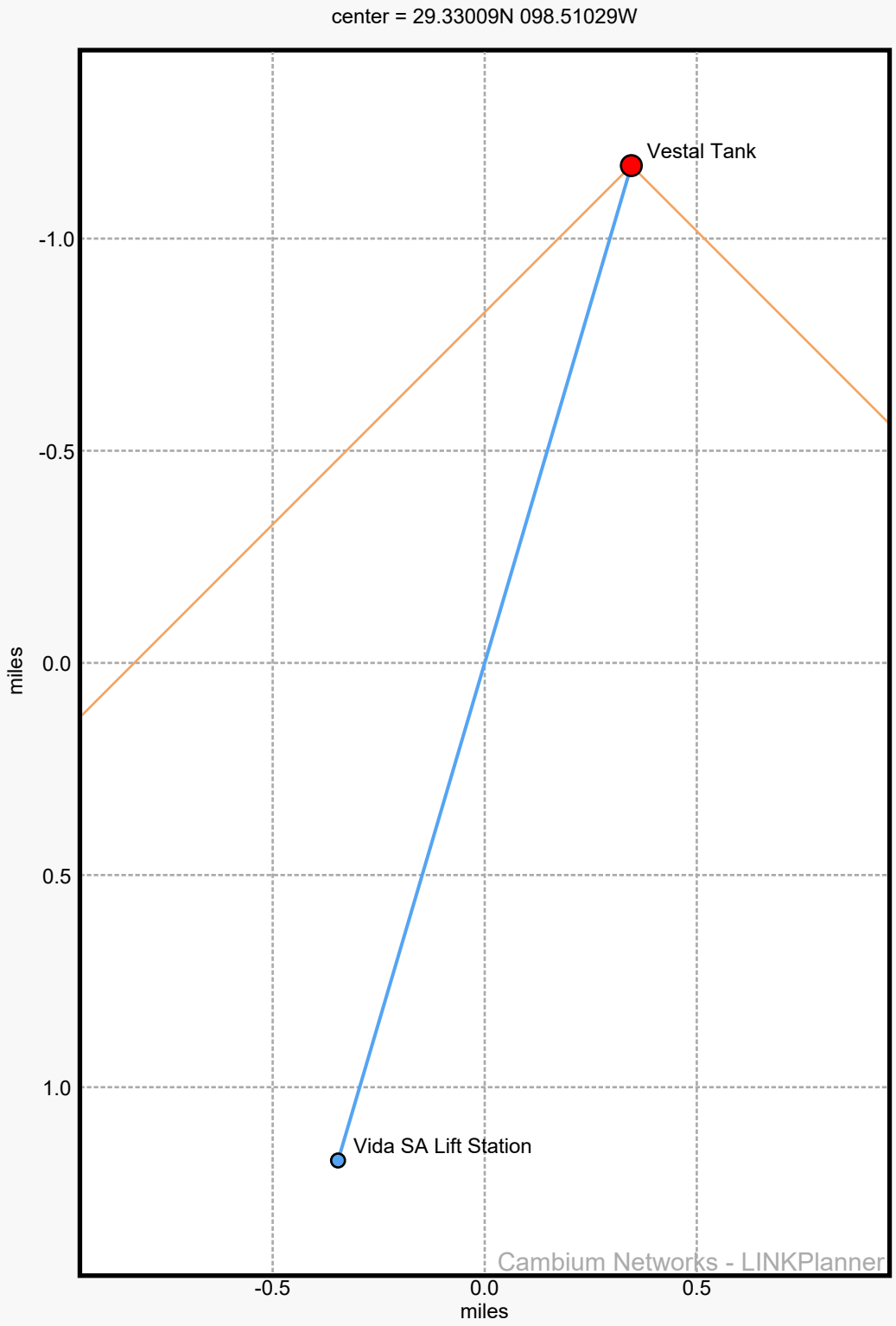
Table of Contents

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

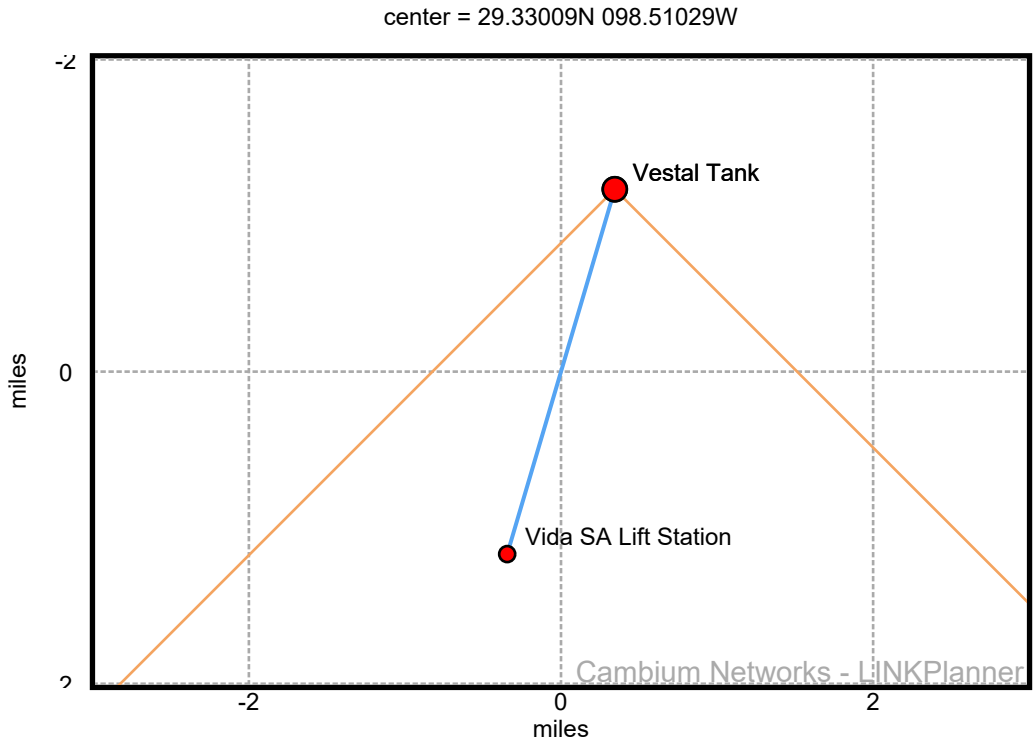
Bill of Materials : Switch Network		
Part Number	Qty	Description

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

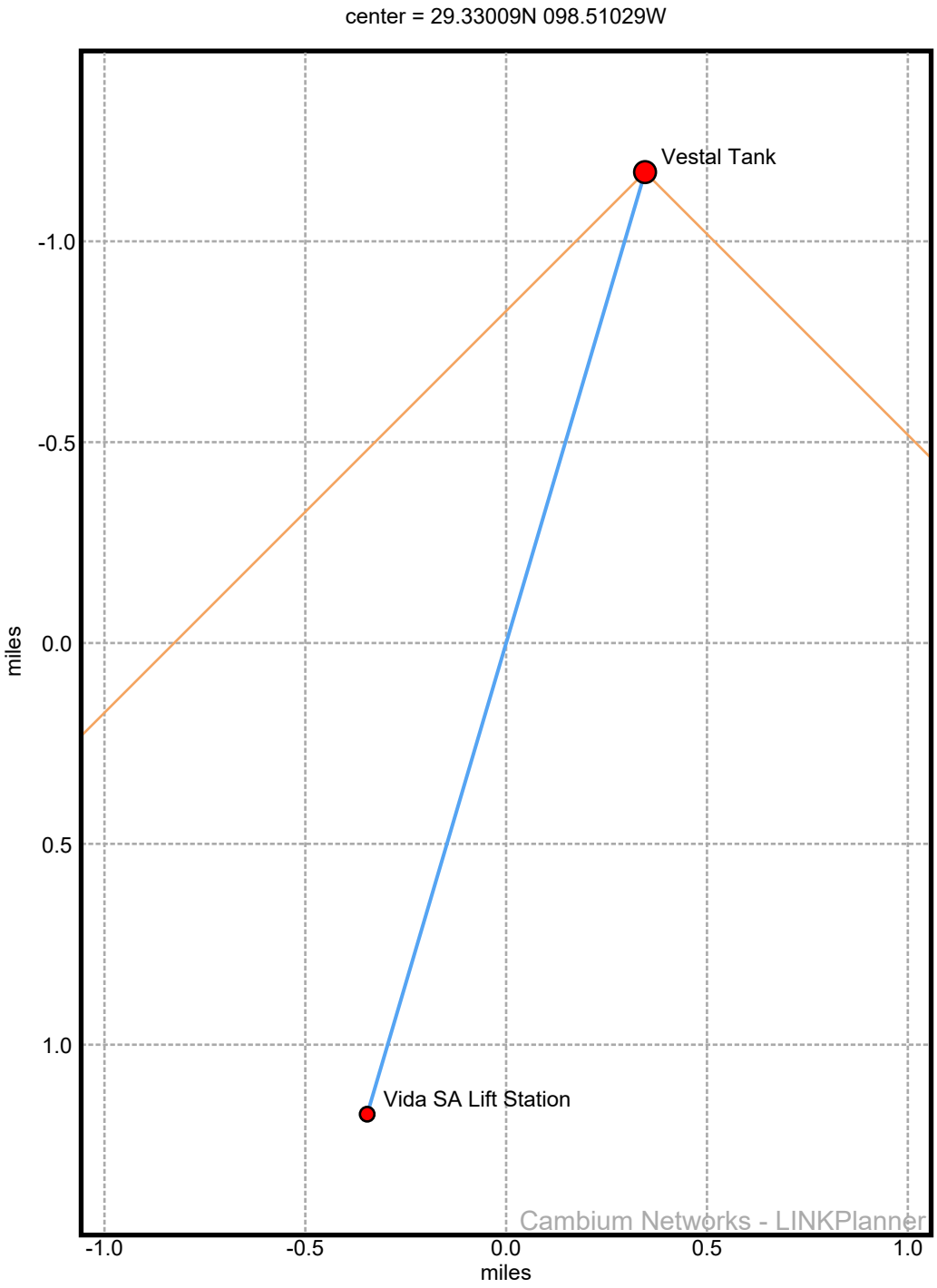
Physical Installation Notes for AP Vestal Tank : 1	
Latitude	29.34693N
Longitude	098.50462W
Platform Variant	4.9 GHz PMP-450i
Antenna Type	Cambium Networks 90° 4.9 - 6 GHz, 90/120 deg Sector Antenna
Antenna Beamwidth	90.0°
Antenna Gain	18.0 dBi
Antenna Height	162.0 feet AGL
Antenna Tilt Angle (mechanical)	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

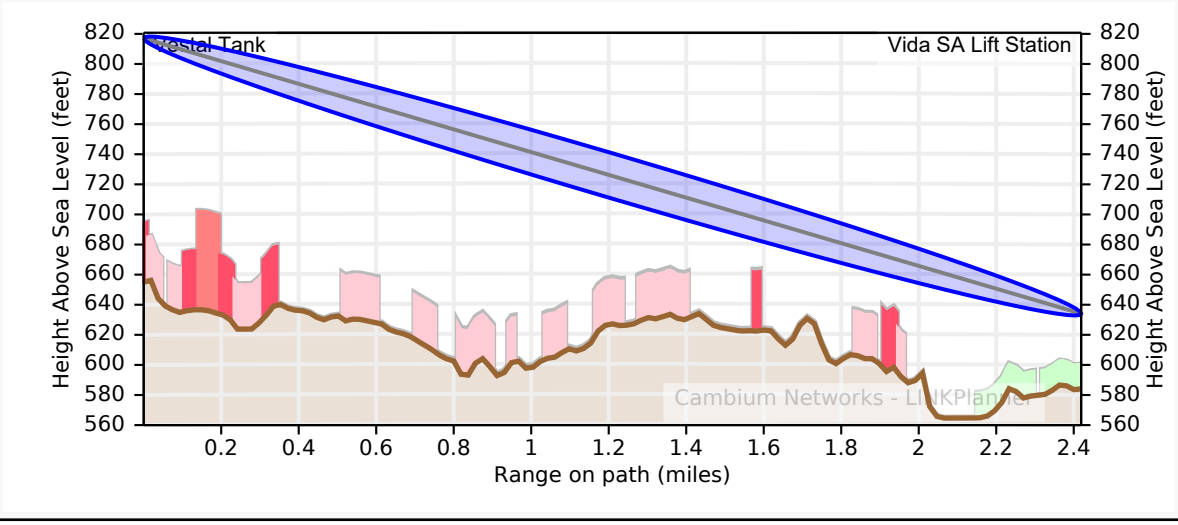
4. Vestal Tank : 1 - Access Point Map



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

Disclaimer

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Colliers
Engineering & Design

Appendix A

Subsurface Exploration and Foundation Analysis, Proposed New Lift Station, Vida San Antonio Subdivision, San Antonio, Texas, prepared by Integrated Testing and Engineering Company of San Antonio, L.P., dated July 07, 2023

Colliers Engineering & Design

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Subsurface Exploration and Foundation Analysis
Proposed New Lift Station
Vida San Antonio Subdivision
San Antonio, Texas

InTEC Project No. S231701-R1
July 07, 2023

Southstar at Verano, LLC
1118 Vintage Way
New Braunfels, Texas 78132

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Integrated Testing and Engineering Company of San Antonio, L.P.
Geotechnical & Environmental Engineering • Construction Services • Geologic Assessment

July 07, 2023

Southstar at Verano, LLC
1118 Vintage Way
New Braunfels, Texas 78132

Attention: **Mr. Jim Vater**
Email: jim@southstarcommunities.com

Re: Subsurface Exploration and Foundation Analysis
Proposed New Lift Station
Vida San Antonio Subdivision
San Antonio, Texas

InTEC Project No. S231701-R1

Ladies & Gentlemen:

Integrated Testing and Engineering Company of San Antonio (InTEC) has completed a **soil and foundation engineering report** at the above referenced project site. The results of the exploration are presented in this report.

We appreciate and wish to thank you for the opportunity to be of service to you on this project. If we can be of additional assistance during the materials testing-quality control phase of construction, please call us.

Sincerely,
InTEC of San Antonio

Murali Subramaniam, Ph. D., P.E.
Vice President

07/07/2023

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EXECUTIVE SUMMARY

The soil conditions at the location of the **proposed new Lift Station at Vida San Antonio Subdivision in San Antonio, Texas** were explored by **drilling two borings to depths of 25 and 40 feet.** Laboratory tests were performed on selected specimens to evaluate the engineering characteristics of various soil strata encountered in the boring. Our findings and recommendations based on the field investigations and the laboratory tests are summarized below:

- The subsurface soils at the boring locations consist of dark brown sandy clays underlain by tan clays to gray clay seams and sandy clay seams.

- The results of our laboratory testing and engineering evaluation indicate that the underlying shallow clays are **moderately plastic to highly in character.** Potential vertical movement on the order of **3 to 4 inches** is estimated.

- Recommendations for lift station design and construction by various options such as a) open cut installation, b) retained excavation, and c) caisson installation are presented in this report. Recommendations for foundations to support the antenna tower and generator pads are also presented in this report.

- **Ground water was encountered at an approximate depth of 27-ft in Boring B-1 at the time of drilling**.

Detailed descriptions of subsurface conditions, engineering analysis, and design recommendations are included in this report.

TABLE OF CONTENTS

INTRODUCTION

General

This report presents the results of our **subsurface exploration and foundation analysis at the location of the proposed new Lift Station at Vida San Antonio Subdivision in San Antonio, Texas.** This project was authorized by **Mr. Jim Vater.**

Purpose and Scope of Services

The purpose of our geotechnical investigation was to evaluate the site's subsurface and ground water conditions and provide **geotechnical engineering recommendations** for the foundation design and construction phase of the lift station project. Our scope of services includes the following:

1) drilling and sampling of two borings – to depths of 25 and 40 feet;

2) evaluation of the in-place conditions of the subsurface soils through field penetration tests;

3) observation of the ground water conditions during drilling operations;

4) performing laboratory tests such as Atterberg limits and Moisture content tests;

5) review and evaluation of the field and laboratory test programs during their execution with modifications of these programs, when necessary, to adjust to subsurface conditions revealed by them;

6) compilation, generalization and analysis of the field and laboratory data in relation to the project requirements;

7) preparation of recommendations for the design and construction phase of the project;

The Scope of Services **did not include slope stability analysis, pavement study, or any environmental assessment** for the presence or absence of wetlands or hazardous or toxic materials in the soil, surface water, groundwater, or air, on or below or around this site. Any statements in this report or on the Boring Logs regarding odors, colors or unusual or suspicious items or conditions are strictly for the information of the client.

Project Description

The proposed project involves the development of the new Lift Station at Vida San Antonio Subdivision in San Antonio, Texas. The proposed lift station project consists of a new Wet Well to be founded at an approximate depth of 28-ft below existing grade elevation, a SCADA tower, equipment & generator pads, and the associated parking and drive areas. Structural details are not available for our review at this time.

SUBSURFACE EXPLORATION

Scope

The field exploration to determine the engineering characteristics of the subsurface materials included a reconnaissance of the project site, drilling the borings, performing Standard Penetration Tests, and obtaining Split Barrel samples.

Two soil borings were drilled at the project site. The borings were **drilled to depths of 25 and 40 feet below the presently existing ground surface**. The boring location was selected by the project civil engineer and established in the field by the drilling crew using normal taping procedures.

Drilling and Sampling

The soil boring was performed with a truck mounted drilling rig equipped with a rotary head. Conventional solid stem augers were used to advance the hole and samples of the subsurface materials were obtained **using a Split Barrel sampler.** The samples were identified according to boring number and depth, encased in polyethylene plastic wrapping to protect against moisture loss, and transported to our laboratory in special containers. The samples were collected as a part of our field exploration procedure.

Field Tests and Water Level Measurements

Penetration Tests – During the sampling procedures, **Standard Penetration Tests were performed** in the boring in conjunction with the split-barrel sampling. The standard penetration value (N) is defined as the number of blows of a 140-pound hammer, falling thirty inches, required to advance the split-spoon sampler one foot into the soil. The sampler is lowered to the bottom of the drill hole and the number of blows recorded for each of the three successive increments of six inches penetration. The "N" value is obtained by adding the second and third incremental numbers. The results of the standard penetration test indicate the relative density and comparative consistency of the soils, and thereby provide a basis for estimating the relative strength and compressibility of the soil profile components.

Water Level Measurements – **Ground water was encountered at an approximate depth of 27-ft in Boring B-1 at the time of drilling**. In relatively pervious soils, such as sandy soils, the indicated elevations are considered reliable ground water levels. In relatively impervious soils, the accurate determination of the ground water elevation may not be possible even after several days of observation. Seasonal variations,

temperature and recent rainfall conditions may influence the levels of the ground water table and volumes of water will depend on the permeability of the soils.

Field Log

A field log was prepared for the boring. The log contained information concerning the boring method, samples attempted and recovered, indications of the presence of various materials such as silt, clay, gravel or sand and observations of ground water. It also contained an interpretation of subsurface conditions between samples. **Therefore, the log included both factual and interpretive information.**

Presentation of the Data

The final logs represent our interpretation of **the contents of the field logs for the purpose delineated by our client.** The final logs are included on **Plates 2 and 3** included in the Illustration section. A key to classification terms and symbols used on the logs is presented on **Plate 4**.

LABORATORY TESTING PROGRAM

Purpose

In addition to the field exploration, a supplemental laboratory-testing program was conducted to determine additional **pertinent engineering characteristics** of the subsurface materials necessary in evaluating the soil parameters.

Laboratory Tests

All phases of the laboratory-testing program were performed **in general accordance with the indicated applicable ASTM Specifications** as indicated in Table No. 1.

Table No. 1 – Laboratory Test Procedures

Laboratory Test	Applicable Test Standard
Liquid Limit, Plastic Limit and Plasticity Index of the Soils	ASTM D 4318
Moisture Content	ASTM D 2216

In the laboratory, each sample **was observed and classified by a geotechnical engineer.** As a part of this classification procedure, the natural water contents of selected specimens were determined. Liquid and plastic limit tests were performed on representative specimens to determine the plasticity characteristics of the different soil strata encountered.

Presentation of the Data

The laboratory tests were conducted in the laboratory to evaluate the engineering characteristics of the subsurface materials. The results of all these tests are presented on the Boring Logs. These laboratory test results were used to classify the soils encountered according to the Unified Soil Classification System (ASTM D 2487).

GENERAL SUBSURFACE CONDITIONS

Soil Stratigraphy

The soils underlying the site may be grouped into **two generalized strata** with similar physical and engineering properties. The lines designating the interface between soil strata on the log represent approximate boundaries. Transition between materials may be gradual. The soil stratigraphy information at the boring location is presented in the **Boring Logs, Plates 2 and 3.**

The engineering characteristics of the underlying soils, based the results of the laboratory tests performed on selected samples, are summarized and presented in the following paragraph.

Dark brown sandy clays and tan clays are moderately plastic to highly plastic in character with tested liquid limit values varying from 41 to 69 and plasticity index values ranging from 22 to 50. The results of Standard Penetration Tests performed within these soils varied from 14 to 32 blows per foot.

Soil stratigraphy may vary across the site. If deviations from the noted subsurface conditions are encountered during construction, they should be brought to the attention of InTEC. We may revise the recommendations after evaluating the significance of the changed conditions. If the construction crew encounters, at the time of grade beam excavations or during utility trench excavations, conditions such as abundant gravel, fill material, or sand seams, please contact InTEC.

Ground Water Observations

Ground water was encountered at an approximate depth of 27-ft in Boring B-1 at the time of drilling. Short term field observations generally do not provide accurate ground water levels. The contractor should verify the subsurface water conditions prior to any excavation activities. The low permeability of the soils would require several days or longer for ground water to enter and stabilize in the bore hole. Ground water levels will fluctuate with seasonal climatic variations and changes in the land use.

It is not unusual to encounter shallow groundwater during or after periods of rainfall. The surface water tends to percolate down through the surface until it encounters a relatively impervious layer.

FOUNDATIONS ON EXPANSIVE SOIL

General

There are many plastic clays **that swell considerably** when **water is added to them and then shrink with the loss of water.** Foundations constructed on these clays are **subjected to large uplifting forces caused by the swelling.**

In the characterization of a building site, two major factors that contribute to potential shrink-swell problems must be considered. Problems can arise if a) **the soil has expansive or shrinkage properties** and b) the environmental conditions that cause **moisture changes to occur in the soil.**

Evaluation of the Shrink-Swell Potential of the Soils

Subsurface sampling, laboratory testing and data analysis is used in the evaluation of the shrink-swell potential of the soils under the foundations.

The Mechanism of Swelling

The mechanism of swelling in expansive clays is complex and is influenced by a **number of factors.** Basically, expansion is a result of changes in the soil-water system that disturbs the internal stress equilibrium. Clay particles in **general have negative electrical charges** on their surfaces and positively charged ends. The negative charges are balanced by actions in the soil water and give rise to an electrical interparticle force field. In addition, adsorptive forces exist between the clay crystals and water molecules, and Van Der Waals surface forces exist between particles. Thus, there exists an internal electro-chemical force system **that must be in equilibrium with the externally applied stresses and capillary tension in the soil water.** If the soil water chemistry is changed either by changing the amount of water or the chemical composition, the interparticle force field will change. If the change in internal forces is not balanced by a corresponding change in the state of stress, **the particle spacing will change** so as to adjust the interparticle forces until equilibrium is reached. **This change in particle spacing manifests itself as a shrinkage or swelling.**

Antecedent Rainfall Ratio

This is a measure of the local climate and is defined as **the total monthly rainfall for the month of and the month prior to laying the slab divided by twice the average monthly rate measured for the period.** The intent of this ratio is to give a relative measure of ground moisture conditions at the time the slab is placed. Thus, if a slab is placed at the end of a wet period, the slab should be expected to experience some loss of support around the perimeter as the wet soil begins to dry out and shrink. The opposite effect could be anticipated if the slab is placed at the end of an extended dry period; as the wet season occurs, uplift around the perimeter may occur as the soil at the edge of the slab gains in moisture content.

Age of Slab

The length of time since the slab was cast provides an indication of the type of swelling of the soil profile that can be expected to be found beneath the slab.

Initial Moisture Condition and Moisture Variation

Volume change in an expansive soil mass is the result of increases or decreases in water content. The initial moisture content influences the swell and shrink potential relative to possible limits, or ranges, in moisture content. Moisture content alone is useless as an indicator or predictor of shrink-swell potential. **The relationship of moisture content to limiting moisture contents such as the plastic limit and liquid limit must be known.**

If the moisture content is below or near plastic limit, the soils have high potential to swell. It has been reported that **expansive soils with liquidity index*** in the range of **0.20 to 0.40 will tend to experience little additional swell.**

The availability of water to an expansive soil profile is influenced by many environmental and man-made factors. Generally, the upper few feet of the profile are subjected to the widest ranges of moisture variation, and is least restrained against movement by overburden. **This upper stratum of the profile is referred to as the active zone.** Moisture variation in the active zone of a natural soil profile is affected by climatic cycles at the surface, and fluctuating groundwater levels at the lower moisture boundary. The surficial boundary moisture conditions are changed significantly simply by placing a barrier such as a building floor slab or pavement between the soil and atmospheric environment. **Other obvious and direct**

causes of moisture variation result from altered drainage conditions or man-made sources of water, such as irrigation or leaky plumbing. The latter factors are difficult to quantify and incorporate into the analysis, but should be controlled to the extent possible for each situation. **For example, proper drainage and attention to landscaping are simple means of minimizing moisture fluctuations near structures, and should always be taken into consideration.**

Man Made Conditions That Can Be Altered

There are a number of factors that can influence whether a soil might shrink or swell and the magnitude of this movement. **For the most part, either the owner or the designer has some control over whether the factor will be avoided altogether or if not avoided, the degree to which the factor will be allowed to influence the shrink-swell process.**

Lot Drainage This provides a measure of the slope of the ground surface with respect to available free surface water that may accumulate around the slab. **Most builders are aware of the importance of sloping the final grade of the soil away from the structure so that rain water is not allowed to collect and pond against or adjacent to the foundations.** If water were allowed to accumulate next to the foundation, it would provide an available source of free water to the expansive soil underlying the foundation. Similarly, surface water drainage patterns or swales must not be altered so that runoff is allowed to collect next to the foundation.

Topography **This provides a measure of the downhill movement that is associated with light foundations built on slopes in expansive soil areas.** The designer should be aware that as the soil swells, it heaves perpendicularly to the ground surface or slope, but when it shrinks, it recedes in the direction of gravity and gradually moves downslope in a sawtooth fashion over a number of shrink-swell cycles. In addition to the shrink-swell influence, the soil will exhibit viscoelastic properties and creep downhill under the steady influence of the weight of the soil. Therefore, if the building constructed on this slope is not to move downhill with the soil, it must be designed to compensate for this lateral soil influence.

Pre-Construction Vegetation **Large amount of vegetation existing on a site before construction may have desiccated the site to some degree, especially where large trees grew before clearing.**

* LIQUIDITY INDEX = {NATURAL WATER CONTENT - PLASTIC LIMIT} / {LIQUID LIMIT - PLASTIC LIMIT}

Constructing over a desiccated soil can produce some dramatic instances of heave and associated structural distress and damage as it wets up.

Post-Construction Vegetation **The type, amount, and location of vegetation that has been allowed to grow since construction can cause localized desiccation. Planting trees or large shrubs near a building can result in loss of foundation support as the tree or shrub removes water from the soil and dries it out.** Conversely, the opposite effect can occur if flowerbeds or shrubs are planted next to the foundation and these beds are kept well-watered or flooded. This practice can result in swelling of the soil around the perimeter where the soil is kept wet**.**

Summation

It is beyond the scope of this investigation to do more than point out that the above factors have a definite influence on the amount and type of swell to which a slab-on-ground is subjected during its useful life**.**

DESIGN ENGINEERING ANALYSIS

Foundation Design Considerations

Review of the boring and test data indicates that the following factors will affect the foundation design and construction at this site:

1) Moderately plastic to highly plastic clays underlie the project site. Structures supported at shallow depths will be subjected to potential vertical movements on the order of **3 to 4 inches.**

2) The select fill should be placed and compacted as recommended under *Select Fill* in the "Construction Guidelines" section of this report.

3) **Ground water was encountered at an approximate depth of 27-ft in Boring B-1 at the time of drilling**.

Vertical Movements

The potential vertical rise (PVR) for slab-on grade construction at the location of the structures had been estimated using Texas Department of Transportation Procedure TXDOT-124-E. This method utilizes the liquid limits, plasticity indices, and in-situ moisture contents for soils in the seasonally active zone, estimated to be about 15 feet at the project site.

The estimated PVR value provided is based on the proposed floor system applying a sustained surcharge load of approximately 1.0 lb. per square inch on the subgrade materials**. Potential vertical movement on the order of 3 to 4 inches was estimated at the existing grade elevation.** These high PVR values will be realized if the subsoils are subjected to **moisture changes from average soil moisture conditions to wet soil moisture conditions.**

The PVR values are based on the current site grades. If cut and fill operations in excess of 6 inches are performed, the PVR values could change significantly. Higher PVR values than the above-mentioned values will occur in areas where water is allowed to pond for extended periods.

If the existing grade is lower than the finish grade elevation, compacted crushed limestone select fill should be used to raise the grade. The select fill should be placed and compacted as recommended under *Select*

Fill in the "Construction Guidelines" section in this report. Each lift should be tested for compaction compliance and approved by InTEC before placement and compaction of the subsequent lifts.

If the underlying clays are removed to a depth of 5-ft and replaced by compacted select fill, potential vertical movement on the order of one inch may be estimated. The select fill should be placed in 6-inch lifts and compacted as recommended under *Select Fill* in the "Construction Guidelines" section in this report.

Notes:

- The select fill should be placed and compacted as recommended under *Select Fill* in the "Construction Guidelines" section in this report. The compacted select fill should extend a minimum of 3-ft outside the perimeter grade beams. Each lift should be tested and approved by the geotechnical engineer before placement of the subsequent lifts.

- The removal and replacement depth may vary across the site to achieve a desired potential vertical movement value based on a) existing grade elevation b) finish grade elevation (at the time of construction).

- If over excavation and select fill replacement is used to lower potential vertical movements, the bottom of excavation should be drained properly. It should not act as a bathtub and hold water in the event any accidental source of water enters the excavation. The subgrade at the excavation level may be sloped down (at least 1% slope) to one side of the excavation and drained using drain gravel and drain pipe. The drain pipe should be daylighted in a detention pond or natural drainage feature.

- The select fill extending 3-ft outside the building should be covered by 2-ft thick compacted impervious clay. The impervious clay (with plasticity index value 35 or greater) should be placed in 8-inch loose lifts and compacted to a minimum of 95 percent of the maximum ASTM D 698 dry density at a water content between Optimum and Optimum Plus two percentage points. The top surface of clay seal should be sloped away from the building perimeter.

- Coping with problems of shrink/swell due to expansive clays is a "fact of life" in the Texas region of south western U.S.A. Support of the buildings on deep underreamed footings with a structurally suspended floor slab (12-inch void) will provide a foundation system with the least

risk for distress due to shrink/swell of the clays. It should be noted that expansive clay does not shrink/swell without changes in moisture content, and thus good site design is very important to minimize foundation movements.

- It is our experience that support of the walls and columns on stiffened grid type beam and slab foundation or post tensioned beam and slab foundation will provide reasonable performance of the foundation if the clay subsoils are wet at the time of earthwork construction. However, some shrink/swell will probably occur causing some cracks in the floor slab and interior walls due to the foundation system because the subsoil conditions between borings are unknown, the moisture content of the clays and groundwater conditions at the time of construction are unknown, and construction practices can adversely affect the supporting properties of the subsoils.

Flatwork

Ground supported flatwork adjacent to the buildings will be subjected to the movements due to shrink / swell of the underlying soils. Differential movement between the flatwork and the building may result in a trip hazard. Reducing the potential vertical movements as described in the Vertical Movements section will reduce the different movement described above.

FOUNDATION RECOMMENDATIONS

General

The following recommendations are based on the data obtained from our field and laboratory tests, our past experience with geotechnical conditions similar to those at this site, and our engineering design analysis.

Surface drainage is very important around the structures and in the pavement areas. The surface water should be drained as fast as possible around the structures and roadways. If enough slopes are not available for a good surface drainage, gratings and pipes may be used to carry the water and drain the area fast. In some areas, a) where surface water gets into the subsurface and b) water travels laterally within the underlying gravel layers should be collected by French Drains and disposed of in the drain areas.

At the time of construction, utility and grade beam excavations may reveal that the soils encountered are different from those encountered in the borings. If this happens, we should be informed. We may revise the foundation recommendations accordingly. If the construction crew encounters, at the time of grade beam excavations or during utility trench excavations, conditions such as abundant gravel, fill material, or sand seams, please contact InTEC.

Foundation Selection

The type and depth of foundation suitable for a given structure primarily depends on several factors: the subsurface conditions, topography, site drainage, the function of the structure, the loads it may carry, and the cost of the foundation. Additional considerations may include acceptable performance criteria set by the owner, architect, or structural designer with respect to vertical and differential movements, which the structure can withstand without damage.

Based on the above mentioned conditions, engineering design analysis considered slab on grade foundation for equipment pads, and various options such as open cut installation, retained excavation, and caisson installation for the lift station.

LIFT STATION FOUNDATIONS

It is our understanding that the bottom of the lift station is approximately 28-ft below existing grade. Based on the soils encountered in the boring, tan clays and silty clays are expected at this depth.

1. **Ground water was encountered at an approximate depth of 27-ft in Boring B-1 at the time of drilling**. Short term field observations generally do not provide accurate ground water levels. The contractor should verify the subsurface water conditions prior to any excavation activities. The low permeability of the soils would require several days or longer for ground water to enter and stabilize in the bore hole. Ground water levels will fluctuate with seasonal climatic variations and changes in land use. It is not unusual to encounter shallow groundwater during or after periods of rainfall. The surface water tends to percolate down through the surface until it encounters a relatively impervious layer.

2. It is our understanding that a mat foundation slab is planned to be used. A soil modulus value of **75 pci** is recommended.

3. An Allowable Bearing Capacity value of 3,750 lbs per sq ft is recommended for the mat foundation slab supported at a minimum depth of 28-ft below existing grade. A Factor of Safety value of 2.5 was used in the evaluation of the Allowable Bearing Capacity. The above recommendation assumes that the final bearing surface consists of undisturbed sandy / silty clays. Any water seepage observed during excavation should be pumped. Contractor should have dewatering measures readily available should excessive water seepage be observed during construction. If subgrade is too wet for a work, the underlying subgrade soils may be cement treated to a depth of 12 inches or twelve inches of gravel may be used to obtain a working platform.

4. The bearing surfaces should not be disturbed during construction.

5. Excavation options for the lift station include: (a) open-cut, (b) retained excavation, and (c) caisson. These excavation procedures and their effect on design and construction of the lift station are discussed in the following paragraphs.

(a) Open Cut Installation for Lift Station

The open-cut option is one of the installation techniques for below-grade facilities. The approach provides the best access for construction and has the least effect on the design of the structure. However, the demands on space and earthwork are upper-bound, and dewatering of transmissive strata, must be sufficient to avoid slope instabilities and maintain a stable bearing surface. The following paragraphs address the design and construction concerns of side-slope stability, dewatering, bottom stability, lateral earth pressures, and uplift design within the contexts of the open-cut option.

Side-slope Stability For open-cut excavation, temporary side-slopes of 1 (V): 1.5 (H) is common in underlying silty clays. It is important that unstable areas, if encountered, be sandbagged, corrected with earthwork, or cut off with a retention system to prevent propagation of the unstable area into a major slide. Sufficient berm area should be provided to accommodate sloughing of the construction slopes with time.

Dewatering Ground water, if encountered at the time of lift station installation, should be handled by sump and pump method of dewatering systems.

Bottom Stability The anticipated potential for bottom instability does not exist at this site since (1) silty clays were encountered at this site, and (2) permanent ground water is not likely at this site. Water seepage was encountered at an approximate depth of 27-ft during drilling. Bottom stability may be improved using methods such as installation of drain system and / or cement treatment of the soils strength.

Lateral Earth Pressures For open-cut techniques, the walls of the lift station will be subjected to lateral earth pressures developed from placed backfill. The magnitude of the lateral earth pressures is primarily dependent on the following factors:

a. Type of backfill materials used
b. Amount of compactive effort in placing the backfill
c. Method of construction
d. Rigidity of the walls

Cohesionless soils, such as sands with little or no fines, are preferred as backfill materials. Granular backfill should have less than 25% of materials finer than No. 200 sieve. Clay soils are typically less desirable materials because they are difficult to keep drained, produce larger earth pressures than granular soils, and can develop high swell pressures from expansion. Cohesive soils with plasticity indices greater than 20 are not recommended.

Granular backfill should be placed in maximum 12-inch lifts and compacted by vibratory or pneumatic equipment to 88% to 92% of the standard Proctor maximum dry density as determined by ASTM 698. We suggest that a 5-ft thick cohesive cap be compacted on top of the granular backfill to reduce surface runoff infiltration.

Over-compaction of the backfill materials should be avoided to reduce lateral earth pressures. A higher compactive effort to achieve 93% to 98% of ASTM D 698 would be required in cases where backfill will support a surcharge.

The lateral earth pressures may be calculated by multiplying the equivalent fluid density for the backfill type by the depth below the ground surface. We recommend installation of a piezometer to evaluate the groundwater level. The equivalent fluid densities for various backfill materials and compactive efforts are outlined in the following table. The equivalent fluid densities outlined for the high compactive effort should be used for level backfill with surcharge.

Table No. 2 – Equivalent Fluid Density Values

Soil Type	Compactive Effort (%)	Equivalent Fluid Density (pcf)	
		Above Water Table	Below Water Table*
Select cohesive backfill (7 <= PI <= 20)	88 to 92 93 to 98	65 85	95 105
Non-select cohesive backfill (PI > 20)	88 to 92 93 to 98	75 100	105 115
Bank Sand (Fines content < 25%)	88 to 92 93 to 98	55 75	89 98
*** These magnitudes do not include a water component, if applicable**			

Surcharge loads adjacent to the subsurface walls should also be considered. Local surcharge loads adjacent to the walls, if present, should be incorporated into the pressure diagrams. A

surcharge load, ***q***, will typically result in a lateral load equal to ***0.4q to 0.5 q***. As a factor of safety for lateral design, the surcharge loads should be multiplied by a factor of 1.5.

Uplift Since permanent water table is not encountered at this site, uplift force need not be considered at this site.

Retained Excavation for Lift Station

Retained excavations generally require less ground surface area than the open-cut approach and less groundwater control support for transmissive zones penetrated by the excavation and the retention system. A retained excavation detail can begin from ground surface or from an initial open-cut. The retention system can consist of driven sheet pile, soldier pile/lagging, or drilled shafts. The bracing system for any of the three methods can be cross-lot bracing or drilled-and-grouted soil tie-backs.

Bottom Stability Stability of the excavation bottom is not greatly affected by the retention system and should be addressed in a manner similar to that for the open-cut option.

Lateral Earth Pressure Lateral earth pressure design for structure walls constructed within a retained excavation is governed by the method of unit construction. Lift station walls are commonly cast against the retention system, so backfill is not placed behind the structure walls. The retention system may or may not be removed. If the structure is cast within the retention system such that the width of the fill body between the wall and the retention system is about 8-ft or more, lateral earth pressure behavior is generally dominated by the backfill. Procedures outlined in the "Open-Cut Installation" section should be used to estimate lateral earth pressures.

If the fill body is less than about 15-ft wide or if the structure walls incorporate the retention system, lateral earth pressure design is generally based on the natural soil stratifications. This design approach assumes that any backfill placed to fill gaps between the wall and the retention system is not over compacted and is similar in character to the natural soil conditions. This section of the report addresses lateral earth pressure design as affected by the in situ soils.

Factors affecting lateral earth pressure design include the following:

a. Type of retention system, such as cantilevered or braced
b. Design condition, such as long-term or during construction
c. Dewatering control
d. Soil type
e. Width of fill, if any, placed between the unit walls and the retention system
f. Quality of compaction

Common geometries of retention systems for lift station excavations are rectangular braced walls or circular shafts. Experience indicates that the lateral earth pressures acting on circular shafts are approximately equal to the pressures on rectangular walls.

Two design cases using these geometries for lateral earth pressure design are temporary braced excavation and permanent wall.

Local surcharge loads adjacent to the lift station, if present, should be incorporated into the pressure diagrams. A surcharge load, q. will typically result in a lateral load equal to 0.4 to 0.5 q. As a safety factor for lateral design, the surcharge loads should be multiplied by a factor of 1.5.

(b) Caisson Installation for Lift Station

The caisson procedure eliminates the need for a retention system and does not have the large area and earthwork requirements of the open cut approach. Caisson units, however, must be structurally stiffer than units installed by conventional techniques, and can experience problems with alignment and termination at the proper design depth. An 18-ft diameter hole may be drilled with a drilling rig. A heavily reinforced cylindrical wall and base slab may be constructed. The cylindrical wall may be designed as a retaining wall. For retaining wall design, design parameters presented in Table No. 4 may be used.

SCADA Tower and Light Pole

Straight shaft piers may be used to support the SCADA tower. It is our understanding that the tower is to be constructed, approximately, at the existing grade elevation.

- **Piers founded at a depth of 22-ft below existing grade may be considered to support the SCADA tower**. Please contact us if deeper pier depths are required.

- Based on the soils encountered in the borings, tan clays are expected at this depth.

- The piers founded at a depth of 22-ft below existing grade may be sized for an Allowable End Bearing Capacity value of 5,750 lbs per sq ft.

- Allowable skin friction value of 675 lbs per sq ft is recommended. Skin friction value should be discarded for the top 8-ft of the pier shaft.

- Uplifts Forces Moisture variation in the expansive soils at this site can cause vertical movements of the subsurface soils. This potential vertical movement can mobilize uplift force along the shaft of a drilled pier. The uplift force acting on the shaft may be estimated by using the Equation No. 1.

  Fu = 36d - - - - - - (1)

  Fu = uplift force in kips

  d = Diameter of the shaft in feet

  Tension steel will be required in each pier shaft to withstand a net force equal to the uplift force minus the sustained compression load carried by that footing. We recommend that each pier be reinforced with tension steel to withstand this net force or one percent of the cross-sectional area that shaft, whichever is maximum.

- Lateral Resistance of the Piers The lateral resistance and the respective lateral deflection at the top of the pier may be evaluated by using the L Pile program. Please contact InTEC to run the L-Pile analysis with the lateral load information. The geotechnical parameters for L-Pile program are presented in Table No. 3.

Table No. 3 – L-Pile Parameters

Depth Range, Feet	Shear Strength, TSF	Soil Modulus, PCI	Ɛ 50	y PCF
8 – 22	0.9	675	0.005	100
Friction angle, phi, for clays = 0				

GENERATOR AND EQUIPMENT FOUNDATIONS

Stiffened grid type beam and slab foundation or Mat foundation may be used to support the Generator and other equipment provided all of the following items are followed:

(a) the anticipated potential vertical movements presented in the "Vertical Movements" section are acceptable to the owner,

(b) the owner (after discussing the resulting corresponding potential movements and their effect on the performance of the structures with the project structural engineer and the project architect) determines that the anticipated movements will not adversely affect the performance of the proposed structures,

(c) the subgrade is proof rolled, and

(d) all the recommendations presented in the "Construction Guidelines" section are followed.

Stiffened Grid Type Beam and Slab Foundations

It is desirable to design the foundations system utilizing the simplifying assumption that the loads are carried by the beams. The grade beams or mat foundation should be supported at a depth of 24 inches below final grade elevation. Allowable Bearing Capacity value is presented in Table No. 4 in the following page. The design plasticity index values will change when cut and fill operations are performed underneath the building pad. Stiffened grid type beam and slab foundation parameters are also presented in Table No. 4. For a mat foundation a subgrade modulus value of **100 pci** is recommended.

Table No. 4 – Stiffened Grid Type Beam and Slab Foundation Parameters

Soil Condition	Net Allowable Bearing Capacity (psf)	Unconfined Compressive Strength (tsf)	Design Plasticity Index Value	Soil Support Index	Climatic Rating
Compacted Subgrade **(PVR of 3 to 4 inches)**	1,500	0.7	44	0.66	17

Notes:

- The grade beams should be founded on or within compacted existing soils or compacted select fill.
- Allowable bearing capacity values as presented above are recommended for grade beams founded at a minimum depth of 24 inches below final grade elevation.
- The bearing stratum should be verified by InTEC prior to installation of steel and concrete.
- Minimum grade beam width of 12 inches is recommended.

Seismic Design Criteria

The following seismic design criteria are presented based on the International Building code 2018 (IBC 2018) Section 1613 - Earthquake Loads. These criteria include the seismic site class and the spectral acceleration values and presented in Table No. 5.

Table No. 5 – Seismic Design Criteria

Site Class Site class definition was determined based on Standard Penetration Test values – ASCE 7-16	D
Maximum considered earthquake 0.2 sec spectral response acceleration - Figure 1613.2.1(1) IBC 2018	S_s = 0.085g
Maximum considered earthquake 1.0 sec spectral response acceleration – Figure 1613.2.1(2) IBC 2018	S_1 = 0.026g

Note: the 2018 International Building Code (IBC) requires a site soil profile determination based on 100-ft depth for seismic site classification. The seismic site class definition considers that the same soils continue below the maximum depth of our borings. Deeper borings will be required to confirm the conditions below the maximum depth of our boring.

PAVEMENT GUIDELINES

General

Pavement areas for the proposed project are expected to include parking areas and driveways. The following recommendations are presented as a guideline for pavement design and construction. These recommendations are based on a) our previous experience with subgrade soils like those encountered at this site, b) pavement sections which have proved to be successful under similar design conditions, c) final pavement grades will provide adequate drainage for the pavement areas and that water will not be allowed to enter the pavement system by either edge penetration adjacent to landscape areas or penetration from the surface due to surface ponding, or inadequate maintenance of pavement joints, or surface cracks that may develop, and d) design criteria presented in the previous paragraph.

It is beyond the scope of this investigation to do more than point out the factors that have a definite influence on the amount and type of swell to which a pavement is subjected during its useful life. The design engineer must be aware of these factors as he develops his design and make adjustments as necessary according to the results of special measurements or from his engineering experience and judgment.

Pavement designs provide an adequate thickness of structural sections over a particular subgrade (in order to reduce the wheel load to a distributed level so that the subgrade can support load). The support characteristics of the subgrade are based on strength characteristics of the subgrade soils **and not on the shrinkage and swelling characteristics of the clays.** Therefore, the pavement sections may be adequate from a structural stand point, may still experience cracking and deformation due to shrinkage and swelling characteristics of the soils. In addition, if the proposed new pavement areas are used to carry temporary construction traffic, then heavier street sections may be needed. Please contact InTEC to discuss options.

It is very important to minimize moisture changes in the subgrade to lower the shrinkage and swell movements of the subgrade clays. The pavement and adjacent areas should be well drained. Proper maintenance should be performed by sealing the cracks as soon as they develop to prevent further water penetrations and damage. In our experience,

(a) majority of the pavement distress observed over the years were caused by changes in moisture content of the underlying subgrade and / or excessive moisture in the base section,

(b) pavements with a grade of one percent or more have performed better than the pavements with allowable minimum grade,

(c) pavements with no underground utilities have performed better than pavements with underground utilities and the associated laterals,

(d) pavements that are at a higher-grade elevation than the surrounding lots have performed better, and

(e) any design effort that minimizes moisture penetration into the pavement layers have performed better.

Periodic maintenance such as crack sealing should be anticipated for pavements constructed on clay subgrades.

"Alligator" type Cracks

A layer of aggregate base is typically used underneath the concrete curbs around the pavement areas. This layer of aggregate base underneath the concrete curb is conducive to the infiltration of surface water into the pavement areas. Water infiltration into the base layer can result in "alligator type" cracks especially when accompanied by construction traffic. Increasing the moisture content of the pavement sections will significantly impact the support characteristics. Penetrating the concrete curbs at least six inches into the native clays soils will act as a barrier to this type of water infiltration. In addition, French Drains installed on the outside of the curbs will reduce this type of water infiltration. Alligator type cracks are also caused by weak / soft pockets within the pavement layers.

Longitudinal Cracks

Asphalt pavements in expansive soil conditions, such as the soils encountered at this site, can develop longitudinal cracks along the pavement edges. The longitudinal cracking typically occurs about 1 to 4 feet inside of the pavement edges and they run parallel to the pavement edge. The longitudinal cracks are generally caused by differential drying and shrinkage of the underlying expansive clays. The

moisture content change of the underlying subgrade clays can be reduced by installing moisture barriers. Vertical moisture barriers along the edge of the pavement or horizontal moisture barriers such as paved sidewalks or geogrid will help reduce the development of the longitudinal or reflective cracks.

Periodic Maintenance

The pavements constructed on clay subgrades such as the one encountered at this site will be subjected to swell and shrinkage related movements. Hence, **periodic maintenance such as crack sealing and surface finishing should be anticipated and performed.**

Pavement Sections

Parking areas and drives may be designed with either a flexible or rigid pavement. Pavement sections for both rigid and flexible types are recommended as follows for drive areas and parking areas. Brown clay subgrades are anticipated. Pavement recommendations presented here are based on existing soil conditions. If the subgrade condition is different from the anticipated brown clays, please contact us.

Table No. 6 – Concrete Pavement

	Parking Areas	Drive Areas	Heavy Duty
Reinforced Concrete (inches)	5 ½	6 ½	8
Cement treated subgrade (inches)	6	6	6

- Heavy Duty concrete section is recommended in areas which receive repetitive traffic such as drive-through lanes, entry / exit ramps, and trash dump areas, even if Asphaltic concrete pavement is used in other areas.

Table No. 7 – Asphalt Pavement

	Parking Areas	Drive Areas
Hot Mix Asphaltic Concrete-HMAC (inches)	2	3
Aggregate Base (inches)	9	10
Cement treated subgrade	6 inches	

- Heavy duty concrete section is recommended in areas which receive repetitive traffic such as drive-through lanes, entry / exit ramps, and trash dump areas, even if Asphaltic concrete pavement is used in other areas.

- It is our understanding that emergency vehicles, weighing up to 75,000 lbs, will also use the pavement at this site. The recommended pavement sections for Drive Areas and Heavy Duty Areas may be used for the use of emergency vehicles.

Notes:

- The recommendations are based on anticipated subgrade material. If cut and fill are performed, please let InTEC know.

- The flexible pavement recommendations are based on input parameters presented in Table No. 8. If recommendations for different inputs are needed, please contact us.

- Recommendations presented in the tables above do not apply to traffic areas with heavy truck or repetitive truck traffic areas.

- Final pavement subgrade Plasticity Index values are anticipated to be greater than 20:

    - Cement treated subgrade: The subgrade may be treated with cement. Application rate of 27 lbs per sq yard for 6 inch depth of treatment is recommended.

- Pavement section recommendations are based on subgrades prepared as described in this report. If water is allowed to get underneath the asphalt / concrete or if moisture content of the base or subgrade changes significantly, then pavement distress will occur.

- Deeper curbs, curbs extending a minimum 6 inches into subgrade will help reduce the moisture getting underneath the pavement.

- The pavement can experience cracking and deformation due to shrinkage and swelling characteristics of the soils as described in the Vertical Movements section of this report. Periodic maintenance will be required.

Table No. 8 – Input Parameters – Flexible Pavement Section Calculation

Parameter	Flexible Pavement Parking Areas	Flexible Pavement Drive Areas
ESAL	20,000	40,000
Reliability Level	R-70	R-70
Serviceability Loss	2.0	2.0
Standard Deviation	0.45	0.45
Service Life	20 years	20 years
Subgrade CBR	2.5	2.5

Subgrade Preparation

Existing asphalt pavement should be removed and the exposed subgrade should be properly prepared prior to pavement installation. The subgrade should be proof rolled and prepared as described in the previous section. Base course material should be placed immediately upon completion of the subgrade compaction operation to prevent drying of the soils due to exposure.

Base Course

Based on the surveys of available materials in the area, a base course of crushed limestone aggregate or gravel appears to be the most practical material for asphalt pavement project. The base course should conform to Texas State Department of Highways and Public Transportation Standard Specifications, Item 247, Type A, Grade 1-2. The base course should be compacted in two lifts to at least 95 percent of maximum dry density as determined by test method TXDOT-113-E at a moisture content in between optimum minus 1 and optimum plus 2 percent.

The existing asphalt and base material may be recycled and should meet the same specifications as noted above, TxDOT Item 247, Type A, Grade 1-2.

Asphaltic Concrete

The Asphaltic concrete surface course material and installation should conform to all applicable City San Antonio Guidelines.

Reinforced Concrete

Concrete material and installation should follow all applicable City of San Antonio Guidelines. At a minimum, 28-day compressive strength requirement of 4000 psi may be utilized.

Concrete Pavement

Concrete pavement slabs should be provided with adequate steel reinforcement. Proper finishing of concrete pavements requires the use of sawed and sealed joints which should be designed in accordance with current Portland Cement Association guidelines. Dowel bars should be used to transfer loads at transverse joints. Related civil design factors such as drainage, cross-sectional configurations, surface elevations and environmental factors which will significantly affect the service life must be included in the preparation of the construction drawings and specifications. Normal periodic maintenance will be required, especially for open jointed areas which may allow surface water infiltration into the subgrade.

Table No. 9 – Concrete Pavement Reinforcement

Reinforcement:	#3 reinforcing steel bars (grade 60) at 18 inches on center each way (at 12 inches on center each way for 8 inch thick concrete)
Contraction joint spacing:	10 feet each way for 5 ½ inch thick concrete 12 feet each way for 6 ½ inch thick concrete 15 feet each way for 8 inch thick concrete The saw cuts should be planned based on features such as inlets, manholes, valves, etc. The saw cuts are recommended to be made the same day.
Contraction joint depth:	At least one-fourth (¼) of pavement thickness
Contraction joint width:	One-fourth (¼) inch or as required by joint sealant manufacturer
Expansion joint:	Expansion joints are not recommended
Isolation joint:	Features such as concrete inlet structures, man-holes, and valve covers should be isolated using isolation joints.

Perimeter Drainage

It is important that proper perimeter drainage be provided so that infiltration of surface water from compacted areas surrounding the pavement is minimized, or if this is not possible, curbs should extend through the base and into the subgrade. A crack sealant compatible to both asphalt and concrete should be installed at the concrete-asphalt interfaces.

The surface water may infiltrate from the compacted areas surrounding the pavement. These areas should be sloped away from the pavement areas and should be grass or concrete covered or rip-rapped. If a berm is provided before the sloped area, the berm should be sloped at least 1V to 8H. The sloped areas may be as steep as 1V to 3H. The sloped area will provide for drainage of the surface water away from the pavement areas.

CONSTRUCTION GUIDELINES

Construction Monitoring

As Geotechnical Engineer of Record for this project, InTEC should be involved in monitoring the foundation installation and earth work activities. Performance of any foundation system is not only dependent on the foundation design, but is strongly influenced by the quality of construction. Please contact our office prior of construction so that a plan for foundation and earthwork monitoring can be incorporated in the overall project quality control program.

Site Preparation

Site preparation will consist of **preparation of the subgrade, and placement of select structural fill.** The project geotechnical **engineer InTEC should approve the subgrade preparation, the fill materials, and the method of fill placement and compaction.**

In any areas where soil-supported floor slabs or pavement are to be used, vegetation and all loose or excessively organic material should be stripped to a minimum depth of six inches and removed from the site. Subsequent to stripping operations, the subgrade should be proof rolled prior to fill placement and recompacted to **95 percent of the maximum dry density as determined by ASTM D 698 test method within one percent below or three percent above optimum moisture content.** The exposed subgrade should not be allowed to dry out prior to placing structural fill.

Voids caused by site preparation should be replaced with select structural fill and compacted in accordance with the select fill compaction recommendations.

Proof Rolling

Proof rolling should be accomplished in order to locate and density any weak compressible zones under the building and pavement areas and prior to placement of the select fill or base. If any area, where soil-supported floor slabs are to be used, is disturbed, then it should be proof rolled as recommended here. A minimum of 10 passes of a 25-ton pneumatic roller should be used for planning purposes. The operating load and tire pressure should conform to the manufactures specification to produce a minimum ground contact pressure of 90 pound per square inch. Proof rolling should be performed under the inspection of InTEC Geotechnical Engineer: The soils that yield or settle under proof rolling

operations should be removed, dried and compacted or replaced with compacted select fill to grade. Density test should be conducted as specified under Control Testing and Filed Observation after satisfactory proof rolling operation.

Select Fill

Any select structural fill used under the building should have a liquid limit less than 40 and a plasticity index in between 5 and 20. The fill should contain no particles greater than 3 inches in diameter. **The percent passing U.S. Standard Sieve No. 4 should be in between 40 and 80 percent and Sieve No. 40 passing should be in between 10 and 50 percent. The percent passing Sieve No. 200 should be less than 20 percent**.

Crushed limestone with sufficient fines to bind the aggregate together is a suitable select structural fill material. The fill materials should be placed in loose lifts not to exceed 8 inches thick (6-inches compacted) and compacted to a minimum of 95 percent of the maximum dry density as determined by ASTM D 1557 procedure at a moisture content within 3 percent of the optimum water content.

Ground Water

In any areas where significant cuts (2-ft or more) are made to establish final grades for building pads, attention should be given to possible seasonal water seepage that could occur through natural cracks and fissures in the newly exposed stratigraphy. Subsurface drains may be required to intercept seasonal groundwater seepage. The need for these or other dewatering devices on building pads should be carefully addressed during construction. Our office could be contacted to visually inspect final pads to evaluate the need for such drains.

The ground water seepage may happen several years after construction if the rainfall rate or drainage changes within the project site or outside the project site. If seepage run off occurs towards the building an engineer should be called on to evaluate its effect and provision of French Drains at this location.

Drainage

Ground water was encountered at an approximate depth of 27-ft in Boring B-1 at the time of drilling. Minor ground water seepage may be encountered within the proposed foundation areas and grading

excavations at the time of construction, especially after periods of heavy precipitation. **Small quantities of seepage may be handled by conventional sump and pump methods of dewatering.**

Temporary Drainage Measures

Temporary drainage provisions should be established, as necessary, to minimize water runoff into the construction areas. If standing water does accumulate, it should be removed by pumping as soon as possible.

Adequate protection against sloughing of soils should be provided for workers and inspectors entering the excavations. This protection should meet O.S.H.A. and other applicable building codes.

Time of Construction

If the foundation slab is installed during or after an extended dry period, the slab may experience greater movement around the edges when the soil moisture content increases, such as due to rain or irrigation. Similarly, a slab installed during or after a wet period may experience greater movement around the edges during the subsequent drying of the soils.

Control Testing and Field Observation

Subgrade preparation and select structural fill placement should be monitored by the project geotechnical engineer or his representative of InTEC. As a guideline, at least one in-place density test should be **performed for each 3,000 square feet of compacted surface lift.** However, a minimum of three density tests should be performed by InTEC on the subgrade or per lift of compaction. Any areas not meeting the required compaction should be re-compacted and retested until compliance is met.

Foundation Construction and Field Observation

It is recommended that all grade beam excavations be extended to the final grade and grade beams constructed as soon as possible to minimize potential damage to the bearing soils. Exposure to environment may weaken the soils at the bearing level if the foundation excavation remains open for long periods of time. The foundation bearing level should be free of loose soil, ponded water or debris. **The bearing level should be inspected by the project geotechnical engineer or his representative of InTEC and approved before placement of concrete.**

Drilled Piers

Field Observations Each drilled pier excavation must be monitored by a qualified individual who is familiar with the geotechnical aspects of the soil stratigraphy, structural configuration, foundation design details and assumptions prior to placing concrete. This is to observe that:

(1) The footing has been drilled to the specific dimensions at the correct depth established by the previously mentioned criteria;

(2) The bottom of the footing is concentric to the pier shaft;

(3) The pier shaft has been drilled plumb within specified tolerances along its total length;

(4) Excessive cuttings, build-up and soft, compressible material have been moved from the bottom of the excavation.

Placement of concrete should be accomplished as soon as possible for each footing to reduce changes in the moisture content or the state of stress of the foundation soils. We recommend that footings be concreted with the approval of the project geotechnical engineer. No completed footing excavation should be left overnight without concreting.

Surface run off or ground water seepage accumulating in the excavation should be pumped out and the condition of the bearing surface should be evaluated immediately prior to placing concrete.

Casing **Ground water seepage was not encountered within 23-ft (pier depth) in the borings at the time of drilling**. **Water seepage was encountered at an approximate depth of 27-ft in Boring B-1 at the time of drilling**. However, ground water seepage may be encountered at shallower depths at the time of pier construction, especially after periods of heavy rainfall at some pier locations. Zones of sloughing soils may also happen during pier construction (gravelly soils were encountered in one of the borings). It is our understanding that TxDOT specifications are planned to be used and these specifications include the cost of casing if needed. If specifications other than TxDOT are used, we recommend that the bid documents require the foundation contractor to specify unit costs for different lengths of casing which may be required.

If groundwater seepage occurs, the use of casing should help to minimize groundwater inflow into the pier excavation, although it may not alleviate seepage from the soils. If seepage persists even after casing installation, the water should be pumped out of the excavation immediately prior to placing concrete. **If**

groundwater inflow is too severe to be controlled by pumping, the concrete should be tremied to the full depth of the excavation to effectively displace the water. In this case, a "clean-out" bucket should be utilized to remove the soil from the pier bottom before placing steel and concrete.

If casing is utilized, removal of the casing should be performed with extreme care under proper supervision to minimize mixing of the surrounding soil and water with the concrete.

Variation in drilled shaft depths should be anticipated at this site. Contract documents should include pay items for constructing drilled shafts on a unit price basis.

Drilling Equipment **High power and high torque drilling equipment will be required to drill through the silty clays encountered at this site**. Based on past experience, sandstone seams should be anticipated at this site. The information presented in the boring logs should not be used as a basis for selecting drilling equipment or for budgeting purposes by the contractor

DRAINAGE AND MAINTENANCE

Final drainage is very important for the performance of the proposed structure and the pavement. Plumbing leaks should be repaired as soon as possible in order to minimize the magnitude of moisture change under the slab. Large trees and shrubs should not be planted in the immediate vicinity of the structures, since root systems can cause a substantial reduction in soil volume in the vicinity of the trees during dry periods.

Adequate drainage should be provided to reduce seasonal variations in moisture content of the soils. All pavement and sidewalks within 10-ft of the structure should be sloped away from the structure to prevent ponding of water around the structure. Final grades within 10-ft of the structure should be adjusted to slope away from structures preferably at a minimum slope of 3 percent. Maintaining positive surface drainage throughout the life of the structure is essential.

In areas with pavement or sidewalks adjacent to the new structure, a positive seal must be provided and maintained between the structure and the pavement or sidewalk to minimize seepage of water into the underlying supporting soils. Post-construction movement of pavement and flat-work is not uncommon. Maximum grades practical should be used for paving and flatwork to prevent areas where water can pond. In addition, allowances in final grades should take into consideration post construction movement of flatwork particularly if such movement would be critical. Normal maintenance should include inspection of all joints in paving and sidewalks, etc. as well as re-sealing where necessary.

Trench backfill for utilities should be properly placed and compacted as outlined in this report and in accordance with requirements of local City Standards. Since granular bedding backfill is used for most utility lines, the backfilled trench should be prevented from becoming a conduit and allowing an access for surface or subsurface water to travel toward the new structures. Concrete cut-off collars or clay plugs should be provided where utility lines cross the structure lines to prevent water traveling in the trench backfill and entering beneath the structure.

The PVR values estimated and stated under “Vertical Movements” are based on provision and maintenance of positive drainage to divert water away from the structures and the pavement areas. If the drainage is not maintained, the wetted front may move below the assumed twelve feet depth, and resulting PVR will be much greater than 2 or 3 times the stated values under Vertical Movements. Utility line leaks may contribute water and cause similar movements to occur.

LIMITATIONS

The analyses and recommendations submitted in this report are based upon the data obtained from **two borings** drilled at the site.

This report may not reflect the exact variations of the soil conditions across the site. The nature and extent of variations across the site may not become evident until construction commences.

The information contained in this report and on the Boring Logs are not intended to provide the contractor with all the information needed for proper selection of equipment, means and methods, or for cost and schedule estimation purposes. The use of information contained in the report for bidding purposes should be done at the contractor's option and risk.

If variations then appear evident, it will be necessary to re-evaluate our recommendations after performing on-site observations and tests to establish the engineering significance of any variations.

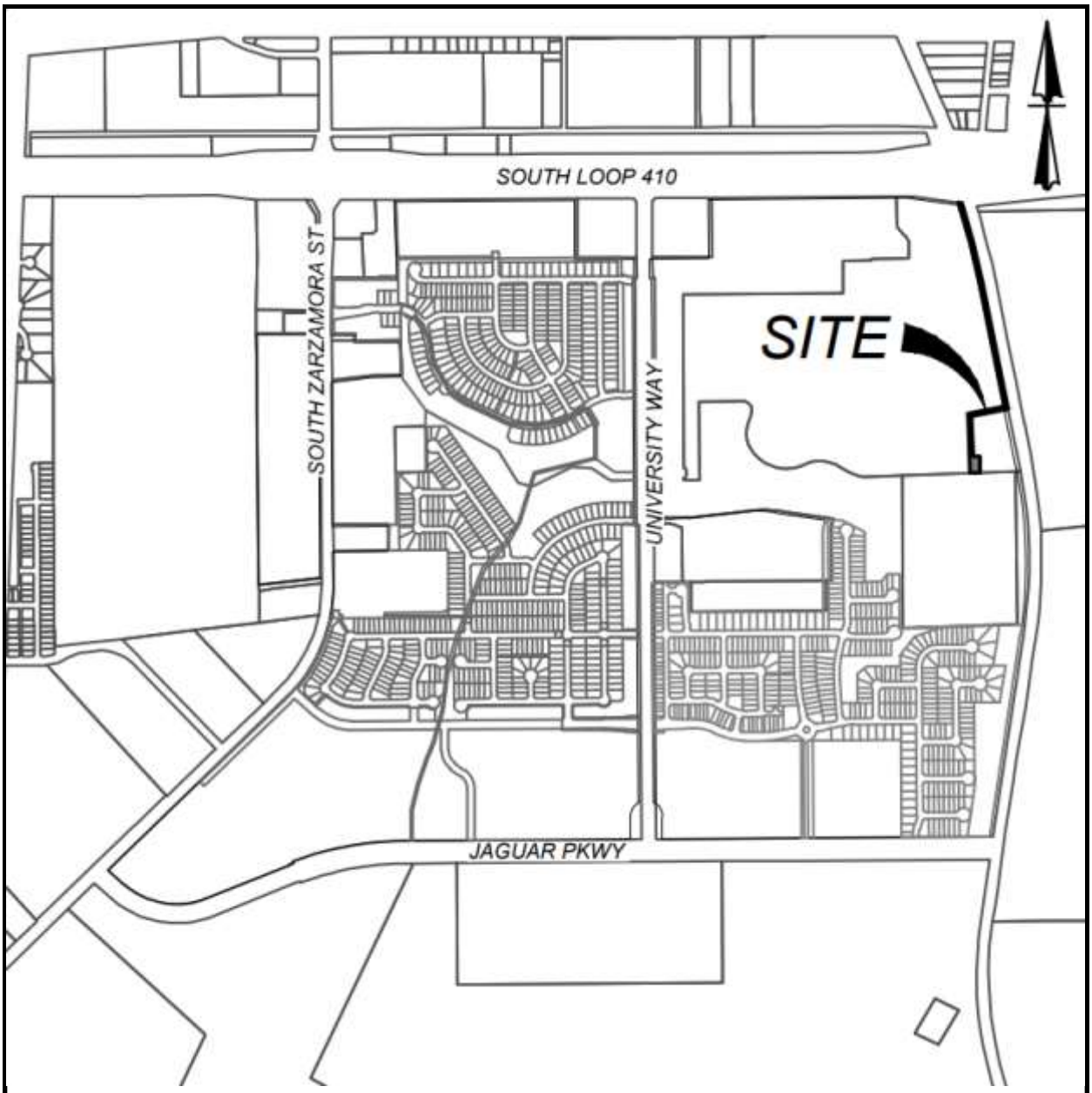
The project geotechnical engineer should review final plan for the proposed structures so that he may determine if change in the foundation recommendations are required.

The project geotechnical engineer declares that the findings, recommendations, or professional advice contained herein have been made and this report prepared in accordance with generally accepted professional engineering practice in the fields of geotechnical engineering and engineering geology. InTEC should be engaged to review the recommendations presented in this report if cut and fill operations are performed or if any changes are made to drainage conditions. No other warranties are implied or expressed.

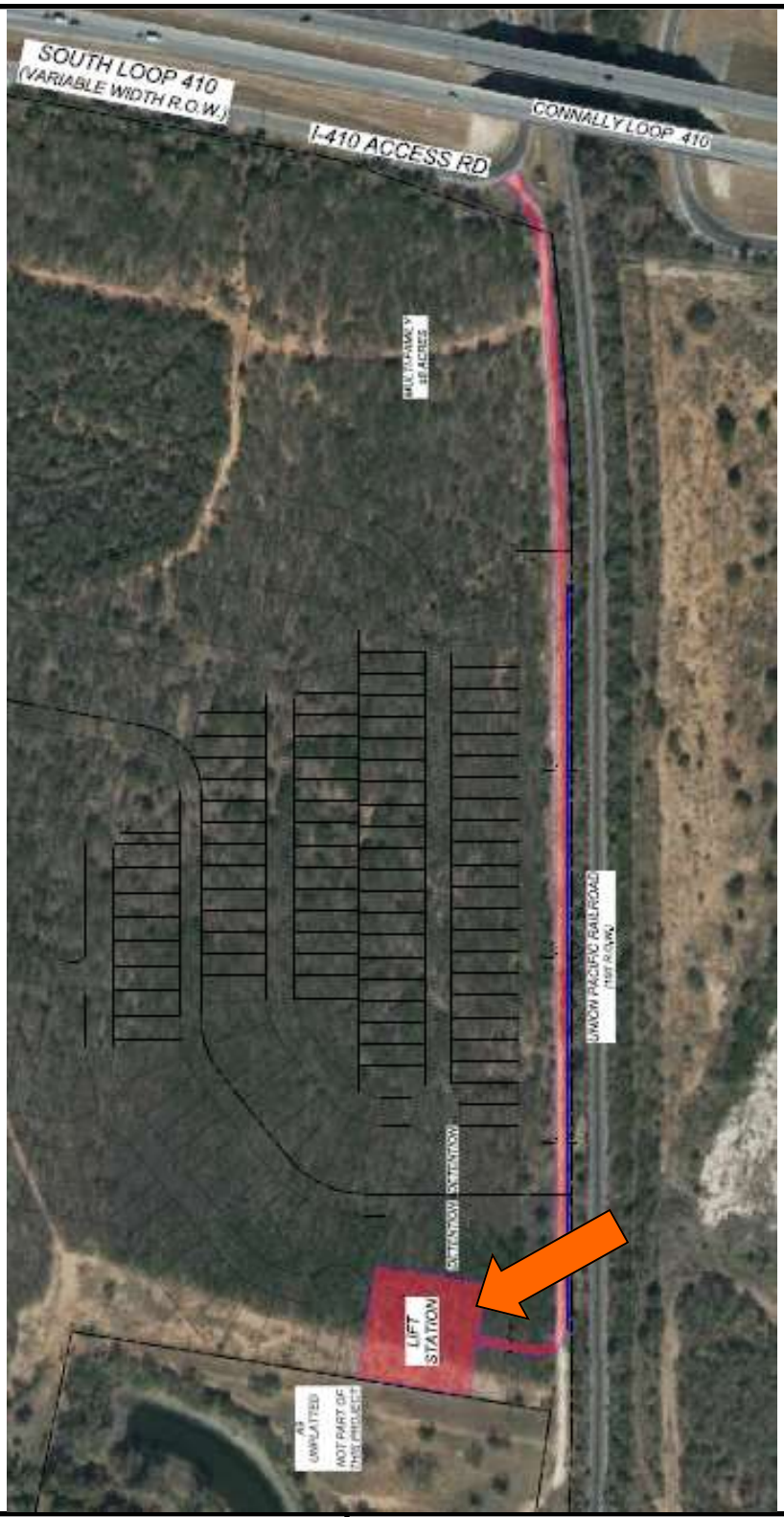
This report has been prepared for the exclusive use of **Southstar at Verano, LLC** and their design team for the design evaluation for the **proposed new Lift Station at Vida San Antonio Subdivision in San Antonio, Texas.**

Illustration Section

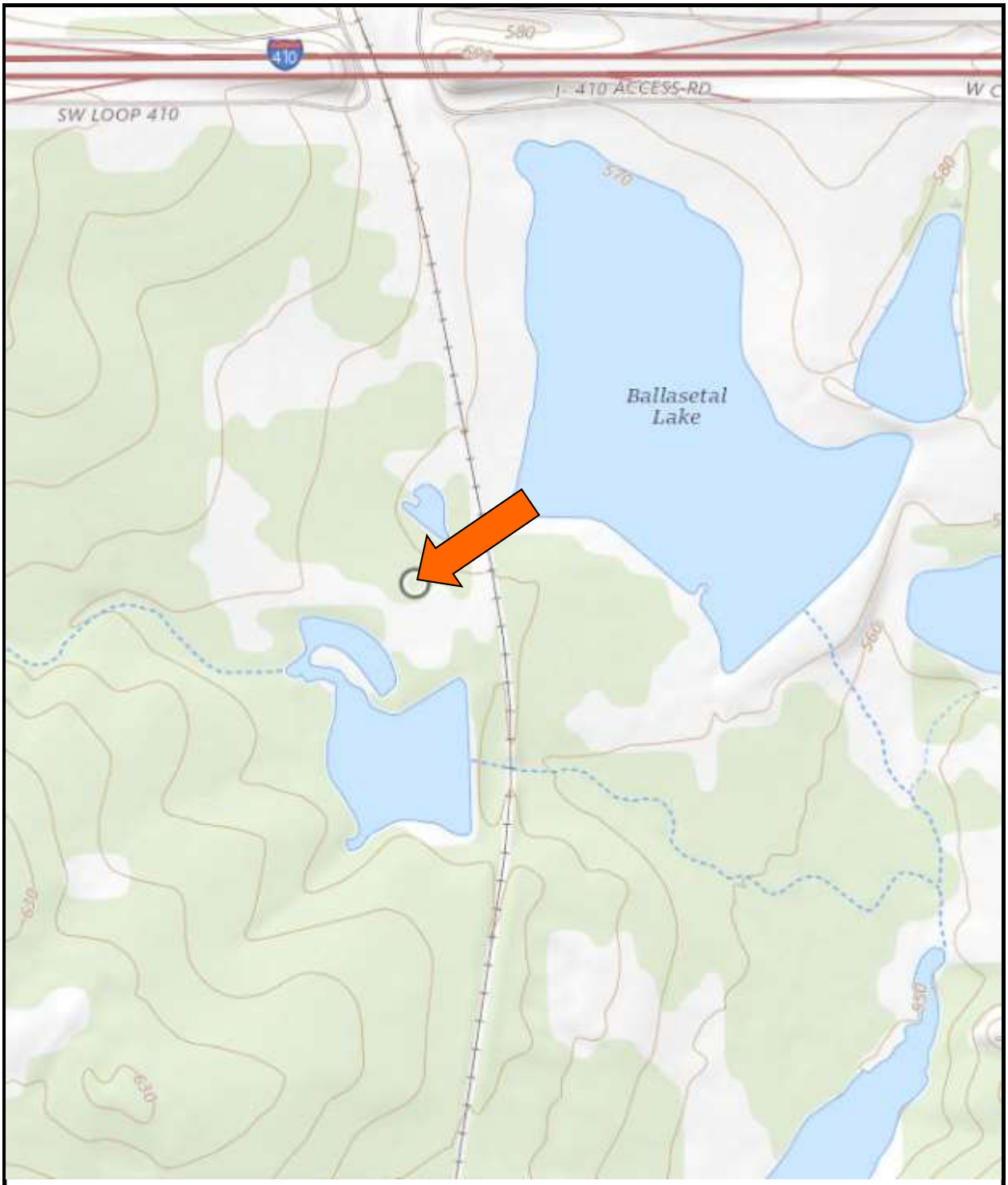
Description	Plate No.
Vicinity Map	Plate 1A
Aerial Map	Plate 1B
Topographic Map	Plate 1C
Geologic Map	Plate 1D
Soil Map	Plate 1E
Approximate Boring Locations	Plate 1F
Boring Logs	Plates 2 & 3
Keys to Classifications and Symbols	Plate 4
Information on Geotechnical Report	Appendix



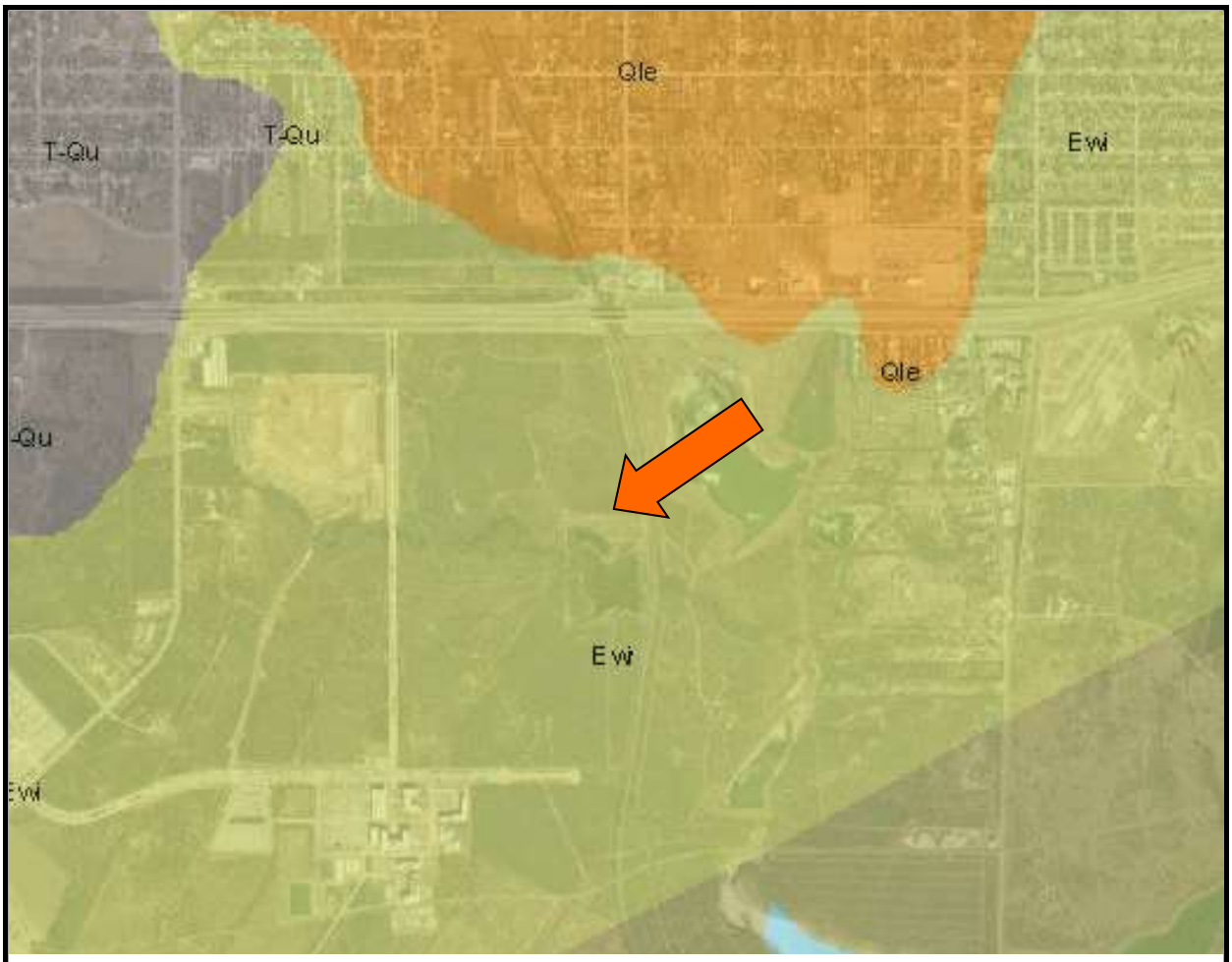
Subsurface Exploration and Foundation Analysis Proposed New Lift Station Vida San Antonio Subdivision San Antonio, Texas	**Vicinity Map**	
	InTEC Project Number: **S231701-R1**	Date: 07/05/2023



Subsurface Exploration and Foundation Analysis Proposed New Lift Station Vida San Antonio Subdivision San Antonio, Texas	**Aerial Map—Approximate Location**	
	InTEC Project Number: **S231701-R1**	Date: 07/05/2023



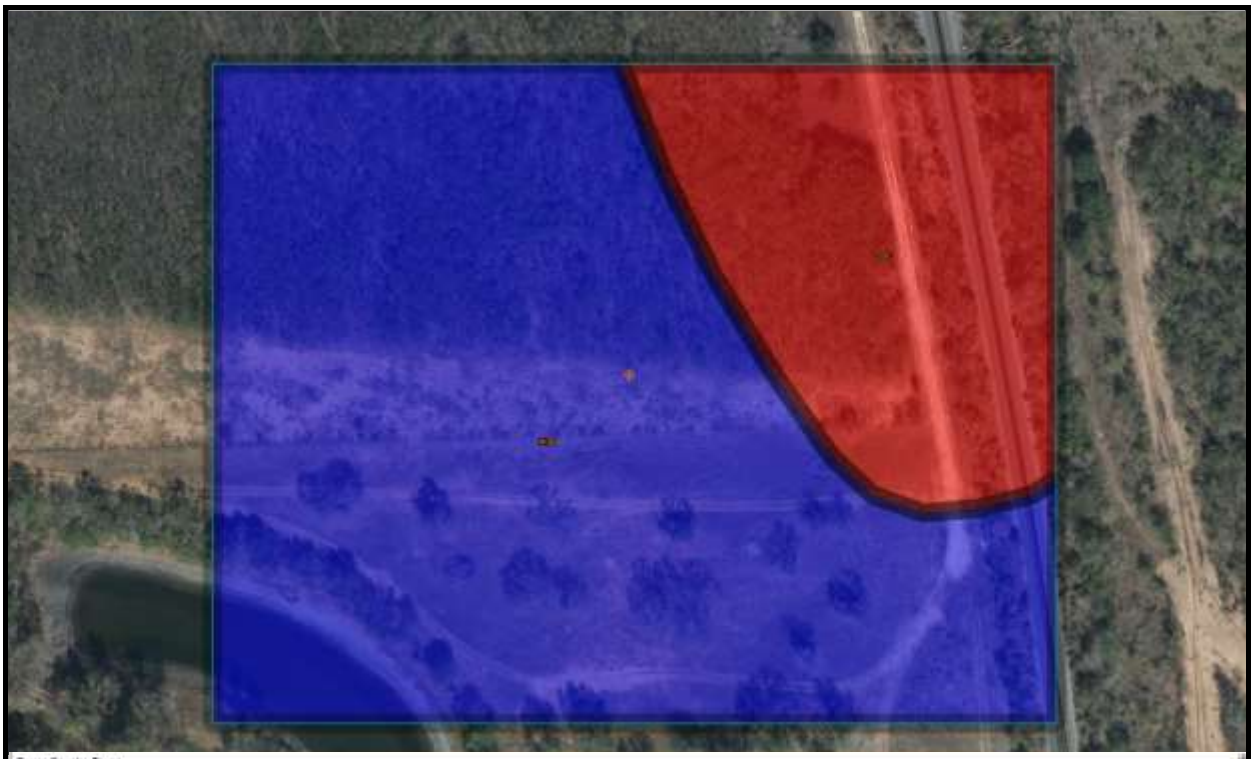
Subsurface Exploration and Foundation Analysis Proposed New Lift Station Vida San Antonio Subdivision San Antonio, Texas	**Topographic Map—Approximate Location**	
	InTEC Project Number: **S231701-R1**	Date: 07/05/2023



Ewi—Wilcox Group

mostly mudstone with varying amounts of sandstone and lignite; in uppermost and lowermost parts commonly glauconitic; mudstone. massive to thin bedded, some silt and very fine sand laminae, pale brown to yellowish brown in upper part, medium to dark gray, weathering yellowish gray in lower part; sandstone in upper part, medium to fine grained, light gray to pale yellowish brown, in lower part very fine grained, yellowish brown to moderate brown, lignite mostly near middle; lower boundary not readily mappable because of gradation into Midway Group (contact taken from sources shown on Index to Geologic Mapping): thickness about 440-1200 feet

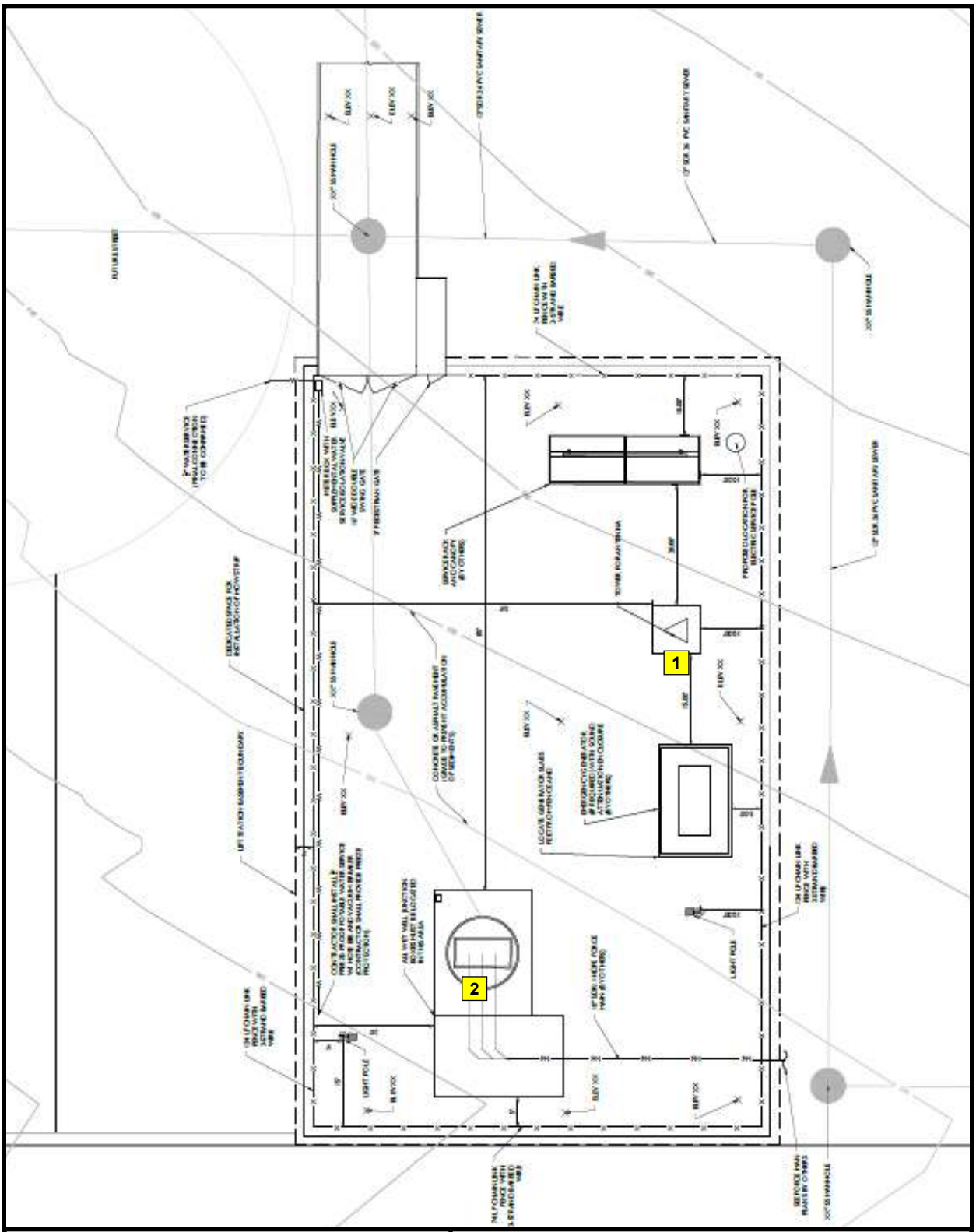
Subsurface Exploration and Foundation Analysis Proposed New Lift Station Vida San Antonio Subdivision San Antonio, Texas	**Geologic Map—Approximate Location**	
	InTEC Project Number: **S231701-R1**	Date: 07/05/2023



Bexar County, Texas

Map unit symbol and soil name	Pct. of map unit	Hydrologic group	Depth	USDA texture	Classification		Pct Fragments		Percentage passing sieve number—				Liquid limit	Plasticity index
					Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
			In				L-R-H	L-R-H	L-R-H	L-R-H	L-R-H	L-R-H	L-R-H	L-R-H
HuB—Houston Black gravelly clay, 1 to 3 percent slopes														
Houston black	80	D	0-6	Gravelly clay	CH, GC	A-7-6	0- 0- 0	0- 3- 4	65-69- 73	46-57- 73	41-55- 73	35-48- 66	63-70 -76	38-44-49
			6-70	Clay, silty clay	CH	A-7-6	0- 0- 0	0- 0- 0	96-98-100	96-96-100	85-92-100	74-81- 90	58-70 -76	38-44-49
			70-80	Clay, silty clay	CH	A-7-6	0- 0- 0	0- 0- 0	94-96-100	86-92-100	74-88-100	65-78- 95	61-71 -75	37-45-50
SaC—San Antonio clay loam, 3 to 5 percent slopes														
San antonio	100	C	0-6	Clay loam	CL	A-6, A-7	0- 0- 0	0- 0- 0	95-98-100	95-98-100	95-98-100	70-78- 85	35-40 -45	15-20-25
			6-28	Clay, clay loam	CH, CL	A-7-6	0- 0- 0	0- 0- 0	95-98-100	90-95-100	90-95-100	75-85- 95	48-57 -65	25-32-39
			28-60	Clay loam, sandy clay loam	CH, CL	A-7-6	0- 0- 0	0- 2- 3	92-96-100	90-95-100	90-95-100	70-78- 85	41-51 -60	20-28-35

Subsurface Exploration and Foundation Analysis Proposed New Lift Station Vida San Antonio Subdivision San Antonio, Texas	**Soil Map—Approximate Location**	
	InTEC Project Number: **S231701-R1**	Date: 07/05/2023



Subsurface Exploration and Foundation Analysis Proposed New Lift Station Vida San Antonio Subdivision San Antonio, Texas	**Approximate Boring Locations**	
	InTEC Project Number: **S231701-R1**	Date: 07/05/2023

PROJECT: Lift Station - Vida San Antonio **PROJECT NO: S231701**

LOCATION: San Antonio, Texas **DATE:** 04/18/2023

CLIENT: Southstar at Verano, LLC

inTEC

BORING NO. B-1

DEPTH (feet)	SYMBOL	SAMPLES	SOIL DESCRIPTION	% MINUS 200 SIEVE	UNIT DRY WT IN PCF	S.S. BY P.P	BLOWS PER FOOT	SHEAR STRENGTH TSF	LIQUID LIMIT	PLASTICITY INDEX
0		SS	Stiff to Very Stiff Dark Brown Sandy Clay				14		42	22
		SS	-with Some Gravel				16			
5		SS					20		47	29
10		AU	Very Stiff Tan Clay -with Gray Silty Clay Seams -with Sandy Clay Seams							
15		SS					28		65	43
20		SS					26			
25		SS					32		53	35
▼			-with Gravel at 26-ft -Water at 27-ft							
30		SS					27			
35		SS					26			
40		SS					25			

Plastic Limit ⊢⊣ *Liquid Limit*

Moisture Content % - ● 20 40 60 80

Notes:

Ground Water Observed: 27-ft

Completion Depth (ft): 40

S.S by P.P - Shear Strength in TSF by Hand Penetrometer

S.S. - Split Spoon Sample
S.T. - Shelby Tube Sample

HA - Hand Auger
AU - Auger Sample

Plate: 2

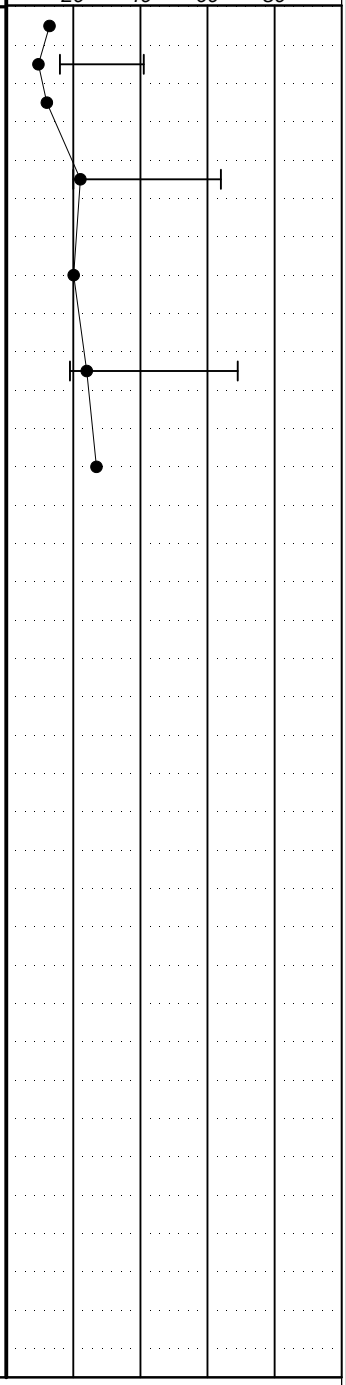
PROJECT: Lift Station - Vida San Antonio **PROJECT NO: S231701**

LOCATION: San Antonio, Texas **DATE:** 04/18/2023

CLIENT: Southstar at Verano, LLC

BORING NO. B-2

DEPTH (feet)	SYMBOL	SAMPLES	SOIL DESCRIPTION	% MINUS 200 SIEVE	UNIT DRY WT IN PCF	S.S. BY P.P	BLOWS PER FOOT	SHEAR STRENGTH TSF	LIQUID LIMIT	PLASTICITY INDEX
0		SS	Very Stiff Dark Brown Sandy Clay -with Some Gravel				15			
		SS	Very Stiff Tan Clay				18		41	25
5		SS	-with Gray Silty Clay Seams				29			
10		AU							64	44
15		SS					26			
20		SS					20		69	50
25		AU	-with Sandy Clay Seams from 23 to 25- ft							



Notes:

Ground Water Observed: No

Completion Depth (ft): 25

S.S by P.P - Shear Strength in TSF by Hand Penetrometer

S.S. - Split Spoon Sample
S.T. - Shelby Tube Sample

HA - Hand Auger
AU - Auger Sample

Plate: 3

KEY TO CLASSIFICATIONS AND SYMBOLS

Soil Fractions

Component	Size Range
Boulders	Greater than 12"
Cobbles	3" - 12"
Gravel	3" - #4 (4.76mm)
Coarse	3" - ¾"
Fine	¾" - #4
Sand	#4 - #200 (0.074mm)
Coarse	#4 - #10 (2.00mm)
Medium	#10 - #40 (0.42mm)
Fine	#40 - #200 (0.074mm)
Silt and Clay	Less than #200

Soil or Rock Types
(Shown in symbols column)
(Predominate Soil Types Shown Heavy)

TERMS DESCRIBING SOIL CONSISTENCY

Description (Cohesive Soils)	Unconfined Compression TSF	Blows/Ft. Std. Penetration Test	Description (Cohesionless Soils	Blows/Ft. Std. Penetration Tests
Very Soft	0.25	<2	Very Loose	0 – 4
Soft	0.25 – 0.50	2 – 4	Loose	4 – 10
Firm	0.50 – 1.00	4 – 8	Medium Dense	10 – 30
Stiff	1.00 – 2.00	8 – 15	Dense	30 – 50
Very Stiff	2.00 – 4.00	15 – 30	Very Dense	50
Hard	>4.00	>30		

SOIL STRUCTURE

Calcareous	Containing deposits of calcium carbonate; generally nodular.
Slickenside	Having inclined planes of weakness that are slick and glossy in appearance.
Laminated	Composed of thin layers of varying color and texture.
Fissured	Containing shrinkage cracks frequently filled with fine sand or silt. Usually more or less vertical.
Interbedded	Composed of alternate layers of different soil types.
Jointed	Consisting of hair cracks that fall apart as soon as the confining pressure is removed.
Varved	Consisting of alternate thin layers of sand, silt or clay formed by variations in sedimentations during the various seasons of the year, of often exhibiting contrasting colors when partially dried. Each layer is generally less than ½" in thickness.
Stratified	Composed of, or arranged in layers (usually 1 inch or more)
Well-graded	Having a wide range of grain sizes and substantial amount of all intermediate particle sizes.
Poorly or Gap-graded	Having a range of sizes with some intermediate sizes missing.
Uniformly-graded	Predominantly of one grain size.

Appendix

Subsurface Exploration and Foundation Analysis Proposed New Lift Station Vida San Antonio Subdivision San Antonio, Texas		
	InTEC Project Number: **S231701-R1**	Date: 07/05/2023

Important Information about This

Geotechnical-Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

The Geoprofessional Business Association (GBA) has prepared this advisory to help you – assumedly a client representative – interpret and apply this geotechnical-engineering report as effectively as possible. In that way, you can benefit from a lowered exposure to problems associated with subsurface conditions at project sites and development of them that, for decades, have been a principal cause of construction delays, cost overruns, claims, and disputes. If you have questions or want more information about any of the issues discussed herein, contact your GBA-member geotechnical engineer. Active engagement in GBA exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project.

Understand the Geotechnical-Engineering Services Provided for this Report

Geotechnical-engineering services typically include the planning, collection, interpretation, and analysis of exploratory data from widely spaced borings and/or test pits. Field data are combined with results from laboratory tests of soil and rock samples obtained from field exploration (if applicable), observations made during site reconnaissance, and historical information to form one or more models of the expected subsurface conditions beneath the site. Local geology and alterations of the site surface and subsurface by previous and proposed construction are also important considerations. Geotechnical engineers apply their engineering training, experience, and judgment to adapt the requirements of the prospective project to the subsurface model(s). Estimates are made of the subsurface conditions that will likely be exposed during construction as well as the expected performance of foundations and other structures being planned and/or affected by construction activities.

The culmination of these geotechnical-engineering services is typically a geotechnical-engineering report providing the data obtained, a discussion of the subsurface model(s), the engineering and geologic engineering assessments and analyses made, and the recommendations developed to satisfy the given requirements of the project. These reports may be titled investigations, explorations, studies, assessments, or evaluations. Regardless of the title used, the geotechnical-engineering report is an engineering interpretation of the subsurface conditions within the context of the project and does not represent a close examination, systematic inquiry, or thorough investigation of all site and subsurface conditions.

Geotechnical-Engineering Services are Performed for Specific Purposes, Persons, and Projects, and At Specific Times

Geotechnical engineers structure their services to meet the specific needs, goals, and risk management preferences of their clients. A geotechnical-engineering study conducted for a given civil engineer will not likely meet the needs of a civil-works constructor or even a different civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client.

Likewise, geotechnical-engineering services are performed for a specific project and purpose. For example, it is unlikely that a geotechnical-engineering study for a refrigerated warehouse will be the same as one prepared for a parking garage; and a few borings drilled during a preliminary study to evaluate site feasibility will not be adequate to develop geotechnical design recommendations for the project.

Do not rely on this report if your geotechnical engineer prepared it:

- for a different client;
- for a different project or purpose;
- for a different site (that may or may not include all or a portion of the original site); or
- before important events occurred at the site or adjacent to it; e.g., man-made events like construction or environmental remediation, or natural events like floods, droughts, earthquakes, or groundwater fluctuations.

Note, too, the reliability of a geotechnical-engineering report can be affected by the passage of time, because of factors like changed subsurface conditions; new or modified codes, standards, or regulations; or new techniques or tools. *If you are the least bit uncertain* about the continued reliability of this report, contact your geotechnical engineer before applying the recommendations in it. A minor amount of additional testing or analysis after the passage of time – if any is required at all – could prevent major problems.

Read this Report in Full

Costly problems have occurred because those relying on a geotechnical-engineering report did not read the report in its entirety. Do not rely on an executive summary. Do not read selective elements only. *Read and refer to the report in full.*

You Need to Inform Your Geotechnical Engineer About Change

Your geotechnical engineer considered unique, project-specific factors when developing the scope of study behind this report and developing the confirmation-dependent recommendations the report conveys. Typical changes that could erode the reliability of this report include those that affect:

- the site's size or shape;
- the elevation, configuration, location, orientation, function or weight of the proposed structure and the desired performance criteria;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project or site changes – even minor ones – and request an assessment of their impact. *The geotechnical engineer who prepared this report cannot accept*

responsibility or liability for problems that arise because the geotechnical engineer was not informed about developments the engineer otherwise would have considered.

Most of the "Findings" Related in This Report Are Professional Opinions

Before construction begins, geotechnical engineers explore a site's subsurface using various sampling and testing procedures. *Geotechnical engineers can observe actual subsurface conditions only at those specific locations where sampling and testing is performed.* The data derived from that sampling and testing were reviewed by your geotechnical engineer, who then applied professional judgement to form opinions about subsurface conditions throughout the site. Actual sitewide-subsurface conditions may differ – maybe significantly – from those indicated in this report. Confront that risk by retaining your geotechnical engineer to serve on the design team through project completion to obtain informed guidance quickly, whenever needed.

This Report's Recommendations Are Confirmation-Dependent

The recommendations included in this report – including any options or alternatives – are confirmation-dependent. In other words, they are not final, because the geotechnical engineer who developed them relied heavily on judgement and opinion to do so. Your geotechnical engineer can finalize the recommendations *only after observing actual subsurface conditions* exposed during construction. If through observation your geotechnical engineer confirms that the conditions assumed to exist actually do exist, the recommendations can be relied upon, assuming no other changes have occurred. *The geotechnical engineer who prepared this report cannot assume responsibility or liability for confirmation-dependent recommendations if you fail to retain that engineer to perform construction observation.*

This Report Could Be Misinterpreted

Other design professionals' misinterpretation of geotechnical-engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer serve as a continuing member of the design team, to:

- confer with other design-team members;
- help develop specifications;
- review pertinent elements of other design professionals' plans and specifications; and
- be available whenever geotechnical-engineering guidance is needed.

You should also confront the risk of constructors misinterpreting this report. Do so by retaining your geotechnical engineer to participate in prebid and preconstruction conferences and to perform construction-phase observations.

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can shift unanticipated-subsurface-conditions liability to constructors by limiting the information they provide for bid preparation. To help prevent the costly, contentious problems this practice has caused, include the complete geotechnical-engineering report, along with any attachments or appendices, with your contract documents, *but be certain to note conspicuously that you've included the material for information purposes only.* To avoid misunderstanding, you may also want to note that "informational purposes" means constructors have no right to rely on the interpretations, opinions, conclusions, or recommendations in the report. Be certain that constructors know they may learn about specific project requirements, including options selected from the report, *only* from the design drawings and specifications. Remind constructors that they may perform their own studies if they want to, and *be sure to allow enough time* to permit them to do so. Only then might you be in a position to give constructors the information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions. Conducting prebid and preconstruction conferences can also be valuable in this respect.

Read Responsibility Provisions Closely

Some client representatives, design professionals, and constructors do not realize that geotechnical engineering is far less exact than other engineering disciplines. This happens in part because soil and rock on project sites are typically heterogeneous and not manufactured materials with well-defined engineering properties like steel and concrete. That lack of understanding has nurtured unrealistic expectations that have resulted in disappointments, delays, cost overruns, claims, and disputes. To confront that risk, geotechnical engineers commonly include explanatory provisions in their reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The personnel, equipment, and techniques used to perform an environmental study – e.g., a "phase-one" or "phase-two" environmental site assessment – differ significantly from those used to perform a geotechnical-engineering study. For that reason, a geotechnical-engineering report does not usually provide environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated subsurface environmental problems have led to project failures.* If you have not obtained your own environmental information about the project site, ask your geotechnical consultant for a recommendation on how to find environmental risk-management guidance.

Obtain Professional Assistance to Deal with Moisture Infiltration and Mold

While your geotechnical engineer may have addressed groundwater, water infiltration, or similar issues in this report, the engineer's services were not designed, conducted, or intended to prevent migration of moisture – including water vapor – from the soil through building slabs and walls and into the building interior, where it can cause mold growth and material-performance deficiencies. Accordingly, ***proper implementation of the geotechnical engineer's recommendations will not of itself be sufficient to prevent moisture infiltration. Confront the risk of moisture infiltration*** by including building-envelope or mold specialists on the design team. ***Geotechnical engineers are not building-envelope or mold specialists.***

GEOPROFESSIONAL BUSINESS ASSOCIATION

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