

SANITARY SEWER STANDARDS AND PROCEDURES

STANDARD TECHNICAL SPECIFICATIONS

JANUARY 2021

TABLE OF CONTENTS

DIVISION 1 – GENERAL

- 01410 REGULATORY REQUIREMENTS AND REFERENCES
- 01550 VEHICULAR ACCESS AND TRAFFIC CONTROL
- 01570 ENVIRONMENTAL PROTECTION
- 01660 MATERIAL STORAGE AND HANDLING

DIVISION 2 - SITE CONSTRUCTION

- 02100 CLEARING AND GRUBBING
- 02210 WORK IN SOUTH CAROLINA DEPARTMENT OF TRANSPORTATION RIGHTS-OF-WAY
- 02221 TRENCH EXCAVATION, BEDDING AND BACKFILL
- 02226 UTILITY REMOVAL AND ABANDONMENT
- 02240 DEWATERING
- 02250 SHEETING AND BRACING
- 02300 TUNNELING OR BORING
- 02575 PAVEMENT REMOVAL AND REPAIR
- 02730 SANITARY SEWER SYSTEMS
- 02731 DUCTILE IRON SEWER PIPE
- 02732 POLYVINYL CHLORIDE SEWER PIPE
- 02733 SANITARY SEWER SERVICE CONNECTIONS
- 02768 MANHOLE LINING

DIVISION 3 – CONCRETE

- 03300 CAST-IN-PLACE CONCRETE
- 03310 GROUT

DIVISION 4 – PUMP STATION AND FORCE MAIN

- 04005 AIR/VACUUM VALVES FOR WASTEWATER SERVICE
- 04212 ASPHALT PAVING
- 04231 CHAIN LINK FENCES AND GATES
- 04301 CORROSION PROTECTION FOR CONCRETE WASTEWATER STRUCTURES
- 04305 CONCRETE VAULTS AND CHAMBERS

04306 IDENTIFICATION AND SIGNAGE FOR UTILITIES

04332 SUBMERSIBLE SEWAGE PUMPING STATION

04531 SANITARY SEWER FORCE MAINS

04600 ELECTRICAL

04632 STANDBY ELECTRICAL POWER SYSTEM

DIVISION 1 – GENERAL

01410 REGULATORY REQUIREMENTS AND REFERENCES

PART 1 GENERAL

1.1 All work shall comply with applicable codes and standards of the following:

- A. U.S. Army Corps of Engineers
- B. South Carolina Department of Health and Environmental Control (SC DHEC)
- C. Occupational Safety and Health Act (OSHA)
- D. South Carolina Department of Transportation (SC DOT)
- E. County, City, and Local Governments
- F. Water and Sewer Municipalities and Districts

1.2 SILTATION AND EROSION CONTROL

Surface drainage within the construction limits, shall be graded to control erosion and sedimentation. Temporary erosion and sediment control measures such as berms, dikes or drains shall be provided and maintained during construction. The area of bare soil exposed at any one time by construction operations should be held to a minimum.

1.3 SAFETY AND HEALTH REGULATIONS

- A. In addition to other requirements stated elsewhere herein, the Contractor shall comply with the Department of Labor Safety and Health Regulations for construction promulgated under the Occupational Safety and Health Act of 1970 (PL 91-596) and under Section 107 of the Contract Work Hours and Safety Standards Act (PL 91-54).
- B. All chemicals used during project construction or furnished for project operations whether herbicide, pesticide, disinfectant, polymer, reactant, paints, solvents, cleaner or of other classification must show approval of either EPA or USDA. Use of all such chemicals and disposal of residues shall be the Contractor's responsibility and shall be in strict accordance with instructions and applicable local, state and federal regulations.

1.4 Reference to technical societies, institutions, or governmental standards is made in the specifications in accordance with the following abbreviations:

- A. AASHTO - American Association of State Highway and Transportation Officials
- B. ACI - American Concrete Institute
- C. ACPA - American Concrete Pipe Association
- D. AIA - American Institute of Architects

- E. ANSI - American National Standards Institute
- F. ASTM - American Society for Testing and Material
- G. AWWA - American Water Works Association
- H. NAAMM - National Association of Architectural Metal Manufacturers
- I. NSF – National Sanitation Foundation
- J. OSHA – Occupational Safety and Health Act
- K. SCDHEC – South Carolina Department of Health and Environmental Control
- L. SCDOT - South Carolina Department of Transportation

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION 01410

01550 VEHICULAR ACCESS AND TRAFFIC CONTROL

PART 1 GENERAL

1.1 RELATED SECTIONS

- A. Section 02210 – Work in South Carolina Department of Transportation Rights-of-Way

1.2 PROJECT ACCESS

- A. Contractor shall establish and maintain temporary access roads to various parts of the site as required to complete the project. Such roads shall be available for the use of all others performing work in connection with the project.
- B. Contractor shall provide and maintain suitable parking areas for the use of all persons performing work on the project. Parking areas shall be of a size that will eliminate the need for parking personal vehicles where they may interfere with traffic, Owner's operations, private property access, or construction activities.

1.2 TRAFFIC CONTROL

- A. Although the nature of the project may require that traffic be halted for temporary periods, vehicular accessibility for local traffic shall be maintained at all times. The Contractor shall provide and be responsible for all signs, barricades, warning lights and flagmen required to allow safe vehicular movement in the vicinity of the project.
- B. The Contractor shall comply with Part V of the current edition of the “South Carolina Manual on Uniform Traffic Control Devices for Streets and Highways” (MUTCD) as published by the South Carolina Department of Transportation (SCDOT). The Contractor shall also comply with any local requirements regarding traffic regulation.
- C. For work in the SCDOT right-of-way, the Contractor shall be responsible for identifying and selecting an appropriate traffic control plan for the given work from the list of standard details available from the SCDOT. These details are listed in Division 600 of the SCDOT Standard Drawings library. Contractor shall submit selected detail to the Metropolitan representative for SCDOT review prior to beginning the work. The work shall not proceed until it has been authorized by the SCDOT as communicated to the Contractor by the Metropolitan representative, if applicable.
- D. All signs, barricades, etc. used for traffic control shall be removed from the site upon completion of the project or portion of project requiring traffic control.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION 01550

01570 ENVIRONMENTAL PROTECTION

PART 1 GENERAL

1.1 SUMMARY

- A. Review exposure to possible environmental problems with Owner. Establish procedures and discipline among tradesmen and provide needed facilities, which will protect against environmental problems (pollution of air, water and soil, excessive noise, and similar problems).

1.2 WATER AND AIR POLLUTION

- A. The Contractor shall exercise every reasonable precaution throughout the life of the project to prevent pollution of rivers, streams, and bodies of water. Pollutants such as chemicals, fuels, lubricants, bitumens, raw sewage, and other harmful waste shall not be discharged into or alongside of rivers, streams, and bodies of water or into natural or manmade channels leading thereto.
- B. Contractor shall provide for the drainage of stormwater and such water as may be applied or discharged on the site in performance of the Work. Drainage facilities shall be adequate to prevent damage to the Work, the site, and adjacent property.
- C. The Contractor shall comply with all State or local air pollution regulations throughout the life of the project.

1.3 WASTEWATER FLOW

- A. The Contractor shall conduct his operations in manner and sequence, which will provide for the continued transportation of wastewater flows during construction. Contractor shall take all actions required to prevent discharge of sewer flow from the system to the ground or any stream. Any construction actions that impede or interrupt flow shall be carefully executed and monitored to prevent surcharging and overflow.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION 01570

01660 MATERIAL STORAGE AND HANDLING

PART 1 GENERAL

1.1 DELIVERY AND HANDLING

- A. All materials shall be handled carefully and in such a manner as to preserve their quality. Materials damaged during delivery or handling shall not be used without approval from the Owner.

1.2 STORAGE

- A. The Contractor shall be responsible for obtaining any material storage site that is required. Storage of materials on the project site is subject to the approval of the Owner.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION 01660

DIVISION 2 - SITE CONSTRUCTION

02100 CLEARING AND GRUBBING

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. Work consists of all necessary clearing and grubbing.
- B. The Contractor shall be responsible for all preparation of work on private property and shall avoid unnecessary removal of trees, unnecessary interference with natural or installed drainage systems, landscaping or fencing. The Contractor shall be responsible for all claims of damage by a property owner arising from the work on or off the right of way and shall agree to indemnify, save and hold harmless the Owner from any and all suits, claims, actions or damages of any kind whatsoever, including costs of litigation and attorney fees arising from the Contractor's acts or omissions whether upon contract, nuisance, tort or on an alleged taking.
- C. The Contractor shall take care to prevent erosion of the area, silting of nearby streams or lakes, and to otherwise avoid the possibility of damage arising from the work during and after construction and in compliance with all applicable local codes and regulations related to erosion and sediment control.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.1 GENERAL

- A. Operations of Contractor shall be conducted with full consideration of all proper and legal rights of the property owner, adjacent property owners and the public, and with the least possible amount of inconvenience to them. In particular, the Contractor is to make every possible effort to avoid damage to trees. Small track backhoes may be required in some cases in order to negotiate the space between trees.
- B. Storage of materials shall be selected so as to prevent damage to remaining trees or property owner improvements.
- C. Upon completion of the construction work the contractor shall immediately remove all construction equipment, excess materials, tools, debris, etc., from the site(s) and leave the same in a neat orderly condition acceptable to the Owner. All project areas shall be graded so as to shed water to natural drainage areas. The areas shall be raked to a uniform surface free from rocks, clods of earth or other irregularities. All areas shall be left in a clean, neat condition.

END OF SECTION 02100

02210 WORK IN SOUTH CAROLINA DEPARTMENT OF TRANSPORTATION RIGHTS-OF-WAY

PART 1 GENERAL

1.1 SCOPE

- A. All work within the rights-of-way of the South Carolina Department of Transportation (DOT) shall be done in accordance with the contract documents and the DOT's requirements. Upon completion of such work and prior to final payment, the Contractor shall present to the Owner certificates in duplicate from the DOT stating that the work has been done in accordance with the DOT's requirements and is acceptable to them. Construction signing and traffic control shall conform to the "Manual on Uniform Traffic Control Devices" (MUTCD) latest revision, as published by the State of South Carolina Department of Transportation, Division of Highways.
- B. Contractor shall meet all requirements of the SCDOT Encroachment Agreement Special Conditions.
- C. All construction shall be in conformance with the current edition of the South Carolina Department of Transportation Standard Specifications for Highway Construction, unless otherwise specified herein.

1.2 RELATED SECTIONS

- A. Section 01550 – Vehicular Access and Traffic Control
- B. Section 02221 - Trench Excavation, Bedding, and Backfill
- C. Section 02250 – Sheeting and Bracing
- D. Section 02290 – Boring and Jacking
- E. Section 02730 – Sanitary Sewer Systems

PART 2 PRODUCTS

- 2.1 Flowable fill is controlled low strength material (CLSM) used as backfill material in SCDOT roadways. Flowable fill used for this purpose shall conform to Section 210 of the South Carolina Department of Transportation Standard Specifications for Highway Construction.

PART 3 EXECUTION

3.1 SAFETY

- A. Barricades, signs, lights, pilot cars, flagmen, and watchmen with reflective vests shall be used where required by the Division Engineer or his representatives. All operations in the DOT's rights-of-way shall be conducted at all times in such a manner so as not to create a hazard to or impede the flow of traffic. All costs for these items shall be included in the base bid.

- B. The Contractor shall provide, erect and maintain all necessary barricades, lights, danger signals, signs and other control devices, provide qualified flaggers and watchmen where necessary; shall take all necessary precautions for the protection of the work, the warning that work is under construction, and the safety of the public. Suitable advance warning signs shall be erected in advance where operations interfere with the use of the road by traffic. Lane closures (or partial closures) will not be permitted unless provided for in the permit. Where a lane (or a portion of a lane) is closed, traffic control devices and flaggers shall be used in accordance with the MUTCD. All barricades, signs and traffic control devices shall conform to the requirements of the MUTCD.
- C. Traffic will be maintained at all times and lane closures will only be permitted after a traffic control plan is approved. Driveways will be maintained so as to permit ingress and egress to properties adjacent to the roadway. Blocking or closing of a driveway will not be permitted without the approval of the property owner.
- D. When equipment is not in use on urban roadways with limited right-of-way and on rural roadways, store material and equipment not closer than 15 feet from the near edge of the adjacent travel lane when space is available. Whenever space is limited and the 15 foot clear distance is not available, store material and equipment at the greatest possible distance from the near edge of the travel lane and supplement the complete length of the storage area with portable plastic drums spaced at 5-foot intervals.
- E. Manholes shall not be located in the wheel path of a vehicle.
- F. All contractors, sub-contractors, utility company employees and their sub-contractors performing work on the right-of-way must wear safety vest and hardhats as outlined in the Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD).

3.2 EXCAVATION AND BACKFILLING IN SCDOT RIGHT-OF-WAY.

- A. No pipeline, including service connections, shall be installed in open trench unless actually shown on plans as open cut. All service connections shall be bored, driven, or punched under roadways maintained by the DOT. If open cutting is allowed, backfilling of trenches is to be accomplished immediately after placement of the pipe. Trenches will not be left open during hours of darkness.
- B. The top of the pipeline or casing shall be installed at a minimum depth of forty-eight (48) inches from grade for longitudinal installations located between the ditch line and the right-of-way line. The top of the pipeline or casing shall be installed at a minimum depth of forty-eight (48) inches from the top of asphalt.
- C. Excavation for the roadways, drives, and parking areas shall conform to the lines, grades, cross sections, and dimensions indicated on the drawings and shall include the excavation of all unsuitable material from the subgrade. After shaping to line, grade, and cross section, the subgrade shall be placed and compacted in six (6) inch layers or less with each layer being thoroughly compacted to a density of 95% standard proctor as determined by AASHTO T-99. This operation shall include any reshaping and wetting or drying required to obtain proper compaction. All soft or otherwise unsuitable material shall be removed and replaced with suitable material. Compaction tests shall be taken per associated SCDOT permit.

- D. Soil unsuitable for backfill shall be replaced with crusher run.
- E. All open trenches shall be covered or backfilled with compacted backfill at the end of each day. Trenches will not be left open during hours of darkness.
- F. Where it is necessary to cut existing pavement in roads, the road shall be repaired with a surface of the same type as the existing unless specified otherwise. All replaced surfacing shall meet the requirements of the DOT both as to material and performance of work. If mutually satisfactory arrangements can be made with the Division Engineer through whose division the pipeline passes, pavement may be restored by the DOT's maintenance forces with the Contractor assuming the cost of replacement.

3.3 INSPECTIONS

- A. Before any crossing of a highway is made, written notice shall be given to the DOT's Division Engineer, 48 hours in advance so that a DOT Inspector may be assigned to the work at the Division Engineer's option. Any inspector assigned to the pipe laying operations shall have full authority to act in behalf of the DOT and to stop any work affecting highways, provided the work is not being performed in accordance with DOT's requirements.
- B. Contractor shall notify Owner when he is ready for final inspection.

3.4 MAINTENANCE

- A. Pavement shall be kept clear of mud and debris.
- B. All work done in DOT's right-of-way shall be maintained by the Contractor for a period of one year (minimum) after completion of the contract. The DOT shall request the Contractor to make any repairs to work not satisfactorily maintained, and if not brought up to the DOT's standard may be repaired by the DOT's forces and all cost of repairs shall be charged to the Contractor.

END OF SECTION 02210

02221 TRENCH EXCAVATION, BEDDING AND BACKFILL

PART 1 GENERAL

1.1 SCOPE

- A. The work required under this section shall consist of furnishing all labor, equipment and materials required for earthwork operations conducted for trenching for all piping and conduit, including bedding and backfill operations necessary for a complete installation as shown on the Drawings.
- B. Excavation shall be classified as "common excavation" or "rock excavation" as defined herein. Excavation of every description, regardless of material encountered within the grading limits of the project shall be performed to the lines and grades indicated. Excavation and backfilling shall be performed in a manner and sequence that will provide drainage at all times. Grading shall be done as may be necessary to prevent surface water from flowing into trenches or other excavations; any water accumulating therein shall be removed by pumping or by other approved methods. Sheeting and shoring shall be erected as required for the protection of the work and for the safety of personnel.

1.2 RELATED WORK

- A. Section 02240 Dewatering
- B. Section 02250 Sheeting and Bracing
- C. Section 02730 Sanitary Sewer Systems

1.3 MANHOLE EXCAVATION

Excavation for manholes and similar appurtenances shall extend a sufficient distance from walls and footings to allow for placing and removal of forms, installation of services and for inspection. An over depth excavation below such appurtenances, which has not been directed by the Engineer, will be considered unauthorized and shall be refilled with sand, gravel, or concrete, as directed by the engineer.

1.4 PIPE LINES

The width of the trench 18-inches above the top of the pipe shall be wide as necessary for sheeting and bracing and the proper performance of the work.

1.5 REFERENCE STANDARDS

- A. ASTM D698 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort
- B. ASTM D2321 – Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity Flow Applications.
- C. ASTM D2487 – Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).

PART 2 PRODUCTS

2.1 BEDDING MATERIALS

Materials for pipe bedding shall be washed stone (No. 57 in accordance with the SCDOT Standard Specifications for Highway Construction).

2.2 BACKFILL MATERIAL

General backfill material for the lower portion of the trench above the bedding material and around manholes shall consist of fine, loose earth, free of large clods, stones, vegetable matter, debris, and/or other objectionable material. It shall have a moisture content suitable for compaction.

2.3 STABILIZATION STONE

Materials used for stabilization shall be equal to bedding materials.

2.4 SELECT BACKFILL

Select backfill material shall be well graded soil obtained from on site or off-site locations. Material shall be free from roots and vegetative matter, debris, stones larger than 1-1/2", and organic matter including soils OL, OH and PT as defined in the Unified Soil Classification System and referenced in ASTM D2487.

PART 3 EXECUTION

3.1 TRENCH EXCAVATION

- A. Trenches shall be excavated by an approved method to a depth to permit installation of pipe along the lines and grades shown on the Drawings.
- B. Where excavation is in rock, the rock shall be removed to a depth below grade of at least 6 inches. Before laying the pipe, the trench shall be refilled to grade with approved gravel, firmly compacted to provide proper bedding for the pipe. Bell holes shall be excavated accurately to size.
- C. If ground water is encountered in the bottom of the trench, material shall be excavated below subgrade sufficiently to allow a bed of suitable material to be placed in which to bed pipe. Depth of cut below subgrade shall be the minimum amount to accomplish the purpose and shall be as directed by the Engineer.

3.2 ROCK EXCAVATION

- A. The Contractor shall notify the Engineer immediately if "rock excavation" is encountered. "Rock excavation" shall be material which, in the opinion of the Engineer, cannot be removed by a John Deere 230, Caterpillar 230, Komatsu 220 or other similar trackhoe, or by means other than blasting or with air hammer. Materials which can be removed by ripping shall not be considered "rock

excavation". Removal of "hard material" will not be considered rock excavation because of intermittent drilling and blasting that is performed merely to increase production.

- B. "Common excavation" shall include all types of materials that do not fall into the category of "rock excavation" as defined above. Classification of excavation shall be determined by the Engineer.
- C. Rock excavation in pipe trenches shall be removed to a width of 8-inches beyond each side of the pipe outside diameter or a minimum width of 4 feet, and 6-inches below the outside bottom of the pipe.
- D. Rock excavation for manholes shall be removed 12" beyond the outside wall. Rock shall be excavated to 6-inches below the base of the manhole and backfilled to subgrade with crushed stone.

3.3 BLASTING

- A. If conditions are such that blasting or any use of explosives is required, the Contractor, prior to blasting, shall submit to the Engineer satisfactory evidence of blasting and explosive insurance. Insurance shall be in the amounts of bodily injury and property damage specified in the Supplemental Conditions. Contractor shall provide to the satisfaction of the Engineer, experience and capability of the Contractor's organization to safely handle and perform such operations.
- B. The Contractor shall maintain the blasting insurance coverage for the duration of the blasting. The Engineer shall be given 5-days written notice of cancellation of the blasting insurance.
- C. Handling and storing of blasting materials shall be performed only by qualified persons skilled in such work. Adequate precautions shall be taken to prevent accidents, injury to persons, or damage to property. Qualifications of blasting operation personnel and safety precautions shall be in full compliance with all codes governing such operations, Local, State or Federal. Full responsibility for all blasting operations shall remain with the Contractor.
- D. Where in close proximity to building, transmission lines, telephone lines or other facilities, timber mats or other means of preventing damage from flying debris shall be used. Ample and suitable signals shall be given in proximity to the work before each blast, and flagmen shall be placed on all roads beyond the danger zone in every direction to warn traffic. Contractor shall be responsible for all damage resulting from blasting.
- E. The Contractor shall maintain drilling and blasting log, in the permanent job file, of all blasting operations performed on the project. The format may vary, but the logs should contain all the information shown on the Typical Blasting Log at the end of this section.

3.4 BEDDING

- A. General. The bedding surface for the pipe shall provide a firm foundation of uniform density throughout the entire length of the pipe. If soft, mucky, or otherwise unstable or unsuitable materials are encountered in the trench bottom, it shall be removed and replaced with stabilization stone as directed by the Engineer.
- B. Joints. Bell holes and depressions for joints shall be shaped in order that the pipe or conduit rest on the prepared bottom for its full length, bell holes and depressions shall be only of such length,

depth and width as required for making the particular type of joint. Blocking under pipe or conduit will not be allowed.

- C. Manholes. Manholes shall have a minimum bedding of 12 inches of compacted angular bedding material placed on a stable subgrade to prevent settlement and misalignment.

3.5 BRACING AND SHEETING

The side of all trenches and excavations shall be adequately braced and sheeted to protect personnel, structures and property from slides, cave-ins, or settlement and to maintain the work clear of all obstructions. Bracing, shoring and sheeting shall comply with all applicable safety regulations governing the work. Full responsibility for the design, type, and strength of shoring, sheeting and bracing shall rest with the Contractor.

3.6 PUMPING

The Contractor shall do all pumping necessary for dewatering trenches and to provide proper work conditions for installation of pipe and appurtenances. Pipe shall be installed on dry, stable trench bottoms.

3.7 TRENCH EARTH DAMS

Earth dams, consisting of a minimum ten (10) foot trench length of select compacted backfill to replace the angular bedding, shall be installed as directed by the Engineer in wet areas to prevent groundwater movement in bedding material.

3.8 BACKFILLING

- A. Immediately after the pipe has been laid the trench shall be backfilled around the barrel of the pipe with the required bedding or backfill material. Backfill materials shall be deposited in layers not to exceed 6-inches in thickness tamped or rammed around the pipe with approved hand or power driven tools until enough material has been placed and compacted to provide a cover of not less than 18-inches over the top of the pipe. Care shall be exercised to avoid any wedging action or eccentric action upon or against any pipe or structure and to avoid any disturbance or damage to the work.
- B. No rock or boulders shall be used in the backfill for at least 18 inches above the top of the pipe and no stone larger than 6-inches in its greatest dimension shall be used in any backfilling.
- C. Along the pipe lines in areas not subject to superimposed loads, trench backfill may be placed from the level 18-inches above the top of the pipe upward in 12-inch layers and compacted lightly by rolling with wheeled equipment or other means. Care shall be taken to prevent damage to the pipe. Such backfill may be coarser than specified above, but shall be free of roots, brush, trash, other perishable matter and organic material, and no stone larger than 6 inches in any dimension. In open acreage areas, backfill shall be neatly rounded and dressed over with sufficient height to allow for settlement to existing surface. The overfill shall not impede existing surface drainage. In built-up areas, the top of backfill shall be maintained to the original surface.
- D. In roads and road right-of-ways, parking lots, across sidewalks and driveways and at other places subject to vehicular traffic or other superimposed loads, trench backfill material as specified above

shall be compacted in 6-inch layers for the full depth of the trench and consolidated in such a manner to provide an unyielding foundation for vehicular traffic. Unless otherwise shown on the plans or required by governing authorities, the compaction density shall be equal to the density of the original adjacent material. However, the minimum compaction density shall be 95% of maximum density as specified by ASTM D698 or AASHTO T 99 (Standard Proctor) Method A, at optimum moisture content. Wet or dry backfill as necessary.

- E. In all paved areas the Contractor shall provide crushed stone for the top 4" of the trench backfill as a temporary patch. The crushed stone shall be maintained flush with existing pavement until the temporary patch is removed and replaced with the required base course. The Contractor shall be responsible for maintaining the pavement cut in a safe condition for pedestrian and vehicular traffic.
- F. Backfill adjacent to manholes shall be placed and compacted uniformly in such a manner as to prevent wedging action or eccentric loading upon or against the structure. Slopes bounding or within the areas to be backfilled shall be stepped or serrated to prevent sliding of the fill. During backfilling operations, equipment that will overload the structure in passing over and compacting these fills shall not be used.
- H. Any deficiency in the quantity or quality of material for backfilling the trenches, or for filling depressions caused by settlement, shall be supplied by the Contractor at his expense from an approved borrow site or the Contractor may use crusher run stone at his option without additional cost to the Owner.
- I. In paved areas or areas subject to vehicular traffic where the Engineer determines soil conditions adjacent to the trench prohibit adequate compaction of soil backfill, crusher run stone shall be required for backfill. The Contractor shall be paid for the backfill material at the unit price bid for crusher run stone.
- J. No more than 350 feet of trench shall be open at any given time.

3.9 TESTING

Field and laboratory tests will be performed as necessary by the soils engineer to ensure compliance of the Contractor's work and materials with the drawings and these specifications. Initial tests will be paid for by the Owner. Should the Contractor's work or materials used fail to meet the specified requirements, the unacceptable areas will be reworked and unacceptable materials replaced with specified materials at the expense of the Contractor. Subsequent tests will be made to ensure compliance of replaced materials and reworked areas. In any case, the Owner shall select the Soils Engineer. Owner shall back charge the Contractor for all retests.

END OF SECTION 02221

02226 UTILITY REMOVAL AND ABANDONMENT

PART 1 GENERAL

1.1 SUMMARY

- A. Work includes the removal and abandonment of utility piping and related structures.

1.2 REFERENCE STANDARDS

- A. ASTM D698 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 REMOVAL

- A. Completely remove and dispose of pipe and appurtenances, and structures to full depth as shown on the plans. Trench widths shall be limited to widths as specified for new pipeline installation. Voids resulting from removed structures and piping shall be filled with acceptable fill material and trench shall be back-filled and compacted.

3.2 ABANDONMENT OF MANHOLES

- A. Remove the upper portion of structures to a depth of at least 1 foot below subgrade in paved and foundation areas. For all other areas, remove to a depth of 3 feet below finished or existing grade, whichever is lower. The bottom of structures shall be broken or perforated to prevent the entrapment of water.
- B. Seal all conduits connecting to structures or ends of conduit to be abandoned with a wall of concrete not less than 6 inches thick or an 8-inch wall of brick and mortar.
- C. Fill structural voids with flowable fill or crushed stone compacted to 90% (unpaved) or 95% (paved) of maximum density at optimum moisture content as defined by ASTM D698.

3.3 SALVAGED PARTS

- A. Grates, rings, covers, and other steel/metal components of removed or abandoned structures shall be salvaged. The Contractor shall deliver salvaged components to a site designated by the Owner.

END OF SECTION 02226

02240 DEWATERING

PART 1 GENERAL

1.1 SUMMARY

- A. Work consists of providing, and maintaining dewatering facilities including well points, sump pumps and underdrains necessary to make excavations and construction areas free from water.
- B. Related Sections
 - 1. Section 02221 - Trench Excavation, Bedding and Backfill
 - 2. Section 02250 - Sheeting and Bracing

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 GENERAL

- A. Provide and maintain adequate pumping, bailing and drainage facilities for removal and disposal of water from trenches or other excavations. Provide pumping and drainage facilities for bulk-headed excavations and operate same until bulkheads have been removed or constructions completed if bulkheads are to be left in place. Where work is in ground containing free water, provide, install and maintain suitable drainage facilities such as well points connected to manifolds and reliable pumping equipment and so operate them to insure proper working conditions. In impervious materials, construct suitable drains, underdrains, and sumps and provide adequate pumping facilities to maintain excavation in a dry condition.
- B. Take measures to protect pipe or structures from hydrostatic uplift. Connect drainage or discharge lines to nearby watercourses wherever possible. In any event, all pumping and drainage shall be done without damage to construction underway or in place or to other property. The Contractor shall ascertain the availability of adequate drainage for dewatering operations.
- C. Earth dams, consisting of a minimum ten-foot trench length of select compacted backfill to replace the angular bedding, shall be installed as directed by the Owner in wet areas to prevent groundwater movement in bedding material.

END OF SECTION 02240

02250 SHEETING AND BRACING

PART 1 GENERAL

1.1 SUMMARY

- A. Work consists of providing and maintaining trench boxes, bracing, shoring and any supports required to stabilize excavations in order to proceed with the work.
- B. Related Sections
 - 1. Section 02221-Trench Excavation, Bedding and Backfill
 - 2. Section 02240-Dewatering

1.2 SITE CONDITIONS

- A. Contractor shall be fully responsible for the protection of his crew and equipment, and to assure compliance with all local, state, and federal regulations. It will not be the Owner's responsibility to notify the Contractor of insufficient or improper supports.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 INSTALLATION

- A. Sheeting and bracing shall remain in place to allow for inspection of the work.

3.2 REMOVAL

- A. In removing sheeting and bracing after the construction has been completed, take special care to prevent any collapse of the excavation and injury to the completed work or adjacent property.
- B. Remove sheeting as the backfilling progresses. Take special care to fill and compact voids created by removal of bracing and sheeting.

END OF SECTION 02250

02300 TUNNELING OR BORING

PART 1 GENERAL

1.1 SCOPE

The work under this section consists of furnishing all materials, labor, equipment and services required for the complete installation of sewer line encasement and carrier pipes under highways and railroads by boring or tunneling as specified herein.

A. All work in connection with constructing encasement pipes under highways and railroads shall comply with all current requirements of governing highway and railroad agencies. The Contractor shall be familiar with these requirements.

B. Related Work

Section 02221 - Trench Excavation, Bedding and Backfill

C. Rock boring and tunneling methods must be reviewed and approved of by the Engineer prior to installation.

1.2 SUBMITTALS

A. Submit material certificates and product data for steel encasement pipe which certify conformance and compliance to specified requirements.

PART 2 PRODUCTS

2.1 ENCASEMENT PIPE

A. Steel encasement pipes shall be smooth wall welded steel pipe, or steel liner plate conforming to ASTM A139, Grade B. The outside of the pipe shall be coated with an asphalt coating. Minimum yield strength shall be 35,000 PSI.

Minimum wall thickness and inside diameter of the encasement pipe shall be:

STEEL CASING SCHEDULE		
DIP CARRIER SIZE	MIN. STEEL CASING SIZE	MINIMUM WALL THICKNESS
6"	12"	0.188"
8"	16"	0.250"
10"	18"	0.250"
12"	20"	0.281"
15"	24"	0.344"
16"	30"	0.406"
18"	30"	0.406"

2.2 STEEL TUNNEL LINER PLATES

- A. Steel Tunnel Liner Plates for encasement pipes shall be galvanized and fully bituminous coated.
- B. Four-flange type with abutting end joints shall be 10-gauge material (T=0.1345 in.).
- C. Two-flange type with lapped offset end joints shall be 12-gauge material (T=0.1046 in.).
- D. Properties of each section are as indicated in Handbook of Steel Drawings and Highway Construction Products, Tunnel Liner Plates (latest edition).
- E. Liner plates shall be self-supporting and erected in accordance with manufacturer's recommendations.

PART 3 EXECUTION

3.1 GENERAL

- A. Encasements shall be installed by boring or tunneling. The method utilized shall be at Contractor's option, except where noted otherwise in the Contract Documents or limited by the official agency having jurisdiction.
- B. Installation of encasement pipe shall include all related work and services such as mobilization of equipment, constructing and maintaining working pits, right-of-way maintenance and restoration, traffic maintenance, mining, excavations, dewatering, sheeting, shoring, bracing, pipe supports, bulkheads, cleaning up, and moving out.

Adequate sheeting, shoring and bracing for embankments, operating pits, and as elsewhere required shall be placed and maintained in order that work may proceed safely and expeditiously.

3.2 EXCAVATION

- A. Excavation shall be classified as "common excavation" or "rock excavation" as defined in Section 02221. It shall be the Contractor's responsibility to notify the Engineer when "rock excavation" is encountered. The Contractor will not be credited for any rock quantities removed before such notice is given.
- B. Rock shall be excavated as required for the proper installation of the encasement system. Rock excavation for work space and operating pits shall be excavated as required. Before any rock is removed the Contractor and Engineer shall agree on the dimensions required for each case.

3.3 INSTALLATION

- A. The alignment and grade shall be carefully maintained and the encasement pipe installed in a straight line.

- B. The space outside the encasement and the ground shall be filled with grout, sand or pea gravel, as directed by the Engineer. The Engineer will direct that this space be filled if the space is large enough to cause any earth settling.
- C. After encasement pipes are installed, the ductile iron carrier pipe shall be installed in the encasement pipe using slip-on joints. The ends of the encasement pipe shall be sealed as shown on the drawings.
- D. The carrier pipe shall be supported and blocked inside the encasement pipe per standard details to true line and grade and in such a manner to prevent horizontal or vertical movement. Steel straps may be used as shown on the drawings, or other means as approved by the Engineer.

END OF SECTION 02300

02575 PAVEMENT REMOVAL AND REPAIR

PART 1 GENERAL

- A. **SCOPE:** Work under this Section consists of furnishing all materials, labor, equipment and services required for removal and replacement of pavement.
- B. **Related Work:**
 - 1. Section 02221 - Trench Excavation, Bedding and Backfill
- C. The South Carolina Department of Transportation (SCDOT) Standard Specification for Highway Construction, latest edition, shall form a part of these specifications to the extent indicated by the references thereto.
- D. All work on South Carolina State Highways shall conform to SCDOT requirements as well as the requirements specified herein. The Contractor shall familiarize himself with all requirements of the SCDOT. The Owner will furnish copies of State Highway Encroachment Permits to the Contractor. The Contractor shall perform all work in accordance with all requirements and stipulations contained therein or per the requirements stated by the encroachment permit.
- E. Traffic shall be maintained on all roads and streets during pipeline construction.
- F. Where drives, patios or pavement on private property must be cut for the execution of the work, the Contractor shall replace pavement with similar materials. Entire disturbed areas shall be repaired to as good or better condition than existed prior to construction.
- G. Copies of load tickets shall be submitted to the Engineer on a daily basis when paving work is performed.

PART 2 PRODUCTS

- A. **SURFACE COURSE:** The surface course shall be "Hot Laid Asphaltic Concrete Surface Course", Type 2, in accordance with Section 403 (omitting paragraphs 403.5 and 403.6) of the SCDOT Specifications.
- B. **STABILIZED AGGREGATE BASE COURSE:** The aggregate base course shall meet all requirements of Section 305 (omitting paragraphs 305.5 and 305.6) of the SCDOT specifications. Rolling shall meet requirements of Section 305.4.3, and the surface shall be rolled three times with a steel roller. The finished surface shall be protected until hard.
- C. **CONCRETE:** Concrete shall be 3,000 PSI minimum 28-day compressive strength air-entrained ready-mix batched in accordance with SCDOT SC-M-501.

PART 3 EXECUTION

- A. **GENERAL:** Asphalt pavement materials specified shall be installed in accordance with the requirements of Section 401 of SCDOT Specifications. Concrete materials shall be installed in accordance with the SCDOT Specification Section 720.

B. SUBGRADE PREPARATION

Before construction of the base course, the subgrade shall be prepared as required. Subgrade shall conform to the lines, grades and cross sections indicated on the Drawings or encroachment permits, and fills shall be compacted as specified in Section 02221.

C. CUTTING AND REPLACING PAVEMENT

1. Where pavement is to be cut for installation of pipe, the Contractor shall saw cut pavement neatly in advance of trenching. Pavement shall be saw cut to a straight edge 12 inches wider than excavated area on each side, with the face of the cut being vertical. Ragged and irregular edges shall be re-cut.
 2. Pavement shall be replaced with base course. Base courses shall be placed to the thickness specified or shown on the Drawings or Encroachment Permit details.
 3. Contractor shall properly maintain the pavement cut until the patch is made and shall promptly fill ruts and depressions.
 4. Entire area to be patched (including edges of existing pavements) shall be primed with an asphalt prime coat before placing new pavement. Material and application shall be as specified in paragraph 305.4.6 of the SCDOT Standard Specifications.
 5. Pavement patch shall be made within the same week the trench is cut unless other procedures are presented to and approved by the Engineer. If inclement weather delays pavement replacement, Contractor shall not cut additional pavement until he has notified Engineer and received specific permission and instructions. Contractor shall be responsible for repairs of pavement damaged outside of specified trench patch.
 6. Pavement shall be replaced with hot laid asphaltic concrete, or Portland cement concrete, all conforming to specifications of State Highway Department of each type.
- D. For asphalt pavement or bituminous surfacing, entire areas to be resurfaced (including edges of existing pavement) shall be primed with an acceptable asphalt prime coat just prior to placing new pavement.
- E. For concrete pavement resurfacing, the entire area to be repaired shall be dampened prior to the placement of the concrete to limit the moisture extraction by the base material.
- F. All Work on State Highways shall conform to State Highway requirements as well as the above. It shall be the responsibility of the Contractor to familiarize himself with all requirements of Highway Encroachment Permits and shall conform to all requirements and stipulations therein.

G. SURFACE COURSE

1. Asphalt surface course shall be as specified and shall be applied at the minimum rate of 110 pounds per square yard per inch of thickness.
2. Where the trench patch crosses a SCDOT roadway, the roadway shall be resurfaced for a distance of 50 feet on each side of the trench patch. The limit of surface course shall be feathered into the existing pavement.

- H. **CONCRETE PAVEMENT AND CURB AND GUTTER:** The replacement of concrete pavements, and concrete curb and gutters shall meet all requirements of Section 720 of the SCDOT specifications.
- I. **CUTTING AND REPLACING SIDEWALK.** Where sidewalk is cut for installation of pipe or other utilities, Contractor shall cut it neatly in advance of trench and replace as described below or as shown on the plans. Where installation is along the line of sidewalk, sidewalk may be removed, with Engineer's approval and replaced in kind.
1. Sidewalk cutting shall be as described for pavement cutting above.
 2. Trench Backfill under sidewalk shall be as describe in Subgrade Preparation (3.B) above.
 3. Base for sidewalk shall be minimum 4-inches compacted crusher run granite stone material.
 4. Pavement for sidewalk shall match existing walk in material and finish with a minimum 3-inches thick hot plant mix asphalt or minimum 4-inches thick concrete, to match existing sidewalk material.

END OF SECTION 02575

02730 SANITARY SEWER SYSTEMS

PART 1 GENERAL

- A. **SCOPE:** Work in this section consists of the supply and installation of all gravity sanitary sewer lines including layout, identification of other utility crossings or conflicts, establishment and maintenance of required alignment and grade, cleaning, and testing as shown on the drawings and specified herein.
- B. **Related Work:**
1. Section 02221 Trench Excavation, Bedding and Backfill
 2. Section 02300 Tunneling and Boring
 3. Section 02731 Ductile Iron Sewer Pipe (DIP)
 4. Section 02732 Polyvinyl Chloride (PVC) Sewer Pipe
- C. **OTHER REQUIREMENTS**
1. All pipe elevations shown on the Drawings are invert elevations (i.e., the bottom inside of pipe), unless otherwise shown.
- D. **SUBMITTALS**
1. Submit material certifications and product data for all pipe, couplings and fittings demonstrating conformance to specifications.
- E. **QUALITY ASSURANCE:** Comply with all applicable standards contained herein and with the provisions of the following codes and standards except as otherwise shown or specified:
1. South Carolina Department of Health and Environmental Control: All applicable rules and regulations.
 2. All requirements of the sewer service agency that will own, operate and maintain this sewer.
- F. **REFERENCE STANDARDS:**
1. ASTM A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 2. ASTM A126 – Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
 3. ASTM A139 - Standard Specification for Electric-Fusion (Arc)-Welded Steel Pipe (NPS 4 and Over).

4. ASTM C425 – Standard Specification for Compression Joints for Vitrified Clay Pipe and Fittings.
5. ASTM C923 – Standard Specification for Resilient Connectors between Reinforced Concrete Manhole Structures, Pipes and Laterals.
6. ASTM D3034 – Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
7. AWWA C200 – Standard for Steel Water Pipe 6 Inch (150 mm) & Larger.

PART 2 PRODUCTS

A. PIPE:

1. Unless specifically noted on the drawings, the Contractor may use any one of the specified materials.
2. Steel Pipe for stream crossing and other locations shall be used where shown on the Plans. Pipe shall be high strength steel seamless or welded pipe to meet ASTM A139 Grade B, ASTM A53 Grade B and AWWA C200. Length and Diameter shall be as shown on the Plans. Pipe shall be in one piece. Pipe shall be designed for the span and connections shown on the Plans with full pipe of water and 75 pounds per foot live load without deflecting more than 1/360 span. Interior coating shall be Tnemec 431 perma shield per manufacturer’s specifications, minimum 40 mils thick or approved equal. Sandblast to commercial standard SSPC SP-6 prior to coating. Apply lining to manufacturer’s recommendations.
3. Steel encasement pipes shall be smooth wall welded steel pipe, or steel liner plate conforming to ASTM Designation A139, Grade B. The outside of the pipe shall be coated in accordance with AWWA Standard C203. Minimum yield strength shall be 35,000 PSI. Minimum pipe wall thickness shall be as follows:

STEEL CASING SCHEDULE		
DIP CARRIER SIZE	MIN. STEEL CASING SIZE	MINIMUM WALL THICKNESS
6"	12"	0.188"
8"	16"	0.250"
10"	18"	0.250"
12"	20"	0.281"
15"	24"	0.344"
16"	30"	0.406"
18"	30"	0.406"

- i. The minimum inside diameter of the encasement pipe shall be equal to or greater than that shown above.

B. COUPLINGS:

1. Couplings shall be used to join pipe of different materials. Couplings with adjustable stainless steel shear rings shall be installed according to the manufacturer's instructions.
2. Provide couplings per approved materials list.
3. Coupling to connect steel pipe shall be steel per approved materials list to suit the piping to be connected. Coat with two coats of paint after installation.

C. PIERS AND PROTECTION WORK: Piers and concrete protection work shall be constructed where indicated on plans or directed by Engineer. All piers shall be of concrete unless shown otherwise on plans or directed by Engineer.

1. Concrete Piers: Foundation for piers shall be adequate to support intended load and will be subject to Engineer's approval prior to pouring concrete.
2. Protection Concrete shall be provided in locations as shown on plans or directed by Engineer.
3. Concrete for piers, protection and other uses shall be composed of Portland cement, sand, coarse aggregate, water and such admixtures as may be allowed, in such proportions as to provide a minimum 28-day compressive strength of 4,000 psi. Source of concrete and mix design shall be approved by Engineer prior to use.

D. PRECAST CONCRETE MANHOLES

1. Sections shall conform to ASTM C478 or ASTM C913. Concrete shall have a minimum 28-day compressive strength of 4,000 psi. Minimum wall thickness shall be 5".
2. Section joints shall be watertight and shall conform to Federal Specification SS-S-210, Type B Butyl Rubber. Joints shall be externally sealed with a polyethylene backed butyl rubber sheet no less than 1/16" thick and 6" wide.

E. FOUNDATION MATERIAL

1. Materials placed for structure foundations shall be washed stone (No. 57 stone per SCDOT Standard Specifications for Highway Construction).

F. FLEXIBLE PIPE CONNECTORS

1. Flexible connectors shall conform to ASTM C923. All clamps and metal accessories shall be stainless steel.

G. CAST-IN-PLACE CONCRETE

1. Concrete shall have a minimum compressive strength of 4,000 psi.

H. MANHOLE STEPS

1. Steps shall be Copolymer Polypropylene Plastic reinforced with a 1/2" diameter grade 60 steel bar.

I. MANHOLE RINGS AND COVERS

1. **Standard Manhole** rings and covers shall be gray iron, Class 35B, conforming to ASTM A48 or AASHTO M105, and AASHTO M306. Manhole rings and covers shall be for heavy duty use with standard weights of 190 pounds min. for each ring, and 90 pounds min. for each cover. Castings shall be free from blow holes, porosity, hard spots, shrinkage distortion, or other defects. Bearing surfaces between ring and cover or grate shall be machined to prevent rocking and rattling. Covers shall be cast with Metro's logo as shown on Standard Detail SS-7.2.
2. **Watertight Manhole** rings and covers shall be gray iron, Class 35B, conforming to ASTM A48 or AASHTO M105, and AASHTO M306. Manhole rings and covers shall be for heavy duty use with standard weights of 190 pounds min. for each ring, and 90 pounds min. for each cover. Castings shall be free from blow holes, porosity, hard spots, shrinkage distortion, or other defects. Bearing surfaces between ring and cover or grate shall be machined to prevent rocking and rattling. Covers must be fitted with adjustable camlocks and TGS gaskets. Covers shall be cast with Metro's logo as shown on Standard Detail SS-7.4.

J. MORTAR

1. Masonry cement shall conform to ASTM C270, Type II non-shrinking with maximum 12% air content by volume. Masonry cement shall be Type S conforming to ASTM C270.
2. Mortar shall have an integral waterproofing additive and shall be composed of masonry cement and sand in proportions recommended by the manufacturer of the cement. Maximum proportions shall not exceed 3 parts sand to one part masonry cement, measured by volume and mixed dry. Bag, premixed Type S mortar may be used in lieu of job mix mortar.
3. Water used in mixing mortar shall be clean and free of deleterious amounts of acid, oil, alkalis or organic materials. Mortar shall not be allowed to stand for longer than one hour after water is added.

K. TRACER WIRE

1. Provide minimum 12-gage solid copper tracer wire encased in 30 mils HDPE insulation for all force mains.
2. Provide tracer wire connection point at each manhole and access ports along force mains.

PART 3 EXECUTION

A. GENERAL

1. Under no circumstances shall pipe be laid in water, on rock, or when trench conditions or weather is unsuitable for such work. Each pipe shall be carefully examined before being

installed and any defective or damaged pipe shall be removed from the site. Proper facilities shall be provided for lowering sections of pipe into trenches. The pipe shall have uniform bearing upon the pipe bed for the full length of its barrel. Raising the pipe off the subgrade (bridging) to obtain the proper elevation will not be allowed. Pipe shall be laid on a uniform slope between pipe invert elevations. Each section shall be securely attached to the adjoining sections by the method approved in accordance with the type of joints used.

2. Any pipe which is not in true alignment or shows undue settlement after laying, or is damaged, shall be taken up and re-laid without extra compensation.
3. Pipe shall be hoisted from the trench side to the trench by means of wide belt slings. Chains, cables, tongs, or other equipment likely to cause damage to the pipe coatings will not be permitted, nor will dragging or skidding of the pipe. The Contractor shall allow inspection of the pipe while it is suspended from the slings. Any damage shall be repaired before the pipe is lowered into the trench.
4. At all times during storage and construction of the pipeline, the Contractor shall use every precaution to prevent damage to protective coating on the pipe. Pipe shall be stored along the trench side, suitably supported off the ground to avoid damage to the coating. No metal tools or heavy objects shall be permitted to come into contact unnecessarily with the finished coating. Any damage to the pipe or the protective coating from any cause before final acceptance by the Owner shall be repaired, as directed by the Engineer by and at the expense of the Contractor.
5. During times when pipe laying is not in progress, the open ends of pipe shall be closed and no trench water shall be permitted to enter the pipe.

B. PIPE INSTALLATION

1. Piping shall be installed in accordance with best practice, manufacturer's instructions and Engineer's direction. Where pipeline crosses under or is installed on highway or railroad right-of-way, work shall be done in accordance with such requirements specified by the right-of-way agreement.
2. Pipelines shall be installed in locations as shown on the plans, and to alignment and grade shown thereon. Prior to beginning work on any section of line, Contractor shall consult with Owner and determine that all rights-of-way and necessary permits have been obtained. Contractor shall familiarize himself with all conditions and/or limitations of such rights-of-way and any encroachment beyond these limits shall be contractor's liability.
3. Pipe shall be laid with bell ends facing in the direction of pipe-laying, beginning at the bottom of the slope and proceed upward with the bell ends of the new pipe upgrade.
4. Pipe joints shall be made up in strict accordance with the manufacturer's directions.
5. Sewer lines in relation to water lines must conform to Section 38.3 of the "Recommended Standards for Wastewater Facilities" 1990 Edition as a minimum. Sewers shall be laid at least 10 feet horizontally from any existing or proposed water main. The distance shall be measured edge to edge. In cases where it is not practical to maintain a ten foot separation, the appropriate reviewing agency shall be contacted to request a deviation. Such deviation

may allow installation of the sewer closer to a water main, provided that the water main is in a separate trench or on an undisturbed earth shelf located on one side of the sewer and at an elevation so the bottom of the water main is at least 18 inches (46 cm) above the top of the sewer.

6. Sewers crossing water mains shall be laid to provide a minimum vertical distance of 18 inches between the outside of the water main and the outside of the sewer. This shall be the case where the water main is either above or below the sewer. The crossing shall be arranged so that the sewer joints will be equidistant and as far as possible from the water main joints. Where a water main crosses under a sewer, adequate structural support shall be provided for the sewer to prevent damage to the water main.
7. When it is impossible to obtain proper horizontal and vertical separation as stipulated above, the sewer shall be constructed equal to water pipe, and shall be pressure tested to assure water-tightness prior to backfilling.

C. INSTALLATION OF PIPE REPAIR COUPLINGS

1. Existing sewer pipe shall be excavated with care so no damage to the pipe or existing fittings is caused. Hand digging around the existing pipe may be required to provide a clear opening for repairing or removing and reinstalling new pipe as specified herein.
2. All repair couplings shall be examined before installation and none shall be installed which are found to be defective.
3. Installation of flexible couplings shall be in accordance with manufacturer's instructions and as specified herein.
4. Any damage to existing pipe or fittings other than pipe or fittings specifically intended to be removed, replaced or abandoned as part of this Contract shall be repaired by the Contractor as directed by the Inspector. If the Contractor damages existing pipe or fittings through error or for his own convenience he will be directed by the Inspector to repair all damages, in which case the repair work shall be performed at his own expense.
5. Flexible sleeve type couplings shall be installed for connecting new replacement pipe and fittings to existing sewer pipe made of any pipe material.
6. Flexible sleeve type couplings shall be installed over smooth spigot or cut ends of pipe. If cutting pipe is required, the cutting shall be done by machine or tool specifically intended for the purpose of cutting the type of pipe being worked on. All cutting of pipe shall be at right angles to the axis of the pipe and shall be performed so as to leave a smooth cut.
7. Replacement of existing sewer pipe using flexible couplings shall consist of removing the damaged pipe to the length as specified on the Drawings for each point repair. Care shall be exercised so that on the existing pipe left-in-place, a clean, unbroken spigot end (or smooth cut end) and a clean, unbroken bell end (or smooth cut end) are available to connect the replacement pipe. The replacement pipe shall have a sleeve coupling slid onto the opposite end of the replacement pipe aligned with the existing spigot end. The sleeve coupling shall then be slid halfway back over the existing spigot and clamped securely into

place. The new pipe shall be bedded and backfilled as specified. The new pipe shall be accurately cut to length so that the gap left is 1/2 inch or less.

D. MANHOLE INSTALLATION

1. Precast base sections shall be installed on a firm foundation, which has been prepared to prevent settlement and misalignment. Refer to specification section 02221 for backfill and compaction requirements. Pipe openings shall be exactly aligned to that of pipe entering and leaving structure.
2. Minimum 1-inch diameter joint sealant shall be installed against clean, dry concrete surfaces to form seal between sections. Remove protective backing from sealant and fill annular space uniform to make a watertight seal between all precast sections.
3. Rings and covers shall be installed per Standard Detail SS-7.3. Use grade rings to adjust rings & covers to final grade. Seal all joints between rings, grade rings and precast sections with butyl sealant. No more than 10" of grade rings will be allowed.
4. Steps shall be vertically aligned at the spacing indicated, but in no case more than 16 inches on center.
5. Pipe shall be placed in openings provided in the base section and properly aligned and set to grade.
6. For Concrete Collars. Pipe shall be firmly held in place, and the opening around the exterior of pipe and the base opening shall be filled with an expanding non-shrink grout rammed into place, to provide a water-tight connection.
7. Inverts shall be U-shaped channel with a minimum height of 0.8 of the diameter and be smooth continuation of the pipe. The benches shall be constructed with a slope of one inch per foot to the channel. The channel and invert shall be constructed with a minimum of 3,500 psi concrete or brick and mortar fill with concrete finish minimum one inch thick. Where sewer changes directions, the manhole channel shall be constructed with a smooth curve with a radius as large as the diameter of the manhole will allow. The bench at the edge of the channel shall be level.
8. Fill in all chips or holes greater than 1/2" in depth with mortar to provide a final finish.
9. Where visible leakage occurs through the structure walls, excavate and expose outside wall, and apply bituminous or cement waterproofing.

E. CLEANING

All foreign matter and dirt shall be cleaned from the inside of the pipe before installing and shall be kept clean during and after installation. All lines, upon completion or at such time as directed, shall be cleaned, inspected and tested.

F. INSPECTION AND TESTING

1. General. After completion of the work or any part thereof, but before its final acceptance, all parts of the job shall be tested to determine that it is constructed or installed in accordance with the Drawings and Specifications. Failure of any section to meet the requirements of the testing shall be repaired at the Contractor's expense and retested until conformance is achieved. The Contractor shall maintain the project for such time as is necessary to satisfy the Engineer that all installations are correct. All final testing and inspections shall be performed in the presence of the Engineer and the Owner's Representative.
2. Infiltration and exfiltration shall not exceed a rate of 200/gpd/in. of pipe diameter/mile of sewer for any section between successive manholes. Infiltration shall be measured by the Contractor using a suitable weir or other device as approved by the Engineer.
3. Air Testing. All new sewer lines including service lines shall be subjected to a low-pressure air test to determine the presence of damaged pipe or faulty installation. The Contractor will furnish all facilities and personnel for conducting the tests. The Contractor may desire to make an air test prior to backfilling for his own purposes. However, the required air test shall be made after backfilling has been completed and compacted and in the presence of the Engineer and/or Owner. The test shall be performed as outlined below.
 - i. Low pressure testing shall be performed with a continuous monitoring gauge no less than 4 inches in diameter with minimum divisions of 0.10 psi, an accuracy of 0.04 psi \pm and a max reading of 30 psi. All air shall pass through a single, above ground control panel visible to the Engineer.
 - ii. Determine the groundwater elevation and determine the average groundwater head above the section being tested. Adjust the test pressures by adding 0.43 psi per foot of groundwater head.
 - iii. Determine the test time for the section being tested using *Low Pressure Air Testing Times* located at the end of this specification section. Add in time for service laterals connected to the line being tested.
 - iv. Plug all openings in test section.
 - v. Pressurize the section to 4.0 psi and allow pressure to stabilize (maintain 4.0 psi for a minimum of 2 minutes). Do not over-pressurize the section. No one will be allowed in the manhole during testing.
 - vi. At a reading between 3.5 and 4.0 psi, shut off pressure supply and start timing using a stop watch or other acceptable timing device. Measure the pressure drop for the period of time as computed above (Item iii).
 - vii. If the pressure drops 1.0 psi or more during the elapsed time, then the section has failed.
4. Deflection of flexible gravity sewer pipe shall be tested by pulling a go/no-go gage through the pipe. Diametric deflection of the pipe shall not exceed 5% of the base inside diameter as stated in ASTM D3034 latest edition. The gage shall be drawn through the pipe from manhole to manhole. Any portion of pipe through which the gage passes freely shall be

deemed to have passed the deflection test. Deflection test shall be performed no sooner than 30 days after installation as stated in ASTM D2321 latest edition.

5. **Manhole Vacuum Testing.** All new manholes shall be subjected to a vacuum test to determine the presence of damaged or faulty installation. The vacuum test shall be made after backfilling has been completed and the base course of roadway has been installed. The vacuum testing must be conducted in the presence of the Owner.

The test will be performed as follows:

- i. Plug all manhole entrances and exits other than the manhole top access using suitably sized pneumatic or mechanical pipeline plugs and follow all manufacturer's recommendations and warnings for proper and safe installation of such plugs.
- ii. Install the vacuum tester head assembly at the top access of manhole.
- iii. Evacuate the manhole to 10" Hg. (approximately negative 5 psig, 0.3 bar).
- iv. Close vacuum inlet/outlet ball valve and shut off vacuum pump. If vacuum does not drop in excess of 1" Hg. within time indicated below manhole is considered acceptable and the manhole passes the test. If manhole fails the test, complete necessary repairs and repeat test procedures until satisfactory results are obtained.

Manhole Diameter (in.)	Test Time (sec.)
48	60
60	75
72	90
84	105
96	120
120	150

6. **Visual Inspection.** Manholes shall be inspected for visible leaks. Manholes showing signs of leakage will not be accepted.

G. CLEAN UP

1. Upon completion of the construction work the Contractor shall immediately remove all construction equipment, excess materials, tools, debris, etc., from the site(s) and leave the same in a neat, orderly condition acceptable to the Engineer. All project areas shall be graded so as to shed water to natural drainage areas. The areas shall be raked to a uniform surface free from rocks, clods of earth or other irregularities. All areas shall be left in a clean, neat condition.
2. Final Clean-Up will meet approval of Engineer, Owner and property owner where applicable, with all defects in trench settlement, pavement patches or other deficiencies being promptly corrected.

Low Pressure Air Testing Times

**MINIMUM SPECIFIED TIME REQUIRED FOR A 1.0 PSIG PRESSURE DROP
FOR SIZE AND LENGTH OF PIPE INDICATED FOR Q = 0.0015**

Pipe Diameter (in.)	Specification Time for Length of Pipe Shown (min:sec)					
	100 ft	150 ft	200 ft	250 ft	300 ft	350 ft
6	5:40	5:40	5:40	5:40	5:40	5:40
8	7:34	7:34	7:34	7:34	7:36	8:52
10	9:26	9:26	9:26	9:53	11:52	13:51
12	11:20	11:20	11:24	14:15	17:05	19:56
15	14:10	14:10	17:48	22:15	26:42	31:09
18	17:00	19:13	25:38	32:03	38:27	44:52

*Source: Unibell PVC Pipe Association – Table UNI-B-6-98

END OF SECTION 02730

02731 DUCTILE IRON SEWER PIPE

PART 1 GENERAL

1.1 SCOPE

- A. This section establishes the criteria for acceptance of Ductile Iron Pipe (DIP).
- B. Related Work.
 - 1. Section 02221 Trench Excavation, Bedding and Backfill
 - 2. Section 02730 Sanitary Sewer Systems
- C. Submittals that include material certifications and product data for all pipe, pipe joints, and fittings that demonstrate conformance to specifications shall meet all requirements of Section 1300.

1.2 REFERENCE STANDARDS

- A. American National Standard Institute (ANSI) and American Water Works Association (AWWA):
 - 1. ANSI/AWWA C110/A21.10 Ductile Iron and Gray Iron Fittings for Water and Other Liquids.
 - 2. ANSI/AWWA C111/A21.11 Rubber Gasket Joints for Ductile Iron and Gray Iron Pressure Pipe and Fittings.
 - 3. ANSI/AWWA C151/A21.51 Ductile Iron Pipe for Water and Other Liquids, as modified by these specifications.
 - 4. AWWA C600 Installation of Ductile Iron Water Mains and Their Appurtenances.
- B. American Society for Testing and Materials (ASTM):
 - 1. ASTM A746 – Standard Specification for Ductile Iron Gravity Sewer Pipe

1.3 QUALITY ASSURANCE

- A. The manufacturer is responsible for the performance of all inspection requirements as specified in ANSI/AWWA and/or ASTM Standards. All pipe and fittings to be installed under this Contract may be inspected at the plant for compliance with these Specifications by the Owner, by an independent testing laboratory selected by the Owner, or by other representative of the Owner.
- B. Care shall be taken in shipping, storing, handling, and laying to avoid damaging the pipe and fittings. Any pipe or fittings damaged in these activities shall be replaced or cut off or repaired as directed solely by the Engineer.
- C. Inspection of the pipe and fittings will be made by the Engineer or other representative of the Owner after delivery and after installation. The pipe shall be subject to rejection at any time on account of failure to meet any of the Specification requirements even though pipes may have been accepted

as satisfactory at the place of manufacture. Pipe rejected after delivery shall be marked for identification and shall be removed immediately from the work site.

- D. Any pipe or fitting showing a crack, indentation, or other obvious damage to the metal shall be marked by the Engineer as rejected and removed immediately from the work site. Pipe damaged on the spigot end may, if approved by the Engineer, be cut off and the end re-prepared and the shorter pipe used. The Engineer's opinion on such observations and rejections shall be final.
- E. The pipe materials specified in this section shall be furnished by a manufacturer who is fully experienced, reputable and qualified in the manufacturing of the specified materials. The manufacturer shall have successfully manufactured and delivered pipe of the diameters used in this project the general intent of this specifications for a minimum of 15 projects over the past 5 years.

1.4 INSPECTION, TEST REPORTS, MARKINGS, AND SUBMITTALS

- A. All pipe and fittings to be installed under this Contract shall be inspected and tested at the place of manufacture by the manufacturer to verify compliance with the Specifications.
- B. Pipe shall be subject to inspection and approval at the factory, place of coating, point of delivery, and before and after installation as specified above. The Engineer shall have the right to reject any pipe whose manufacture, in his sole opinion, is inconsistent with the Specifications and to take independent samples of the materials being used at any time.
- C. The manufacturer shall perform factory testing as specified herein and in accordance with the standards. Copies of test reports shall be submitted to the Engineer before the pipe is shipped to the site.
- D. In the event that any of the test results fail to meet the Specifications, all pipe represented by such tests shall not be shipped to the job site and shall be subject to rejection. The Contractor may perform additional tests from the pipe represented by the failed tests if he desires to verify the inadequacy of the original tests. The Engineer will review the test results and advise on the suitability of the pipe.
- E. Pipe which has been rejected by the Engineer shall not be shipped to the site or shall be removed from the site of the work by the Contractor and replaced with pipe which meets these Specifications.
- F. All pipe and fittings shall be stenciled in durable white paint on opposite exterior sides or coded with the following information:
 - 1. Manufacturer name or trade mark.
 - 2. Date and place of manufacture.
 - 3. Size, type, thickness or class, and wall thickness.
 - 4. Standard produced to (ANSI/AWWA).
 - 5. Other markings as required by standard.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Care shall be taken in loading, transporting and unloading to prevent injury to the pipe or coatings. Under no circumstances shall the pipe be dropped or skidded against each other. Slings, hooks, or pipe tongs shall be padded and used in such a manner as to prevent damage to the exterior surface or internal coating or lining of the pipe.
- B. Stored pipe shall be kept safe from damage and away from traveled ways. The interior of all pipes, fittings and other appurtenances shall be kept free from water, dirt, or foreign matter at all times.
- C. Stored pipe shall not be placed on the ground or in contact with another or stacked. The bottoms shall be kept off the ground on plastic film and timbers, rails, or concrete. Pipe shall be chocked. At least 4- by 4-inch timbers shall be placed on each side of each pipe in order to prevent movement.

PART 2 PRODUCTS

2.1 DUCTILE IRON PIPE (DIP)

- A. Pipe shall comply with ASTM A746 and ANSI A21.50, ANSI/AWWA C151/A21.51 and shall be Thickness Class 50 or Pressure Class 350 unless otherwise noted meeting the size and dimensions shown on the drawings. Pipe shall be furnished with push-on, mechanical or flanged joints, as indicated.
- B. Mechanical and Push on joints shall conform to ANSI/AWWA C111/A21.11. When required or necessary, use approved type joint restrain devices with a minimum working pressure of 200 psi and a factor of safety of 2.
- C. Rubber gaskets shall conform to ANSI A21.11 and AWWA C111 for mechanical and push-on type joints. Natural rubber will not be accepted.
- D. Flanged Joints shall conform to ANSI/AWWA C115/A21.15. Bolts per ASTM A307, chamfered or rounded ends projecting 1/4 to 1/2 inch beyond outer face of nut. Nuts per ASTM A307, hexagonal, ANSI/ASME B18.2.2, heavy semi-finished pattern. Gaskets per ASTM D1330, Grade I rubber, full face type, 1/8-inch thick.
- E. Fittings shall meet the requirements of ANSI/AWWA C110/A21.10 or ANSI/AWWA C153/A21.53. Fittings and Specials shall be manufactured of ductile iron and rated as a minimum to equal the pressure rating of the pipeline. Ductile iron tee-wyes for service laterals shall meet the requirements of this Specification section. Fittings shall have joints compatible with the pipe with which it is to be connected.
 - 1. 12-inch x 6-inch fittings shall be mechanical joint (MJ), domestic manufacture with interior lining as specified in paragraph 2.1.G. Provide transition gaskets in conformance to AWWA C111/A21.11 to accommodate the transition from MJ to SDR-26. Fittings on the 6-inch lateral to accommodate pipe bends and alignment to the existing service laterals shall conform to paragraph 02732.2.A.

- F. Interior Lining: Unless stated otherwise on the plans, the interior of all ductile iron pipe and fittings shall be coated with Tnemec 431 per manufacturer's specifications and in accordance with AWWA C210. All field touchups to be completed per manufacturer's specifications. The epoxy lining shall be applied to a minimum 40 mils dry film thickness and shall cover the entire inside of the pipe.

The epoxy lining shall be applied only by a firm certified as an applicator by the epoxy manufacturer. Application of the epoxy lining to the ductile iron pipe shall be in strict accordance with the epoxy manufacturer's specifications and installation procedures. All pipe linings shall be checked for thickness using a magnetic film thickness gauge. The thickness testing shall be done using the method outlined in SSPC-PA-2 film thickness testing. The barrel of all pipe and fittings shall be pinhole detected with a non-destructive 2,500-volt pinhole test. Each pipe joint and fitting shall be marked with the date of application of the lining system and with its numerical sequence of application on that date. The pipe or fitting manufacturer must supply a certificate attesting to the fact that the Applicator met the requirements of this specification, that the material used was as specified, and that the material was applied as required by the specification.

All pinholes and damaged lined areas shall be repaired in accordance with written repair procedures furnished by the manufacturer of the lining material so that the repaired area is equal in performance to the undamaged lined areas.

- G. Lined pipe and fittings must be handled only from the outside of the pipe and fittings. The pipe shall not be dropped or unloaded by rolling. Care should be taken to not let the pipe strike sharp objects while swinging or being off loaded. Ductile iron pipe should never be placed on grade by use of hydraulic pressure from an excavator bucket or by banging with heavy hammers.
- H. Exterior of all pipe fittings and specials shall be coated with asphaltic coating in accordance with ANSI/AWWA C151/A21.51.
- I. Bolts, nuts, gaskets and any other material needed for the complete installation of all pipe joints shall be furnished.

2.2 RESTRAINED JOINT DUCTILE IRON PIPE

- A. Pipe shall comply with all paragraphs of Section 2.1 and shall be furnished with mechanical joints.

2.3 DUCTILE IRON EXPANSION JOINTS

Provide ductile iron expansion joints per approved materials list.

PART 3 EXECUTION

3.1 GENERAL

- A. Ductile iron pipe shall be installed in accordance with AWWA C600 latest edition.
- B. Bedding shall be as shown on the detail drawings for gravity sewer.

END OF SECTION 02731

02732 POLYVINYL CHLORIDE SEWER PIPE

PART 1 GENERAL

1.1 SCOPE

- A. This section establishes the criteria for acceptance of Polyvinyl Chloride (PVC) pipe.
- B. Related Work.
 - 1. Section 02221 Trench Excavation, Bedding and Backfill
 - 2. Section 02730 Sanitary Sewer Systems
- C. DRAWINGS AND DATA. Drawings and data shall include, but not be limited to, the following:
 - 1. Details of joints.
 - 2. Gasket material.
 - 3. Pipe length.
 - 4. Certification in accordance with ASTM D3034, Section 11, ASTM F679, Section 10, or ASTM F794.

1.2 REFERENCE STANDARDS

- A. American Society for Testing and Materials (ASTM):
 - 1. ASTM C1173 – Standard Specification for Flexible Transition Couplings for Underground Piping Systems.
 - 2. ASTM D1784 – Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
 - 3. ASTM D2241 – Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure Rated Pipe (SDR Series).
 - 4. ASTM D3034 – Type PSM PVC Sewer Pipe and Fittings.
 - 5. ASTM D3139 – Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
 - 6. ASTM D3212 – Standard Specifications for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
 - 7. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

8. ASTM F679 - Standard Specification for Polyvinyl Chloride (PVC) Large Diameter Plastic Gravity Sewer Pipe and Fittings.
 9. ASTM F794 - Standard Specification for Polyvinyl Chloride (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter.
- B. American National Standard Institute (ANSI) and American Water Works Association (AWWA):
1. AWWA C900 (latest edition) - Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. Through 12 In. (100 mm Through 300 mm), for Water Transmission and Distribution.

1.3 QUALITY ASSURANCE

- A. The PVC pipe shall be furnished by manufacturers who are fully experienced, reputable and qualified in the manufacture of the PVC pipe to be furnished. The pipe shall be designed, constructed and installed in accordance with the best practices and methods and shall comply with this Section.
- B. Inspections of the pipe may be made by the Inspector or other representatives of the Owner after delivery. The pipe shall be subject to rejection at any time on account of failure to meet any of the requirements specified herein, even though sample pipes may have been accepted as satisfactory at the place of manufacture. Pipe rejected after delivery shall be marked for identification and shall be removed from the job at once.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Care shall be taken in shipping, handling and laying to avoid damaging the pipe and fittings. Extra care will be necessary during cold weather construction. Any pipe damaged in shipment shall be replaced as directed by the Inspector.
- B. Any pipe or fitting showing a crack or which has received a blow that may have caused an incipient fracture, even though no such fracture can be seen, shall be marked as rejected and removed at once from the work.
- C. While stored, pipe shall be adequately supported from below at not more than 3 ft intervals to prevent deformation. Pipe shall not be stacked higher than 6 ft. Pipe and fittings shall be stored in a manner which will keep them at ambient outdoor temperatures. Temporary shading as required to meet this requirement shall be provided. Simple covering of the pipe and fittings which allows temperature buildup when exposed to direct sunlight will not be permitted.

PART 2 PRODUCTS

2.1 SDR-26 PVC PIPE

- A. All PVC pipe shall meet or exceed the performance requirements of ASTM D3034 and ASTM F679. Push-on and/or mechanical joints shall conform to ASTM D3212. Gaskets shall conform to ASTM F477 for joining plastic pipe, synthetic rubber. Natural rubber will not be acceptable. No solvent-cement weld pipe or fittings will be accepted unless stated on detail.
- B. Smooth Wall PVC Pipe shall conform to the following requirements:

<u>Pipe Size</u>	<u>ASTM (latest edition)</u>
6 to 15 inch	D3034
18 to 27 inch	F679

- C. Each length of pipe and each fitting shall be marked with the name of the manufacturer, nominal size and SDR designation. All gaskets shall be marked with the name of the manufacturer, size and proper insertion direction.
- D. Field-cut joints and connections to other piping in gravity applications shall be made with a SDR-26 gasketed sewer fitting.
- E. Pipe or fittings having spiral external reinforcing ribs will not be acceptable. Pipe or fittings having concentric external reinforcing ribs will not be acceptable in any pipe size less than 24 inch.

2.2 C-900 PVC PIPE

- A. General. Products delivered under this specification shall meet the requirements of AWWA C900.
- B. Nominal outside diameters and wall thicknesses of restrained join pipe shall conform to the requirements of AWWA C900. Integral bell joint pipe shall be furnished in 4", 6", 8", 10" and 12" sizes, in Class 150(DR18). Pipe shall be furnished in standard lengths of 20 feet.
- C. Pipe shall incorporate a formed bell complete with a single rubber gasket conforming to ASTM F477. Joints shall be designed to meet the zero leakage test requirements of ASTM D3139.
- D. Pipe shall be homogeneous throughout and free from voids, cracks, inclusions and other defects, and shall be as uniform as commercially practicable in color, density and other physical characteristics.
- E. Every pipe shall pass the AWWA C900 hydrostatic proof test requirements of 4 times the pressure class for 5 seconds.
- F. Marking

Pipe shall be legibly and permanently marked in ink with the following minimum information:

- Nominal Size (for example, 4")
- PVC
- Dimension Ratio (for example, DR18)
- AWWA pressure class (for example, PC 150)
- ANSI/AWWA C900 (latest edition)

- Manufacturer's name or trademark and production record code
- Seal (mark) of the testing agency verifying the suitability of the pipe material for potable water service

PART 3 EXECUTION

3.1 GENERAL

Flexible Conduit PVC Pipe shall be installed in accordance with ASTM D2321-11.

3.2 JOINTING METHODS

- A. PVC sewer pipe and fittings shall be jointed in accordance with the recommendations of the latest ASTM Standards and detailed instructions of the manufacturer.
- B. All manhole connections shall be per Standard Details SS-6.4 or SS-7.0.

END OF SECTION 02732

02733 SANITARY SEWER SERVICE CONNECTIONS

PART 1 GENERAL

1.1 SCOPE

- A. Work in this section consist of the supply and installation of service connections from sanitary sewer collector lines to each dwelling, commercial building and/or residential or industrial lot in the area unless designated by the Engineer to the contrary.
- B. Related Work.
 - 1. Section 02221 Trench Excavation, Bedding and Backfill
 - 2. Section 02730 Sanitary Sewer System
 - 3. Section 02731 Ductile Iron Sewer Pipe
 - 4. Section 02732 Polyvinyl Chloride Sewer Pipe
- C. The Contractor shall contact property owners whenever feasible and cooperate with the property owner in the placement of the service unless otherwise directed by the Engineer or Owner's representative.
- D. Unless otherwise noted on the drawings or instructed by property owner or Engineer, service connections for vacant lots shall be extended to the property line and shall terminate on the property at a minimum distance of five (5) feet upgrade of the low property corner.
- E. The Contractor shall be responsible for locating existing service lines and coordinating reconnection locations that provide the best gravity sewer solution with the Engineer and/or Owner. Reconnection of existing services shall be performed after sanitary sewer collector lines have been completed, tested and accepted.

1.2 SUBMITTALS

- A. Submit product data for all service pipe and fittings.
- B. Drawings showing the location of service connections properly referenced sewer line station numbers shall be prepared as the work progresses.

1.3 QUALITY ASSURANCE

- A. Comply with all applicable standards contained herein and with the provisions of the following codes and standards except as otherwise shown or specified.
 - 1. South Carolina Department of Health and Environmental Control: All applicable rules and regulation.
 - 2. All requirements of the sewer service agency that will own, operate and maintain this sewer.

1.4 REFERENCE STANDARDS

C. American Society for Testing and Materials (ASTM):

1. ASTM D3034 – Type PSM PVC Sewer Pipe and Fittings.
2. ASTM F949 – Standard Specification for Poly(Vinyl Chloride) (PVC) Corrugated Sewer Pipe With a Smooth Interior and Fittings

PART 2 PRODUCTS

2.1 SERVICE PIPE

- A. Tee-wyes for service connections to mainline carrier pipe shall be either PVC or DIP. DIP shall be used when the main line pipe material is either vitrified clay pipe (VCP) or DIP.
- B. PVC and fittings shall be SDR-26 pipe meeting all requirements of ASTM D3034, latest edition. Tee-wyes on ribbed PVC pipe shall have SDR-26 branches and meet all requirements of ASTM F949, latest edition.
- C. DIP tee-wyes shall meet all requirements of Specification Section 02731.

PART 3 EXECUTION

3.1 GENERAL

- A. The service shall be placed to a minimum grade of 1% and shall be left low enough to give basement service to the building to be served and placed low enough to give a minimum of 2'-0" cover in piping to the building unless otherwise designated by the Engineer.
- B. Failure on the part of the Contractor to place the service to the grades specified shall make the Contractor liable for paralleling the lateral sewer to a point where grade can be met.
- C. Tee-wyes are to be placed on the sewer main and services installed during installation of the lateral sewer. Saddles are not acceptable.
- D. Service connection to manholes shall be installed with inverts and benches to prevent solids deposition in manhole.

3.3 INSPECTION AND TESTING

- A. Service laterals shall be tested in accordance with Section 02730. For services being reconnected, Contractor shall test lateral prior to reconnection to existing service.

END OF SECTION 02733

02768 MANHOLE LINING

PART 1 GENERAL

1.1 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required and install the manhole lining system and appurtenances as specified herein. The protective manhole lining shall be used to rehabilitate the interior of all designated existing sewer manholes as shown on the Drawings.
- B. The Contractor shall accurately field measure and size each individual manhole. The Contractor is reminded that each existing sewer manhole designated to receive the lining may have a different configuration and varying field dimensions. All field measurements shall conform to the requirements of the monolithic lining manufacturer.
- C. The manhole lining shall not be installed until all main sewer, service lateral, and manhole work is complete.
- D. Each manhole shall be thoroughly cleaned and then inspected for loose or missing bricks, loose mortar, holes, etc. All leaks shall be plugged prior to manhole lining.

1.2 RELATED WORK

- A. Manhole covers and other components are included in Section 02730.
- B. Manhole vacuum testing is included in Section 02730.

1.3 SUBMITTALS

- A. Material type and manufacturer to be used including: catalog data sheets, ASTM references, material composition, manufacturers recommended specifications, component physical properties and chemical resistance.
- B. Manufacturer's detailed description of the recommended procedures for handling and storing materials including a proposed method for monitoring temperatures of the storage location, if applicable to the specific material.
- C. Manufacturers detailed description of the recommended material installation/application process including mixing, additives, set time, cure time (return to service) and all equipment required for quality product delivery.
- D. Technical data sheet describing each rehabilitation component to be applied/installed, stating the expected longevity of the component in a wastewater environment. Data shall be based on independent third party tests.
- E. Manufacturer's detailed description of all required field testing processes and procedures.

- F. Copies of independent testing performed on the rehabilitation component, indicating that the product meets the requirements as specified in these contract documents and the manufacturers design.
- G. Technical data sheet and project specific data for manhole repair materials to be used in conjunction with each rehabilitation component(s) including application cure time and surface preparation procedures.
- H. Certification that backup installation equipment is available on the job site or can be delivered to the job site by the morning of the next business day.
- I. All shipping, storage and safety requirements including MSDS documents.
- J. Certified statement, from the manufacturer, that the contractor/installer is an approved installer of the cementitious material with certificates of completed training for each crew member involved.
- K. Submittal of all quality assurance documentation and test reports for materials installed. (After Completion)

1.4 REFERENCE STANDARDS

- A. American Society for Testing and Materials (ASTM)
 - a. ASTM C39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
 - b. ASTM C109 - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars
 - c. ASTM C293 - Standard Test Method for Flexural Strength of Concrete (Using Simple Beam With Center-Point Loading)
 - d. ASTM C321 - Standard Test Method for Bond Strength of Chemical-Resistant Mortars
 - e. ASTM C496 - Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens
 - f. ASTM C596 - Standard Test Method for Drying Shrinkage of Mortar Containing Portland Cement
 - g. ASTM C666 - Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing
 - h. ASTM C1244 - Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test
 - i. ASTM D638 – Standard Test Method for Tensile Properties of Plastics

- j. ASTM D695 – Standard Test Method for Compressive Strength of Rigid Plastics
 - k. ASTM D790 – Standard Test Method for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
 - l. ASTM D2240 – Standard Test Method for Rubber Property – Durometer Hardness
 - m. ASTM D4414 – Standard Practice for Measurement of Wet Film Thickness by Notch Gages
 - n. ASTM D4541 – Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
 - o. ASTM F2551 – Standard Practice for Installing a Protective Cementitious Liner System in Sanitary Sewer Manholes
- B. NACE - The published standards of National Association of Corrosion Engineers (NACE International), Houston, TX.
- a. NACE RPO 188-99 Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates
- C. Where reference is made to one of the above standards, the revision in effect at the time of the pre-construction meeting shall apply.

1.5 QUALIFICATIONS

- A. The Contractor performing the work shall be fully qualified, experienced and equipped to complete this work expeditiously and in a satisfactory manner and shall be an approved installer as certified and licensed by the manufacturer. The Contractor shall have successfully installed the proposed lining system in a minimum of 400 manholes as documented by verifiable references. There shall be no exceptions to this experience requirement. The Contractor shall submit the following information to the Owner for review and approval before any work is performed.
- 1. The number of years of experience in performing this type of specialized work and in installing the specified lining system.
 - 2. Name of the manufacturer and supplier for this work and previous work listed below.
 - 3. A list of municipal clients that the Contractor has performed this type of work including contact names, phone numbers, and number of manholes.
 - 4. The Contractor shall submit a certified statement from the manufacturer that he/she is a certified and/or licensed installer of the liner.
- B. The Contractor shall also be capable of providing crews as needed to complete this work without undue delay.
- C. The Owner reserves the right to approve or disapprove the Contractor, based on the submitted qualifications.

1.6 GUARANTEE

- A. All monolithic cementitious lining installed shall be guaranteed by the Contractor for a period of one year from the date of final acceptance. During this period, all defects discovered in the monolithic lining, as determined by the Engineer, shall be repaired or replaced in a satisfactory manner by the Contractor at no cost to the Owner.
- B. All epoxy lining installed shall be guaranteed by the Contractor for a period of five years from the date of final acceptance. During this period, all defects discovered in the monolithic lining, as determined by the Engineer, shall be repaired or replaced in a satisfactory manner by the Contractor at no cost to the Owner.
- C. The Contractor is responsible for properly preparing the existing manhole for lining prior to the installation of the monolithic lining system, including stopping all leaks, patching voids, removing steps/manhole rungs, cleaning, removing rubble, root removal, etc.

1.7 QUALITY ASSURANCE

- A. Coating product(s) shall be capable of being installed and cured properly within an active sanitary sewer manhole environment. Coating product(s) shall be resistant to all forms of chemical or bacteriological attack found in municipal sanitary sewer systems; and, capable of adhering to the manhole structure substrates.
- B. Repair product(s) shall be fully compatible with coating product(s) including ability to bond effectively forming a composite system.
- C. Contractor shall utilize equipment for the spray application of the coating product(s) which has been approved by the coating product manufacturer; and, Contractor shall have received training on the operation and maintenance of said equipment from the coating product manufacturer.
- D. Contractor shall be trained by, or have their training approved and certified by, the coating product manufacturer for the handling, mixing, application and inspection of the coating product(s) to be used as specified herein.
- E. The supplier shall be responsible for the provisions of all test requirements specified in the above referenced ASTM Standards as applicable. In addition, all lining products to be installed under this Contract may be inspected at the plant for compliance with these specifications by an independent testing laboratory acceptable to the Owner. The Contractor shall require the manufacturer's cooperation in these inspections. The cost of plant inspection of all lining products and materials approved for this Contract shall be borne by the Contractor.
- F. Inspections of the lining products and materials may also be made by any representative of the Owner after delivery. The lining products and materials shall be subject to rejection at any time on account of failure to meet any of the Specification requirements, even though samples may have been accepted as satisfactory at the place of manufacture. Manhole lining materials rejected after delivery shall be marked for identification and shall be removed from the job at once.

- G. Contractor shall be trained in the use of testing or inspection instrumentation and knowledgeable of the proper use, preparation and installation of the coating product(s) to be used as specified herein. Contractor shall provide appropriate guidance on inspecting coating application prior to construction.
- H. Contractor shall initiate and enforce quality control procedures consistent with the coating product(s) manufacturer recommendations and applicable standards as referenced herein.

1.8 DELIVERY, STORAGE AND HANDLING

- A. Care shall be taken in shipping, handling and placing to avoid damaging the lining products. Extra care may be necessary during cold weather construction. Any lining product or material damaged in shipment shall be replaced as directed by the Inspector.
- B. Any lining product showing deterioration, or which has been exposed to any other adverse storage condition that may have caused damage, even though no such damage can be seen, shall be marked as rejected and removed at once from the work.
- C. While stored, the lining products shall be adequately packaged and protected. The lining products shall be stored and handled in a manner as recommended by the manufacturer and material safety data sheets (MSDS).
- D. Do not store coating products near flame, heat or strong oxidants.

1.9 SITE CONDITIONS

- A. Contractor shall conform to all local, state and federal regulations including those set forth by OSHA, RCRA and the EPA and any other applicable authorities.
- B. Confined space entry, flow diversion and/or bypass plans shall be presented by Contractor as necessary to perform the specified work.

PART 2 PRODUCTS

2.0 DESIGN CRITERIA

- A. Condition A: Low to mild hydrogen sulfide (pH > 3.0) shall receive a cementitious manhole liner.
- B. Condition B: High to harsh hydrogen sulfide (pH < 3.0) shall receive epoxy liner.

2.1 CONDITION A: CEMENTITIOUS MANHOLE LINING - WALLS AND BENCHES

- A. Liner material shall consist of a cementitious based product capable of forming a structurally enhanced monolithic covering. The cementitious lining system shall be a pumpable Portland based cement or fused calcium aluminate cement. The lining shall be installed via low-pressure application only. The materials shall be suitable for all the specified design conditions. The following materials are pre-approved:
 - a. MS-2 A by Strong-Seal,
 - b. QM-1S by Quadex, Inc.,
 - c. MH Line by Parson Environmental, or
 - d. Permacast MS-10,000 by AP/M Permaform.
- B. The cementitious lining shall be self-forming and shall be applied to cover all exterior manhole surfaces including the invert, walls, benches and chimney. All cementitious lining shall be troweled smooth after spray application. The cured cementitious lining shall be applied to a minimum total thickness of $1.0 \pm \frac{1}{4}$ inch. The cured surfacing thickness shall be smooth and continuous with proper sealing connections to all unsurfaced areas.
- C. The materials used in the cementitious lining systems shall be mixed on site in accordance with the manufacturer's recommendations. Water shall only be added to the materials during the mixing process and prior to material pumping or spray application. No water shall be added at the nozzle.
- D. The cementitious liner when cured shall have the following minimum characteristics as measured by the applicable ASTM standards referenced herein:

Compressive Strength	ASTM C109	> 8,000 psi @ 28 days
Tensile Strength	ASTM C496	> 600 psi @ 90 days
Flexure Strength	ASTM C293	> 1,200 psi @ 28 days
Shrinkage @ 90% Relative Humidity	ASTM C596	0% @ 28 days
Bond Strength	ASTM C321	Substrate Failure
Freeze/Thaw Resistance	ASTM C666	100 cycles with no visible damage.

- E. The cementitious lining shall provide a minimum service life of 25 years.
- F. The cured cementitious lining shall be continuously bonded to all the brick, mortar, concrete, chemical sealant, grout, pipe and other surfaces inside the sewer manhole.
- G. Chemical sealants or grouts used to seal active manhole leaks, to patch cracks, to fill voids and to otherwise prepare the manhole surfaces for the lining installation shall be suitable for the intended purpose and shall be compatible with the lining as certified by the manufacturer.
- H. When cured, the monolithic cementitious lining shall form a continuous, tight-fitting, hard, impermeable surfacing which is suitable for sewer system service and chemically resistant to any chemicals or vapors normally found in domestic sewage.

- I. The monolithic cementitious lining shall cover the complete interior of the existing sewer manhole including the benches (shelves). The lining shall effectively seal the interior surfaces of the sewer manhole and prevent any penetration or leakage of groundwater infiltration.
- J. The lining shall be compatible with the thermal condition of the existing sewer manhole surfaces. Surface temperatures will range from 20°F to 100°F. Provide test data on shrinkage of the cementitious lining based on ASTM C596.

2.2 CONDITION A: CEMENTITIOUS MANHOLE LINING - INVERT CHANNEL COATING

- A. All invert channels shall be coated with cementitious mortar.
- B. The cementitious mortar used for the invert channel shall be suitable for the intended purpose and shall be compatible with the materials used for the lining system. The cementitious mortar for the invert channel shall be as manufactured by the cementitious liner manufacturer.

2.3 CONDITION B: EPOXY MANHOLE LINING

- A. The materials to be utilized in the lining of manholes shall be designed and manufactured to withstand the severe effects of hydrogen sulfide in a wastewater environment. Manufacturer of corrosion protection products shall have long proven experience in the production of the lining products utilized and shall have satisfactory installation record.
- B. The materials shall be applied by an approved certified applicator and must meet the manufacturer's recommendations.
- C. Equipment for installation of lining materials shall be high quality grade and be as recommended by the manufacturer.
- D. The epoxy liner when cured shall have the following minimum characteristics as measured by the applicable ASTM standards referenced herein:

Color		Any
Solids Content		100%
Solvent Content		0%
Compressive Strength	ASTM D695	135,00 psi
Tensile Strength	ASTM D638	7,500 psi
Tensile Elongation	ASTM D638	1.5%
Flexural Strength	ASTM D790	11,500 psi
Shore Hardness, Type D	ASTM D2240	80
Bond Strength	ASTM D4541	> Tensile Strength of Concrete
Primer Required		None

PART 3 EXECUTION

3.1 INSTALLATION - GENERAL

- A. The Contractor shall complete manhole installation prior to lining including surface preparation, patching of voids and sealing of leaks, invert channel coating, and other required manhole rehabilitation work. The Contractor shall dispose of any resulting material.
- B. The Contractor shall notify all property owners who discharge sewage directly to the manhole being surfaced that their service will be discontinued while the lining is being placed, cured and active pipe and service connections reopened.
- C. The Contractor shall provide bypass pumping of sewage flows where and when the rehabilitation work is being performed.
- D. Prior to placing the lining, the Inspector and the manufacturer's representatives (when on site) along with the Contractor must inspect and approve the surface preparation work. The Contractor shall notify the Inspector when the manholes are ready for inspection. The Contractor is responsible for ensuring proper installation conditions including temperature and moisture.
- E. If the drawings call for a flexible ring-chimney seal, then the lining shall be installed to 1 inch below the bottom of the manhole ring. The termination of and surface of the lining shall be suitable for proper installation of the manhole ring-chimney seal. If a ring-chimney seal is not required, then manhole lining shall be installed to the bottom of the manhole ring.
- F. Temperature limitations must be handled as appropriate and as approved by the manufacturer.
- G. A complete, watertight seal shall be provided at pipe and manhole wall connections.
- H. The Contractor shall reopen all of the existing active pipe connections in each sewer manhole following lining.

3.2 INSTALLATION - CEMENTITIOUS LINERS

- A. The Contractor shall furnish and place cementitious lining in each manhole as shown on the Drawings and where directed by the Inspector. The installation of the lining shall be in complete accordance with the applicable provisions of ASTM F2551 and the manufacturers' specifications. A representative of the manufacturer shall be present during actual installation of lining of the first ten (10) manholes.
- B. All bottom and horizontal surfaces including the benches shall have the lining applied to the required thickness by hand troweling or spray-on methods. Cementitious linings that are spray-applied shall be troweled smooth after application.
- C. All side vertical surfaces shall have the monolithic lining applied to the required thickness by a spray-on method in one pass or application. All lining shall be troweled smooth after spray application.

3.3 INSTALLATION - EPOXY LINERS

- A. The corrosion resistant barrier shall be spray applied as per the manufacturer's recommendation and shall have an average minimum finished thickness of 80 mils if applied in conjunction with cementitious liner.
- B. Where corrosion resistant barrier is applied directly to manhole wall, upon cleaning and surface preparation, the average minimum finished thickness shall be 125 mils.
- C. The Contractor shall have manufacturer's representative present on site at all times during the installation of corrosion resistant barrier of the first ten (10) manholes.
- D. The Contractor shall make provisions in his unit price bid for each structure to maintain dry conditions for the corrosion resistant liner application and subsequent curing as per manufacturer's recommendations.

3.4 FIELD TESTING AND ACCEPTANCE

- A. Field acceptance of manhole lining shall be based on the Inspector's evaluation of the proper surfacing of the manhole per field inspections. Acceptance shall also be based on the Inspector's evaluation of the appropriate installation and curing test data.
- B. Minimum Liner Thickness:
 - 1. The cementitious lining shall provide a continuous monolithic surfacing with uniform thickness throughout the manhole interior, and this depth shall be verified by the use of a feeler gauge or by counting the number of bags required. Special attention shall be given to the chimneys of brick manholes to insure that liner material covers and seals the bottom joints at all masonry units.
 - 2. If the thickness of the cementitious lining is not uniform or is less than specified, it shall be repaired or replaced.
 - 3. Epoxy Liner Thickness Measurement: During application of corrosion resistant liner, a wet film thickness gauge, meeting ASTM D4414, shall be provided by the Contractor and used. Measurements shall be taken, documented and attested by the Contractor for submission to the Owner. Additional measurements may be made by the Inspector.
- C. The Inspector may enter the manholes to inspect the benching, invert channels, manhole wall/pipe connections, surface preparation, and other parts of the work. The Contractor shall provide forced air ventilation, gas monitors and detectors, harnesses, lights, etc. for the Inspector to enter the manhole and perform the inspection in complete accordance with OSHA requirements.
- D. There shall be no groundwater infiltration or other leakage through the manhole wall after it has been lined. If leakage is found, it shall be eliminated with an appropriate method as recommended by the liner manufacturer and approved by the Inspector.

- E. All pipe connections shall be open and clear.
- F. Cementitious Material Property Testing: One 2X2 inch sample cube shall be taken for every 50 bags of material used. Samples shall be sprayed from nozzle, identified in the presence of the Owner's representative and sent, by the Owner's representative, to an independent test laboratory for compression strength testing as described in ASTM C-109.
- G. Manhole Vacuum Testing:
 - 1. All manholes shall be tested via vacuum testing when all manhole rehabilitation work is complete including installation of ring-chimney seals after liner installation. The vacuum tests shall test the manhole lining and the manhole ring-chimney seal. The testing shall be paid for by the Contractor and be included in the bid price for manhole lining. The Contractor shall notify the Inspector 48 hours prior to testing. The Contractor shall be required to complete manhole test forms supplied by the Owner. Any manhole that fails the vacuum test shall be repaired and retested immediately by the Contractor.
 - 2. Manhole vacuum testing will be performed in accordance with Section 02730. If the manhole fails the initial test, necessary repairs shall be made with a suitable non-shrink grout while the vacuum is being drawn. Re-testing shall proceed until a satisfactory test is obtained.
- H. Cementitious Liner: There shall be no cracks, voids, pinholes, uncured spots, dry spots, lifts, de-laminations or other type defects in the cementitious lining.
- I. Holiday Testing of Epoxy Liner: Holiday testing may be performed in lieu of vacuum testing, with Owner approval. After proper curing, epoxy liner shall be inspected for holidays with high-voltage holiday detection equipment provided by the Contractor. Reference NACE RPO 188-99 for performing holiday detection.
 - 1. An induced holiday shall be made into the coated surface and serve to determine the min/max voltage to be used to test the coating.
 - 2. The holiday tester shall be initially set to 100 volts per mil of specified thickness but shall be increased if it cannot detect induced holidays.
 - 3. All detected holidays shall be marked and repaired by abrading the coating surface with grit disk paper or other hand tooling method. After abrading and cleaning, additional coating can be hand applied to the repair area. All touch-up/repair procedures shall follow the coating manufacturer's recommendations. Documentation on areas tested, results and repairs made shall be provided to Owner by Contractor.
- J. If any defective lining is discovered after it has been installed, it shall be repaired or replaced in a satisfactory manner within 72 hours. This requirement shall apply for the entire guarantee period.

3.5 DOCUMENTATION

- A. Rehabilitation Documentation: Contractor shall complete a Rehabilitation Report for each sewer manhole that includes the following information:
- a. Owner Name
 - b. Project Location
 - c. Cleaning Date
 - d. Rehabilitation Date
 - e. Superintendent's Name
 - f. Rehabilitation Weather Conditions
 - g. Manhole Number
 - h. Manhole Location
 - i. Manhole Diameter
 - j. Manhole Height
 - k. Manhole Substrate Material (i.e., brick, block, pre-cast concrete, etc.)
 - l. Liner Thickness Applied
 - m. Type and Amount of Patching Material Used
 - n. Type of Liner Used
 - o. Number of Bags/Tubs of Cementitious Liner Used
 - p. Gallons of Epoxy Applied
 - q. Steps Removed?
 - r. Description of any problems during installation
 - s. Duration of Vacuum Test
 - t. Holiday Test Voltage
 - u. Number of Holidays Found
 - v. Signature of Tester

END OF SECTION 02768

DIVISION 3 – CONCRETE

03300 CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.1 DESCRIPTION

This section covers all cast-in place structural concrete including forms, vapor barriers, reinforcement, finishing, and curing for curbs and sidewalks.

1.2 TOLERANCES

- A. Float and Broom Finish. Plane within 5/16-inch in 10 feet as determined by a 10 foot straightedge.
- B. Formed Surfaces: ACI 301.
- C. Reinforcement (Fabricating and Placing): ACI 301.

1.3 APPLICABLE PUBLICATIONS

The publications (latest edition) listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.

- A. American Society for Testing and Materials (ASTM).

A615 Deformed and Plain Billet-Steel Bars for Concrete Reinforcement

C33 Concrete Aggregates

C94 Ready-Mixed Concrete

C150 Portland Cement

C171 Sheet Material for Curing Concrete

C260 Air-Entraining Admixtures for Concrete

C494 Chemical Admixtures for Concrete

C618 Fly Ash and Raw or Calcined Natural Pozzolan for use as a mineral admixture in Portland Cement Concrete

- B. American Concrete Institute (ACI).
 - 301 Specification for Structural Concrete for Buildings
 - 304R Guide for Measuring, Mixing, Transporting, and Placing Concrete
 - 305 Recommended Practice for Hot Weather Concreting
 - 306 Recommended Practice for Cold Weather Concreting
 - 315 Details and Detailing of Concrete Reinforcement
 - 318 Building Code Requirements for Reinforced Concrete
 - 347 Recommended Practice for Concrete Formwork

PART 2 PRODUCTS

2.1 FORMS

Forms may be wood, plywood, or metal, of grade or type suitable to obtain type of finish specified.

2.2 MATERIALS FOR CONCRETE

The following materials shall conform to the respective specifications and other requirements specified herein.

- A. Portland Cement: ASTM C150, Type I or II
- B. Coarse Aggregate: ASTM C33. The nominal maximum size of coarse aggregate shall not be larger than (a) 1/5 the narrowest dimension between sides of forms, (b) 1/3 the depth of slabs. Maximum size for coarse aggregate is 1-1/2 inches.
- C. Fine Aggregate: ASTM C33. Do not use manufactured sands.
- D. Mixing Water: Fresh, clean and potable
- E. Air-Entraining Admixture: ASTM C260
- F. Chemical Admixture: ASTM C494
- G. Pozzolan: ASTM C618, Class C or F.

2.3 CONCRETE MIXES

- A. Compressive strength shall be 3000 psi and maximum slump shall be 4".

1. The strength of the concrete mixes proposed for use shall be established prior to beginning concrete operations. The concrete mix may be proportioned on the basis of field experience, trial mixes, or water cement ratio as stated in ACI 318-89, paragraphs 5.3 and 5.4.
 2. Water shall not be added at the site that will cause the design mix water/cement ratio to be exceeded.
- B. A high range water-reducing (HRWR) admixture conforming to ASTM C-494 may be used to increase slump above that specified in Paragraph A. Concrete that will be manually screeded shall have HRWR added to increase slump to no more than 8 inches.
- C. Air-entrainment is required. Air content shall conform to the following table:

Nominal Maximum Size of Coarse Aggregate, Inches	Total Air Content Percent by Volume
3/8	6 to 10
1/2	5 to 9
3/4	4 to 8
1	3-1/2 to 6-1/2
1-1/2	3 to 6

- D. Materials shall be stored, batched, and mixed as specified in ASTM C94.

2.4 REINFORCING STEEL

ASTM A615, deformed Grade 60

2.5 SHEET MATERIALS FOR CURING CONCRETE

ASTM C171.

2.6 LIQUID CURING COMPOUNDS

ASTM C1315, Type 1, Class A.

PART 3 EXECUTION

3.1 FORMWORK

Installation of formwork shall conform to ACI 347. Design, engineering, and construction of the formwork shall be the responsibility of the Contractor.

3.2 REINFORCEMENT

Details of concrete reinforcement, unless otherwise shown, shall be in accordance with ACI 318, ACI 315, and ACI 301. All reinforcing steel shall be supported and securely tied to prevent displacement during the placing of concrete.

3.3 PLACING, PROTECTION AND CURING CONCRETE

- A. In normal weather conform to ACI 304.
- B. In cold weather conform to ACI 306, except that the use of calcium chloride shall not be permitted.
- C. In hot weather conform to ACI 305.
- D. Conform to ACI 302.1R, ACI 308 and as specified herein.
- E. Approved curing methods are as follows:
 - 1. Water curing by covering the entire surface of concrete with water. The curing water should not be more than 20 degrees F cooler than the concrete.
 - 2. Water curing by fog spraying or sprinkling to provide a continuous film of water over the entire surface of concrete.
 - 3. Water curing by means of covering the entire surface with absorbent materials which shall be kept moist. Absorbent materials can be burlap, cotton mats, rugs, or other approved materials.
 - 4. Curing by means of covering the entire surface with waterproof sheet materials to reduce the loss of mixing water from the concrete. Materials can be polyethylene sheeting, waterproof paper, or polyethylene coated burlap. On slabs the sheets should extend over the edges at least twice the slab thickness. During cold weather black polyethylene sheeting should be used and in hot weather white polyethylene sheeting should be used. Do not use polyethylene on slab surfaces that will be exposed.
 - 5. Curing by means of spraying or rolling a liquid membrane forming curing compound according to manufacturer's recommendations over the entire surface. A white-pigmented Class 2 compound shall be used when the concrete is exposed to the sun; otherwise use Class 1. Curing compounds shall not be used in areas to receive adhesives for floor coverings or paint without certification of compatibility from the Contractor.
 - 6. Minimum period of curing for all methods is 7 days unless a shorter period is approved by the engineer.

3.4 FINISHES

A. Vertical Surfaces in Channel in Screen Vault:

Chip away all "high" spots and fill all "low" spots with a grout composed of the same cement/sand ratio as the concrete used for the wall.

Rub entire surface of wall with a fine abrasive stone to create a smooth surface, free of all form marks. Finishing of wall is to start as soon as possible after wall will support itself. Finishing of any section of wall is to be complete within 4 hours of the stripping of forms.

B. Slab Finishes:

1. Float Finish: After the concrete has been placed, struck off, and leveled, the concrete shall not be worked further until ready for floating. Floating shall begin when the water sheen has disappeared. During the first floating the concrete shall be checked for planeness of surface. The concrete shall then be refloated immediately to a uniform sandy texture.
2. Troweled Finish: The bottom surfaces of the Channel in the Screen Vault are to receive a troweled finish. The surface shall first be float-finished as specified above. It shall then be power troweled, and finally hand troweled such that the finished surface is essentially free of trowel marks and uniform in texture and appearance.

END OF SECTION 03300

03310 GROUT

PART 1 GENERAL

1.1 SUMMARY

- A. The work under this section consists of furnishing all labor, materials, equipment required to place non-shrink grout in vault bottoms, wet wells, manholes, and under metal pump station as shown on drawings and specified herein.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Portland Cement: ASTM C 150, Type 1.
- B. Aggregate: ASTM C 33.
- C. Water: Potable and free from foreign materials.
- D. Admixtures: ASTM C 494.

2.2 GROUT MIX

- A. A suggested guide for the grout mixture for one cubic yard is:

Portland Cement	940 lbs.
Fine Aggregate	2,220 lbs.
Water	415 lbs.
Admixture	per manufacturer

- B. Material quantities shown are surface dry quantities.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Surfaces to receive grout shall be cleaned to remove any grease, dirt, or other materials, which might prevent adhesion of the grout.
- B. A cement wash mix shall be broomed onto the concrete surface prior to placement of grout. The cement wash shall consist of water and portland cement.
- C. The grout shall be placed to the elevations and slopes as indicated on the Drawings.

END OF SECTION 03310

DIVISION 4 – PUMP STATION AND FORCE MAIN

04005 AIR/VACUUM VALVES FOR WASTEWATER SERVICE

PART 1 - GENERAL SUMMARY

- A. Section Includes: Air release/vacuum breaker valves for wastewater treatment facilities.
- B. Related Requirements:
 - 1. Section 02730 – Sanitary Sewer Systems.

1.2 REFERENCE STANDARDS

- A. American Water Works Association:
 - 1. AWWA C512 - Air-Release, Air/Vacuum, and Combination Air Valves for Waterworks Service.
- B. ASME International:
 - 1. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
- C. ASTM International:
 - 1. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
 - 2. ASTM A351/A351M - Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.
 - 3. ASTM A536 - Standard Specification for Ductile Iron Castings.
 - 4. ASTM B584 - Standard Specification for Copper Alloy Sand Castings for General Applications.
- D. International Organization for Standardization:
 - 1. ISO 9001 - Quality Management Systems.

1.3 COORDINATION

- A. Coordinate Work of this Section with installation of process piping.

1.4 SUBMITTALS

- A. Provide submittals in accordance with requirements set forth in the project manual.
- B. Product Data: Submit manufacturer catalog information.

- C. Shop Drawings: Indicate materials, dimensions, weights, and end connections on assembly drawings.
- D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- E. Manufacturer Instructions: Submit special procedures and setting dimensions.
- F. Source Quality-Control Submittals: Indicate results of shop/factory tests and inspections.
- G. Manufacturer Reports: Certify that equipment has been installed according to manufacturer instructions.
- H. Qualifications Statements:
 - 1. Submit qualifications for manufacturer.

1.5 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of air release/vacuum breaker valves.

1.6 QUALITY ASSURANCE

- A. Manufacturer Quality Management System: Certified to ISO 9001.
- B. Perform Work according to SCDOT Standard Specifications.

1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' documented experience.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.
- B. Store materials according to manufacturer instructions.
- C. Protection:
 - 1. Protect materials from moisture and dust by storing in clean, dry location.
 - 2. Furnish temporary end caps and closures on piping and fittings and maintain in place until installation.
 - 3. Provide additional protection according to manufacturer instructions.

1.9 EXISTING CONDITIONS

A. Field Measurements:

1. Verify field measurements prior to fabrication.
2. Indicate field measurements on Shop Drawings.

1.10 WARRANTY

- A. Furnish five-year manufacturer's warranty for air release/vacuum breaker valves.

PART 2 - PRODUCTS

2.1 AIR/VACUUM VALVES FOR WASTEWATER SERVICE

A. Manufacturers:

1. ARI Model D-025 - "SAAR" Short Version
2. Vent Tech Model SDG – Sewage Short Valve
3. Ventomatic
4. Or Approved Equal

B. Description:

1. Type: Fully automatic, float operated.
2. Comply with AWWA C512.
3. Size: As indicated on Drawings.
4. Suitable for sewage service.
5. Valve Body Connections: Furnish 2-inch NPT cleanout and 1-inch NPT drain.
6. Pressure Rating: 740 psig.

C. Materials: As specified by individual manufacturer

D. End Connections:

1. Size 3 Inches and Smaller:
 - a. Threaded, NPT.
 - b. 1-Inch Valves: Furnish 2-inch inlet.
2. Size 4 Inches and Larger: Flanged, ASME B16.1.
3. Backwash Accessories: Furnish three additional NPT connections.

E. Valve Body Connections:

1. Threaded, NPT.
2. Cleanout: 2 inches.
3. Drain: 1 inch.

F. Accessories:

1. Backwash accessories, including inlet shutoff valve, blowoff valve, rubber supply hose, and quick-disconnect couplings.
2. Epoxy lining.

2.2 INSULATION

- A. As indicated on Drawings.

2.3 SOURCE QUALITY CONTROL

- A. Provide shop inspection and testing of completed assembly.

B. Certificate of Compliance:

1. If fabricator is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at fabricator's facility conforms to Contract Documents.
2. Specified shop tests are not required for Work performed by approved fabricator.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that field dimensions are as indicated on Shop Drawings.
- B. Inspect existing flanges for nonstandard bolt hole configurations or design and verify that new pipe and flanges mate properly.

3.2 PREPARATION

- A. Thoroughly clean end connections before installation.
- B. Close pipe and equipment openings with caps or plugs during installation.
- C. Cleaning: Clean surfaces to remove foreign substances.

3.3 INSTALLATION

- A. According to manufacturer instructions.
- B. Provide access for operation, removal, and maintenance, and to avoid discharge to occupied areas or other equipment.

3.4 FIELD QUALITY CONTROL

- A. Inspect for interferences and proper supports.
- B. Testing:
 - 1. As specified in Section 02730 – Sanitary Sewer Systems.
 - 2. Demonstrate operation without undue noise or vibration.
- C. Equipment Acceptance:
 - 1. Adjust, repair, modify, or replace components failing to perform as specified and rerun tests.
 - 2. Make final adjustments to equipment under direction of manufacturer's representative.
 - 3. Repair damaged coatings with material equal to original coating.
- D. Furnish installation certificate from equipment manufacturer's representative attesting that equipment has been properly installed and is ready for startup and testing.

3.5 CLEANING

- A. Keep interior of air release valves clean as installation progresses.

3.6 DEMONSTRATION

- A. Demonstrate equipment startup, shutdown, routine maintenance, and emergency repair procedures to Owner's personnel.

END OF SECTION 04005

04212 ASPHALT PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Asphalt materials.
2. Aggregate materials.
3. Aggregate subbase.
4. Asphalt paving base course, binder course, and wearing course.
5. Asphalt paving overlay for existing paving.

1.2 REFERENCE STANDARDS

A. SCDOT Standard Specifications:

1. Standard Specifications for Highway Construction, latest edition, published by the South Carolina Department of Transportation.

B. American Society of Testing Materials

1. ASTM D2950 - Standard Test Method for Density of Bituminous Concrete in Place by Nuclear Methods

1.3 SUBMITTALS

A. Product Data:

1. Submit product information for asphalt and aggregate materials.
2. Submit mix design with laboratory test results supporting design.

B. Manufacturer's Certificate: Certify Products are produced at a plant approved by SCDOT and that meet or exceed specified requirements.

1.4 QUALITY ASSURANCE

A. Mixing Plant: Conform to Division 400 of SCDOT Standard Specifications.

B. Obtain materials from same source throughout.

- C. Perform Work in accordance with SCDOT and/or Local Municipality standards.
- D. Maintain one copy of each document on site.
- E. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.

1.5 QUALIFICATIONS

- A. Installer: Company specializing in performing work of this section with minimum three years documented experience approved by manufacturer.

1.6 AMBIENT CONDITIONS

- A. Do not place asphalt mixture when ambient air or base surface temperature is less than 50 degrees F, or surface is wet or frozen.
- B. Place asphalt mixture when temperature is not more than 15 degrees F less than initial mixing temperature.

PART 2 - PRODUCTS

2.1 ASPHALT PAVING

- A. Performance / Design Criteria:
 - 1. Paving: Design for light duty commercial vehicles.
- B. Asphalt Paving Materials:
 - 1. Prime Coat
 - a. The work covered under this section of this specification shall be performed in strict conformance with SCDOT Section 305.4.6 & 401.4.18.
 - 2. Tack Coat
 - a. The work covered under this section of this specification shall be performed in strict conformance with SCDOT Section 401.4.18.
 - 3. Aggregate Base Course
 - a. The work covered under this section of this specification shall be performed in strict conformance with SCDOT Section 305
 - 4. Asphalt Intermediate Course (Type B)
 - a. The work covered under this section of this specification shall be performed in strict conformance with SCDOT Section 402.
 - 5. Asphalt Surface Course (Type C)
 - a. The work covered under this section of this specification shall be performed in strict conformance with SCDOT Section 403.

2.2 ACCESSORIES

- A. Geotextile Fabric: AASHTO M288; non-woven, polypropylene.

2.3 SOURCE QUALITY CONTROL

- A. Submit proposed mix design of each class of mix for review prior to beginning of Work.
- B. Test samples in accordance with Section 401 of SCDOT Standard Specifications.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify utilities indicated under paving are installed with excavations and trenches backfilled and compacted.
- B. Verify compacted subgrade subbase is dry.
 - 1. Proof roll subbase with steel wheel 2-axle tandem roller in minimum two perpendicular passes to identify soft spots.
 - 2. Remove soft subbase and replace with compacted fill.
- C. Verify gradients and elevations of base are correct.
- D. Verify manhole frames are installed in correct position and elevation.

3.2 PREPARATION

- A. Prepare subbase in accordance with SC DOT Standards.

3.3 DEMOLITION

- A. Saw cut and notch existing paving as indicted on Drawings.
- B. Clean existing paving to remove foreign material, excess joint sealant and crack filler from paving surface.
- C. Repair surface defects in existing paving to provide uniform surface to receive new paving.

3.4 INSTALLATION

- A. Subbase:
 - 1. Prepare subbase in accordance with SCDOT Standard Specifications.

- B. Primer:
 - 1. Apply primer on aggregate subbase at uniform rate of 0.25-0.30 gal/sq yd.
 - 2. Use clean sand to blot excess primer.

- C. Tack Coat:
 - 1. Apply tack coat on asphalt and concrete surfaces over subgrade surface at uniform rate.
 - a. New or Existing Asphalt Surfaces: 0.05 – 0.15 gal/sq yd.
 - 2. Apply tack coat to contact surfaces of curbs, gutters and concrete pads.
 - 3. Coat surfaces of manhole] frames with oil to prevent bond with asphalt paving. Do not tack coat these surfaces.

- D. Double Course Asphalt Paving:
 - 1. Place asphalt binder course within 24 hours of applying primer or tack coat.
 - 2. Place binder course to thickness indicated on Drawings.
 - 3. Place wearing course within 24 hours of placing and compacting binder course. When binder course is placed more than 24 hours before placing wearing course, clean surface and apply tack coat before placing wearing course.
 - 4. Place wearing course to thickness indicated on Drawings.
 - 5. Compact each course by rolling to specified density. Do not displace or extrude paving from position. Hand compact in areas inaccessible to rolling equipment.
 - 6. Perform rolling with consecutive passes to achieve even and smooth finish, without roller marks.

- E. Asphalt Paving Overlay
 - 1. Apply tack coat to existing paving surface at rate recommended by geotextile fabric manufacturer.
 - 2. Install geotextile fabric in accordance with manufacturer's instructions to permit asphalt saturation of fabric. Lap fabric edge and end joints 4 inches.
 - 3. Place wearing course to thickness indicated on Drawings.
 - 4. Compact overlay by rolling to specified density. Do not displace or extrude paving from position. Hand compact in areas inaccessible to rolling equipment.
 - 5. Perform rolling with consecutive passes to achieve even and smooth finish, without roller marks.

- F. Curbs:
 - 1. Install extruded asphalt curbs as indicated on Drawings.

3.5 TOLERANCES

- A. Flatness: Maximum variation of 1/8 inch measured with 10 foot straight edge.
- B. Scheduled Compacted Thickness: Within 1/4 inch.
- C. Variation from Indicated Elevation: Within 1/2 inch.

3.6 FIELD QUALITY CONTROL

- A. Perform Contractor Quality Control Program in accordance with Appendix C of the SCDOT Construction Manual, May 2004 (or most recent), published by the South Carolina Department of Transportation.
- B. Asphalt Paving Mix Temperature: Measure temperature at time of placement.
- C. Asphalt Paving Density: ASTM D2950 nuclear method; test one location for every 1000 square yards compacted paving.

3.7 PROTECTION

- A. Immediately after placement, protect paving from mechanical injury for seven days or until surface temperature is less than 140 degrees F.

END OF SECTION 04212

04231 CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fence framework, fabric, and accessories.
2. Excavation for post bases.
3. Concrete foundation for posts and center drop for gates.
4. Manual gates and related hardware.

1.2 REFERENCES

A. ASTM International:

1. ASTM A121 - Standard Specification for Metallic-Coated Carbon Steel Barbed Wire.
2. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
3. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
4. ASTM A392 - Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric.
5. ASTM A817 - Standard Specification for Metallic-Coated Steel Wire for Chain-Link Fence Fabric and Marcellled Tension Wire.
6. A1011/A1011M-07 Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
7. ASTM C94/C94M - Standard Specification for Ready-Mixed Concrete.
8. ASTM F552 - Standard Terminology relating to Chain Link Fencing.
9. ASTM F567 - Standard Practice for Installation of Chain-Link Fence.
10. ASTM F626 - Standard Specification for Fence Fittings.
11. ASTM F900 - Standard Specification for Industrial and Commercial Swing Gates.
12. ASTM F1043 - Standard Specification for Strength and Protective Coatings on Metal Industrial Chain Link Fence Framework.
13. ASTM F1083 - Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures.
14. ASTM F1345 - Standard Specification for Zinc - 5% Aluminum -Mischmetal Alloy-Coated Steel Chain-Link Fence Fabric.

B. Chain Link Fence Manufacturers Institute:

1. CLFMI - Product Manual.

C. SCDOT Standard Specifications:

1. Standard Specifications for Highway Construction, latest edition, published by the South Carolina Department of Transportation (SCDOT).

1.3 SYSTEM DESCRIPTION

- A. Fence Height: as indicated on Drawings.
- B. Line Post Spacing: As indicated on Drawings, not exceeding 10 feet.
- C. Fence Post and Rail Strength: Conform to ASTM F1043 Light Industrial / Commercial Fence quality.

1.4 SUBMITTALS

- A. Shop Drawings: Indicate plan layout, spacing of components, post foundation dimensions, hardware anchorage, gates, and schedule of components.
- B. Product Data: Submit data on fabric, posts, accessories, fittings and hardware.
- C. Manufacturer's Installation Instructions: Submit installation requirements including post foundation anchor bolt templates if required.

1.5 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Accurately record actual locations of property perimeter posts relative to property lines and easements.
- B. Operation and Maintenance Data: Procedures for submittals.

1.6 QUALITY ASSURANCE

- A. Supply material according to CLFMI - Product Manual.
- B. Perform installation according to ASTM F567.

1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum five years documented experience.

1.8 DELIVERY, STORAGE AND HANDLING

- A. Deliver fence fabric and accessories in packed cartons or firmly tied rolls.
- B. Identify each package with manufacturer's name.
- C. Store fence fabric and accessories in secure and dry place.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Framing (Steel): ASTM F1083 Schedule 40 galvanized steel pipe, welded construction, minimum yield strength of 50 ksi; coating conforming to ASTM F1043 Type A on pipe exterior and interior.
- B. Fabric Wire (Steel): ASTM A392 Class 1 zinc coated steel wire.
- C. Barbed Wire: ASTM A121 Coating Type Z, galvanized steel; 12 gage thick wire, 2 strands, 4 points at 3 inch on center.
- D. Concrete: Class 2500 concrete in accordance with SCDOT Standard Specifications with 2500 psi compressive strength at 28 days.

2.2 COMPONENTS

- A. Line Posts: 2.5 inch diameter.
- B. Corner and Terminal Posts: 2.875 inch.
- C. Gate Posts: 4.0 inch diameter.
- D. Top and Brace Rail: 1.625 inch diameter, plain end, sleeve coupled.
- E. Gate Frame: 1.925 inch diameter for welded fabrication.
- F. Tension Wire: 6 gage thick steel, single strand.
- G. Tension Band: 3/16 inch thick by 3/4 inch wide steel.
- H. Tie Wire: Aluminum alloy steel wire, 9-gage or 11-gage as indicated.

2.3 ACCESSORIES

- A. Caps: Cast steel galvanized, galvanized pressed steel, malleable iron galvanized, or aluminum alloy; sized to post diameter, set screw retainer.
- B. Fittings: Sleeves, bands, clips, rail ends, tension bars, fasteners and fittings; galvanized steel.
- C. Extension Arms: Cast steel galvanized or galvanized pressed steel to accommodate 3 strands of barbed wire, single arm, for placing vertical or sloped to 45 degrees as indicated on Drawings.
- D. Gate Hardware: Fork latch with gravity drop or center gate stop and drop rod; two 180 degree gate hinges for each leaf and hardware for padlock keyed to match hardware as directed by Architect/Engineer.

2.4 GATES

A. General:

1. Gate Types, Opening Widths and Directions of Operation: As indicated on Drawings.
2. Factory assemble gates.
3. Design gates for operation by one person.
4. Finish is to be galvanized, aluminum coated, or PVC coated to match fence.

B. Swing Gates:

1. Fabricate gates to permit 180 degree swing.
2. Gates Construction: ASTM F900 with welded corners. Use of corner fittings is not permitted.

2.5 FINISHES

- A. Components and Fabric: Galvanized to ASTM A123/A123M for components; ASTM A153/A153M for hardware; ASTM A392 for fabric; 1.8 oz/sq ft coating.
- B. Hardware: Galvanized to ASTM A153/A153M, 2.0 oz/sq ft coating.
- C. Accessories: Same finish as framing.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install framework, fabric, accessories, and gates according to ASTM F567.
- B. Set intermediate, terminal, gate, and corner posts plumb, in concrete footings with top of footing 2 inches above finish grade. Slope top of concrete for water runoff.
- C. Line Post Footing Minimum Depth Below Finish Grade: 3 feet.
- D. Corner, Gate and Terminal Post Footing Depth Below Finish Grade: 3 feet.
- E. Brace each gate and corner post to adjacent line post with horizontal center brace rail and diagonal truss rods. Install brace rail one bay from end and gate posts.
- F. Install top rail through line post tops and splice with 6 inch long rail sleeves.
- G. Install center and bottom brace rail on corner gate leaves.
- H. Do not stretch fabric until concrete foundation has cured 28 days.
- I. Install bottom tension wire stretched taut between terminal posts.

- J. Install support arms sloped-outward and attach barbed wire; tension and secure.
- K. Support gates from gate posts. Do not attach hinged side of gate from building wall.
- L. Install gate with fabric and barbed wire overhang to match fence. Install three hinges on each gate leaf, latch, catches, and foot bolts and sockets.
- M. Provide concrete center drop to footing depth and drop rod retainers at center of double gate openings.
- N. Connect to existing fence at new terminal post or an existing line post converted to terminal post by installation of brace rails and brace rods.
- O. Install posts with 6 inches maximum clear opening from end posts to buildings, fences and other structures.
- P. Excavate holes for posts to diameter and spacing indicated on Drawings without disturbing underlying materials.
- Q. Center and align posts. Place concrete around posts, and vibrate or tamp for consolidation. Verify vertical and top alignment of posts and make necessary corrections.
- R. Extend concrete footings 1 inches above grade, and trowel, forming crown to shed water.
- S. Allow footings to cure minimum 7 days before installing fabric and other materials attached to posts.

3.2 ERECTION TOLERANCES

- A. Maximum Variation From Plumb: $\frac{1}{4}$ inch.
- B. Maximum Offset From Indicated Position: 1 inch.
- C. Minimum distance from property line: 6 inches.

END OF SECTION 04231

04301 CORROSION PROTECTION FOR CONCRETE WASTEWATER STRUCTURES

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide all labor, materials, equipment, tools and incidentals required and perform all coatings work as shown on the Drawings and specified herein.
- B. "Paint" as used herein means all coating systems materials, including primers, emulsions, enamels, stains, sealers and fillers, and other applied materials whether used as prime, intermediate or finish coats.
- C. This Section includes surface preparation and field painting of the following:
 - 1. Surfaces described in Finish Schedule, notes on Drawings, and vendor submittals.
 - 2. Interior and exterior piping, regardless of type of factory-applied finish, where color-coding is required.
 - 3. Color-coded equipment and piping.
 - 4. Exposed and submerged exterior items and surfaces with paint and coatings.
 - 5. Exposed interior items and surfaces with paint and coatings.
 - 6. All painted or pre-finished surfaces of existing plant that are currently red.
 - 7. Surface preparation, priming, and finish coats specified in this Section are in addition to shop priming and surface treatment specified in other Sections.
 - 8. Equipment including motors, structural supports, fasteners, and attached portions of electrical conduits.
- D. Paint exposed surfaces, except where the paint schedules indicate that a surface or material is not to be painted or is to remain natural. If the paint schedules do not specifically mention an item or a surface, paint the item or surface the same as similar adjacent materials or surfaces whether or not schedules indicate colors. If the schedules do not indicate color or finish, the Engineer will select from standard colors and finishes available.
 - 1. Painting includes field painting of exposed bare and covered pipes and ducts (including color coding), hangers, exposed steel and ironwork, exposed conduit and primed metal surfaces of mechanical and electrical equipment, except as otherwise indicated.
- E. Do not paint pre-finished items, concealed surfaces, finished metal surfaces, operating parts, and labels, unless otherwise indicated.
 - 1. Pre-finished items may include the following factory-finished components:
 - a. Acoustic materials.
 - b. Finished mechanical and electrical equipment.
 - c. Louvers.
 - d. Light fixtures.
 - e. Switchgear.
 - f. Distribution cabinets.

2. Concealed surfaces may include walls or ceilings in the following concealed and generally inaccessible spaces:
 - a. Ceiling plenums.
 - b. Pipe spaces.
 - c. Duct shafts.
 3. Finished metal surfaces may include the following:
 - a. Anodized aluminum, except for railings.
 - b. Stainless steel.
 - c. Chromium plate.
 - d. Copper.
 - e. Bronze and brass.
 4. Operating parts may include moving parts of operating equipment, units, mechanical and electrical parts, and the following:
 - a. Valve and damper operators.
 - b. Linkages.
 - c. Sensing devices.
 - d. Motor and fan shafts.
- F. Labels: Do not paint over Underwriters Laboratories (UL), Factory Mutual (FM), or other code-required labels or equipment name, identification, performance rating, or nomenclature plates.

1.2 DEFINITIONS

- A. General: Standard coating terms defined in ASTM D16 apply to this Section.
1. Flat refers to a lusterless or matte finish with a gloss range below 15 when measured at an 85-degree meter.
 2. Eggshell refers to low-sheen finish with a gloss range between 20 and 35 when measured at a 60-degree meter.
 3. Satin refers to low-sheen finish with a gloss range between 15 and 35 when measured at a 60-degree meter.
 4. Semi-gloss refers to medium-sheen finish with a gloss range between 30 and 70 when measured at a 60-degree meter.
 5. Full gloss refers to high-sheen finish with a gloss range more than 70 when measured at a 60-degree meter.
 6. Ambient Conditions:
 - a. Chemical: Surface subject to corrosive chemical splash or fumes.
 - b. Moist: Surface subject to wet and damp areas such as toilets, rooms with open tanks, and rooms below grade.
 - c. Normal: Surface subject to normal temperatures and humidity such as found in offices and corridors.
 7. Splash: Surface subject to frequent washing and chemical splash.

8. Submerged: Surface submerged in a liquid such as wastewater and sludge, or within one (1) foot above the high liquid level.
9. First coat: Field prime, factory prime, or shop prime. When only one coat is required, first coat is finish coat.
10. Second or Third Coat: Successive finish coats applied over first coat.

1.3 SUBMITTALS

A. Product Data: For each paint system specified. Include block fillers and primers.

1. Material List: Provide an inclusive list of required coating materials. Indicate each material and cross-reference specific coating, finish system, and application. Identify each material by manufacturer's catalog number and general classification.
2. Manufacturer's Information: Provide manufacturer's technical information, including label analysis and instructions for handling, storing, and applying each coating material proposed for use.
3. Certification by the manufacturer that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).

Samples: Prior to beginning work, submit samples for Engineer's review of color and texture only. Provide a listing of material and application for each coat of each finish sample. Use representative colors when preparing samples for review.

1. On 12-inch by 12-inch hardboard, provide two (2) samples of each color and material, with texture to simulate actual conditions. Resubmit samples as requested by Engineer until acceptable sheen, color, and texture is achieved.
2. On concrete masonry, provide two (2) 4-inch square samples of masonry for each type of finish and color, defining filler, prime and finish coat.

Qualification Data: For firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of engineers and owners, and other information specified.

1.4 QUALITY ASSURANCE

Applicator Qualifications: Engage an experienced applicator who has completed painting system applications similar in material and extent to that indicated for this Project with a record of successful in-service performance.

B. Single Source Responsibility: Provide primers and other undercoat paint produced by same manufacturer as finish coats. Use only thinners approved by paint manufacturer, and use only within recommended limits.

Coordination of Work: Review other sections of these specifications in which prime paints are to be provided to ensure compatibility of total coatings system for various substrates. Upon request from other trades, furnish information or characteristics of finish materials provided for use, to ensure compatible prime coats are used.

1. Notify Engineer about anticipated problems using the materials specified over substrates primed by others.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver materials to job site in original, new and unopened packages and containers bearing manufacturer's name and label, and the following information:
 1. Product name or title of material.
 2. Product description (generic classification or binder type).
 3. Federal Specification number, if applicable.
 4. Manufacturer's stock number and date of manufacturer.
 5. Manufacturer's name.
 6. Contents by volume, for major pigment and vehicle constituents.
 7. Thinning instructions.
 8. Application instructions.
 9. Color name and number.
 10. VOC content.

Store materials not in actual use in tightly covered containers in a well-ventilated area at a minimum ambient temperature of 45 degrees F. Maintain containers used in storage of paint in a clean condition, free of foreign materials and residue.

1. Protect from freezing where necessary. Keep storage area neat and orderly. Remove oily rags and waste daily. Take all precautions to ensure that workmen and work areas are adequately protected from fire hazards and health hazards resulting from handling, mixing and application of paints.

1.6 PROJECT CONDITIONS

- A. Apply water-base paints only when temperature of surfaces to be painted and surrounding air temperatures are between 50 degrees F and 90 degrees F, unless otherwise permitted by paint manufacturer's printed instructions.
- B. Apply solvent-thinned paints only when temperature of surfaces to be painted and surrounding air temperatures are between 45 degrees F and 95 degrees F, unless otherwise permitted or restricted by paint manufacturer's printed instructions.

Do not apply paint in snow, rain, fog or mist, or when relative humidity exceeds 85 percent, or to damp or wet surfaces, unless otherwise permitted or restricted by paint manufacturer's printed instructions.

1. Painting may be continued during inclement weather if areas and surfaces to be painted are enclosed and heated within temperature and humidity limits specified by paint manufacturer during application and drying periods.
- D. Maintain interior temperature and relative humidity of space, as recommended by paint manufacturer, 24 hours before applying and until paint has cured.

- E. Maintain surface temperature of items to be painted.

Protection:

- 1. Cover materials and surfaces, including floors, adjoining or below work with clean drop cloths or canvas.

1.7 EXTRA MATERIALS

- A. Furnish extra paint materials from the same production run as the materials applied in the quantities described below. Package paint materials in unopened, factory-sealed containers for storage and identify with labels describing contents. Deliver extra materials to the Owner.
 - 1. Quantity: Furnish the Owner with an additional 5 percent, but not less than 1 gallon, as appropriate, of each material and color applied.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Sherwin Williams
- B. Tnemec, Inc.

2.2 MATERIALS

- A. Material Compatibility: Provide block fillers, primers, undercoats, and finish-coat materials that are compatible with one another and the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.
- B. Material Quality: Provide best quality grade of various types of coatings as regularly manufactured by acceptable paint materials manufacturers. Materials not displaying manufacturer's identification as a standard best-grade product will not be acceptable.
- C. Color Pigments: Pure, non-fading, applicable types to suit substrates and service indicated.
- D. Colors:
 - 1. Selected and approved by Owner and Engineer. Sherwin Williams System 4000 Series Colors to be used.
 - 2. Prior to beginning Work, Engineer will provide color-coordinating schedule. System color-coding will comply with Section 40 05 05 – Process Mechanical Piping.
 - 3. In areas where existing surfaces are coated, coat new exposed piping, conduit, and ducts to match adjacent or near surfaces, except for color-coding.
 - 4. Rooms and spaces may have certain walls coated different color than other walls in same room and ceilings and trim may be different color or colors than walls.
 - 5. Equipment Colors:

- a. Equipment includes equipment, motors, and structural supports, fasteners, and attached portions of electrical conduit.
- b. Coat equipment same color or colors as piping equipment serves.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Contractor must examine areas and conditions under which painting work is to be applied. If surfaces to be finished cannot be put into proper condition for finishing by customary cleaning, sanding, and puttying operations or if surfaces were improperly primed by others, notify Engineer of defects in writing.
- B. Commencement of Work indicates acceptance of surfaces.
- C. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions otherwise detrimental to formation of a durable paint film.
- D. Provide coats compatible with the surface and prior coats.

3.2 SURFACE PREPARATION

- A. General: Perform preparation and cleaning procedures in accordance with paint manufacturer's instructions and as herein specified, for each particular substrate condition.
 1. Remove incompatible primers and reprime as required. Notify Engineer in writing of any anticipated problems in using the specified coating systems with substrates primed by others.
 2. Remove hardware, hardware accessories, machined surfaces, plates, lighting fixtures, and similar items in place and not to be finish-painted, or provide surface-applied protection prior to surface preparation and painting operations. Remove, if necessary, for complete painting of items and adjacent surfaces. Following completion of painting of each space or area, reinstall removed items.
 3. Clean surfaces to be painted before applying paint or surface treatments. Remove oil and grease prior to mechanical cleaning. Schedule cleaning and painting so that contaminants from cleaning process will not fall onto wet, newly-painted surfaces.
- B. Cementitious Materials: Prepare cementitious surfaces of concrete, concrete block, cement plaster and cement-asbestos board to be painted by removing efflorescence, chalk, dust, dirt, grease, oils, and by roughening as required to remove glaze.
 1. Workmanship for surface preparation as specified shall conform as follows:
 - a. SSPC SP-13: Concrete preparation.
 - b. ICRI CSP 4 - 5.

2. Determine alkalinity and moisture content of surfaces to be painted by performing appropriate tests. If surfaces are found to be sufficiently alkaline to cause blistering and burning of finish paint, correct this condition before application of paint. Do not paint over surfaces where moisture content exceeds that permitted in manufacturer's printed directions.
- C. Metals: Clean surfaces, which are not galvanized or shop-coated, of oil, grease, dirt, loose mill scale and other foreign substances by solvent or mechanical cleaning methods that comply with the Steel Structures Painting Council's (SSPC) recommendations.
1. Workmanship for metal surface preparation as specified shall conform with SSPC specifications as follows:
 - a. SP-1: Solvent Cleaning.
 - b. SP-2: Hand Tool Cleaning.
 - c. SP-3: Power Tool Cleaning.
 - d. SP-5: White Metal Blast Cleaning.
 - e. SP-6: Commercial Blast Cleaning.
 - f. SP-7: Brush-off Blast Cleaning.
 - g. SP-10: Near White Blast Cleaning.
 - h. NAPF 500-03-04 Abrasive Blast Cleaning of Ductile Iron Pipe
 2. Wherever "solvent cleaning," "hand tool cleaning," "wire brushing," or "blast cleaning," or similar words of equal intent used in Specifications or coating manufacturer's specifications, they shall be understood to refer to applicable SSPC specifications listed above.
 3. Use hand tools to clean areas that cannot be cleaned by power tools.
 4. Touch-up shop-applied prime coats wherever damaged or bare, where required by other sections of these Specifications. Clean and touch-up with same type of shop primer.
- D. Galvanized Surfaces: Clean free of oil and surface contaminants with non-petroleum-based solvent.
- E. Materials Preparation: Mix and prepare painting materials in accordance with manufacturer's directions.
1. Maintain containers used in mixing and application of paint in a clean condition, free of foreign materials and residue.
 2. Stir materials before application to produce a mixture of uniform density, and mix as required during application. Do not stir surface film into material. Remove film and, if necessary, strain material before using.
 3. Use only thinners approved by paint manufacturer and only within recommended limits.
- F. Shading: Alternate Colors between each coat. Tint each undercoat a lighter shade to simplify identification of each coat when multiple coats of the same material are applied. Tint undercoats to match the color of the finish coat, but provide sufficient differences in shade of undercoats to distinguish each separate coat.

- A. General: Apply paint in accordance with manufacturer's directions. Use applicators and techniques best suited for substrate and type of material being applied.
1. Paint colors, surface treatments, and finishes, are indicated in the Specifications, and on the Drawings.
 2. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to formation of a durable paint film.
 3. Provide finish coats that are compatible with prime paints used.
 4. Apply additional coats when undercoats, stains or other conditions show through final coat of paint, until paint film is of uniform finish, color and appearance. Give special attention to insure that surfaces, including edges, corners, crevices, welds, and exposed fasteners receive a dry film thickness equivalent to that of flat surfaces.
 5. The term "exposed surfaces" includes areas visible when permanent or built-in fixtures, convector covers, covers for finned-tube radiation, grilles, and similar components are in place. Extend coatings in these areas, as required, to maintain the system integrity and provide desired protection.
 6. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Paint surfaces behind permanently-fixed equipment or furniture with prime coat only before final installation of equipment.
 7. Paint interior surfaces of ducts, where visible through registers or grilles, with a flat, non-specular black paint.
 8. Paint backsides of access panels, and removable or hinged covers to match exposed surfaces.
 9. Finish exterior doors on tops, bottoms and side edges same as exterior faces, unless otherwise indicated.
 10. Sand lightly between each succeeding enamel or varnish coat.
 11. Omit first coat (primer) on metal surfaces which have been shop-primed and touch-up painted, unless otherwise indicated.
 12. Accomplish thinning of paint in accordance with the manufacturer's recommendations.
 13. Apply a brush coat to all weld seams prior to the application of the first field coat.
- B. Scheduling Painting: Apply first-coat material to surfaces that have been cleaned, pretreated or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration. Allow sufficient time between successive coatings to permit proper drying. Do not recoat until paint has dried to where it feels firm, does not deform or feel sticky under moderate thumb pressure, and application of another coat of paint does not cause lifting or loss of adhesion of the undercoat.
- C. Minimum Coating Thickness: Apply materials at not less than manufacturer's recommended spreading rate, to establish a total dry film thickness as indicated or, if not indicated, as recommended by coating manufacturer.
- D. Mechanical and Electrical Work: Painting of mechanical and electrical work is limited to those items exposed in mechanical equipment rooms and in occupied spaces.
- E. Prime Coats: Apply prime coat of material which is required to be painted or finished, and which has not been prime coated by others.

1. Recoat primed and sealed surfaces where there is evidence of suction spots or unsealed areas in first coat, to assure a finish coat with no burn-through or other defects due to insufficient sealing.
- F. Dissimilar Metals: Completely protect dissimilar metals as directed by Engineer and paint manufacturer.
- G. Metals and Concrete: Completely protect metals in contact with concrete as directed by Engineer and paint manufacturer.
- H. Pigmented (Opaque) Finishes: Completely cover to provide an opaque, smooth surface of uniform finish, color, appearance and coverage. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness or other surface imperfections will not be acceptable.
- I. Completed Work: Match approved samples for color, texture and coverage. Remove, refinish or repaint work not in compliance with specified requirements.

3.4 FIELD QUALITY CONTROL

- A. The right is reserved by Owner to invoke the following material testing procedure at any time, and any number of times during period of field painting:
 1. Engage services of an independent testing laboratory to sample paint being used. Samples of materials delivered to Project site will be taken, identified and sealed, and certified in presence of Contractor.
 2. Testing laboratory will perform appropriate tests for any or all of following characteristics: Abrasion resistance, apparent reflectivity, flexibility, washability, absorption, accelerated weathering, dry opacity, accelerated yellowness, recoating, skinning, color retention, alkali resistance and quantitative materials analysis.
 3. Testing laboratory will perform holiday and dry film thickness test on prime, intermediate and final coats.
- B. If test results show that material being used does not comply with specified requirements, Contractor may be directed to stop painting work, and remove non-complying paint; pay for testing; repaint surfaces coated with rejected paint; remove rejected paint from previously painted surfaces if, upon repainting with specified paint, the two coatings are non-compatible.
- C. **To assist in quality assurance, a NACE certified representative from the paint/coatings/linings manufacturer be available to provide job site oversight during painting. Coordination of visits should be made at least 72 hours prior to visit by the contracted coating installer.**

3.5 CLEAN-UP AND PROTECTION

- A. Clean-Up: During progress of Work, remove from site discarded paint materials, rubbish, cans and rags at end of each workday. Upon completion of painting work, clean window glass and other paint - spattered surfaces. Remove spattered paint by proper methods of washing and scraping, using care not to scratch or otherwise damage finished surfaces.

- B. Protection: Protect existing surfaces and work of other trades, whether to be painted or not, against damage by painting and finishing work. Correct any damage by cleaning, repairing or replacing, and repainting, as acceptable to Engineer.
 - 1. Provide "Wet Paint" signs as required to protect newly-painted finishes. Remove temporary protective wrappings provided by others for protection of their work, after completion of painting operations.
 - 2. At completion of work of other trades, touch-up and restore all damaged or defaced painted surfaces.
- C. Stopping Leaks - Infiltration leakage of all concrete and brick structures shall be stopped by trenchless technology method of chemical grouting with polyurethane grouts. Products shall be classified as "Hydrophobic Foam", "Hydrophilic Gel" or "Hydrophilic Foam" grouting compounds or a combination of these materials and methods as recommended by the manufacturer.

3.6 PRODUCTS AND PAINTING SCHEDULE – NEW SURFACES

- A. Ferrous Metals and Ductile Iron Pipe – Structural Steel, Pipes and Equipment, Miscellaneous Metals: Apply stripe coat to all welds and edges, flanges, etc.
 - 1. Above grade exposed, Non-Submerged:
 - Surface Preparation Carbon Steel: SSPC-SP6 Commercial Blast Cleaning.
 - Surface Preparation Ductile Iron: NAPF 500-03-004 Abrasive Blast Cleaning of

Ductile Iron Pipe

System A: Sherwin Williams

DFT - Mils

1 st Coat	Corothane 1k Galvapac Zinc Primer	2.0 - 3.0
Stripe Coat	Duraplate 235 MP Epoxy	4.0 - 6.0
2 nd Coat	Duraplate 235 MP Epoxy	4.0 - 6.0
3 rd Coat	Hi Solid Polyurethane	2.0 - 3.0

System B: Tnemec

1st Coat:	Series 1 Omnithane	2.0 - 3.0
Stripe Coat:	Series N69-Color Hi-Build Epoxoline	4.0 - 6.0
2nd Coat:	Series N69-Color Hi-Build Epoxoline	4.0 - 6.0
3rd Coat:	Series 1074 Endura-Shield II	2.0 - 3.0

*Caulking: Apply after stripe coat, to gap where flange is connected to pipe apply a clean bead of Loxon S1 Smooth Poly Urethane Sealant per product data pages.

- 2. Below Grade Wet Well (Wastewater):

Surface Preparation Ductile Iron: NAPF 500-03-004 Abrasive Blast Cleaning of

Ductile Iron Pipe

Primer: Duraplate 235 2-3 mils DFT (*Told hold blast only*)

One Coat: Sherwin-Williams Duraplate 6100/6000 Epoxy	<u>DFT - Mils</u> 50- 60
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B. Below Grade Concrete and Precast Concrete Waste Water Service:

Interior: Wet Well or Manhole

1. Leak Stop/I&I Prevention : Avanti 275 or 202
As Needed
2. Surface Preparation: Clean per SSPC SP-13/NACE 6 Joint Surface Preparation Standards for concrete , C. Create a minimum surface profile for the system specified in accordance with the methods described in ICRI No. 03732 to achieve profile CSP-4 to CSP-5.
3. Repair/Resurfacer Repair Mortars (Concrete): fill all voids and bug holes to provide a surface free of voids deeper than 1/8. Finish mortar with a broom or sponge float to promote adhesion.

NEW PRECAST: AW Cook Thin Patch Mortar	As Needed
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DETERIORATED CONCRETE: AW Cook Micro Silica Mortar	1/2 – 2 inches
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4. Corobond 100 Penetrating Epoxy Primer: *For Outgassing ONLY* 4-5 mils
Duraplate 6100/6000 100% Solids Infrastructure Epoxy Coating: 120-125 mils

3.7 COLORS

- A. Paint: Contractor shall submit colors for approval to be used for interior and exterior exposed equipment and piping.
- B. Lines 4 inches and larger shall have flow arrows and contents painted in white for better identification.

END OF SECTION 04301

04305 CONCRETE VAULTS AND CHAMBERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Precast concrete wet well structures.
2. Access hatches
3. Access hatch Safety Grate

B. Related Requirements:

1. Section 02730 – Sanitary Sewer Systems
2. Section 04301 – Corrosion Protection for Concrete Wastewater Structures
3. Section 04531 - Sanitary Sewer Force Mains

1.2 REFERENCE STANDARDS

A. American Concrete Institute:

1. ACI 311
2. ACI 301
3. ACI 318
ACI 347

B. ASTM International:

1. ASTM C923 - Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals.

C. National Precast Concrete Association:

1. NPCA Plant Certification Program.
2. NPCA Quality Control Manual for Precast and Prestressed Concrete Plants.

D. South Carolina Department of Health and Environmental Control

1. Regulation 61-67 – Standards for Wastewater Facility Construction

1.3 SUBMITTALS

A. Product Data: Submit manufacturer information regarding frames and covers, component construction, features, configuration, and dimensions.

B. Shop Drawings:

1. Indicate Precast structure location, elevations, sections, equipment supports, piping, conduit, and sizes and elevations of penetrations.
 2. Indicate design, construction and installation details, typical reinforcement and additional reinforcement at openings and for each type, size, and configuration.
- C. Submit concrete mix design for each different mix.
- D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- E. Design Submittals: Submit signed and sealed Shop Drawings with design calculations, buoyancy calculations, and assumptions for custom fabrications.
- F. Manufacturer Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.
- G. Source Quality-Control Submittals: Indicate results of shop/factory tests and inspections.
- H. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.
- I. Qualifications Statements:
1. Submit qualifications for manufacturer, installer, and licensed professional.
 2. Submit manufacturer's approval of installer.

1.4 QUALITY ASSURANCE

- A. Perform structural design according to ACI 318.
- B. Perform Work according to NPCA Quality Control Manual for Precast and Prestressed Concrete Plants.
- C. Material and Fabrication:
1. Other Structures: Comply with ASTM C913.
- D. Maintain one copy of each standard affecting Work of this Section on Site.

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum five years' documented experience.
- B. Plant to be certified under the P.C.I. Plant Certification Program

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Concrete Products: Do not deliver products until concrete has cured five days or has attained minimum 75 percent of specified 28-day compressive strength.

- B. Inspection: Accept materials on Site for damage.
- C. Handling:
 - 1. Comply with manufacturer instructions for unloading, storing, and moving Precast structures.
 - 2. Lift Precast Structure from designated lifting points.
- D. Storage:
 - 1. Store Precast Structure according to manufacturer instructions.
 - 2. Store to prevent damage to Owner's property or other public or private property.
 - 3. Repair property damaged from materials storage.
- E. Protection:
 - 1. Provide additional protection according to manufacturer instructions.

1.7 EXISTING CONDITIONS

- A. Field Measurements:
 - 1. Verify field measurements prior to fabrication.
 - 2. Indicate field measurements on Shop Drawings.

1.8 WARRANTY

- A. Furnish five-year manufacturer's warranty for concrete structures

PART 2 - PRODUCTS

2.1 PERFORMANCE AND DESIGN CRITERIA

- 1. Walkway Traffic:
 - a. Comply with ASTM C857; A-0.3.
 - b. Maximum Loading: 300 psf.

2.2 PRECAST CONCRETE WET WELL STRUCTURES

- A. Fabricator List:
 - 1. MST Concrete Products, Inc.;
 - 2. Tindall Corporation;
 - 3. ARMOROCK (Polymer Concrete);

4. Or Equal.

B. Material of Construction: Reinforced precast concrete or Polymer Concrete (as directed by Metro).

C. Foundation Slab:

1. Precast concrete of type as shown on drawings.

2. Design Engineer to provide slab design to resist floatation. Engineer to provide signed & sealed buoyancy calculations for Metro information prior to fabrication.

2.3 FRAMES AND COVERS

1. See Section 02730 – Sanitary Sewer Systems for frame and cover specifications.

2.4 ACCESS HATCHES

A. Manufacturers:

1. Halliday Products;
2. The Bilco Company;
3. U.S. Foundry;
4. Or Approved Equal.

B. Description:

1. Materials of Construction: Aluminum

2. Size: As indicated on Drawings.

3. Door Configuration: As shown on drawings.

4. Cover:

a. Fabrication: Diamond Plate ¼” Thick

b. Reinforce with structural stiffeners as required to support indicated loads of 300 PSF.

c. Double Leaf Construction

5. Frame:

a. Extruded cast in place aluminum.

6. Hinge Material: Stainless steel and Hardware with Tamper Proof Fasteners

7. Lift Handle:

a. Recessed

8. Lifting Mechanism:

a. Compression Springs: T-316 Stainless steel.

b. Furnish automatic hold-open and dead stop to retain cover in open position.

- c. Cover springs to prevent contact by personnel entering structure.
9. Latch Mechanism:
- a. Lock: T-316 Stainless steel slam lock
 - b. Furnish removable external handle and permanent internal release mechanism.
10. Hardware: Stainless steel.
11. Fall Protection Grate
- a. Protective grating panel shall be 1 inch (25 kg.) aluminum “I” bar grating with Safety Orange powder-coated finish. Grating shall be hinged with tamper proof stainless steel bolts, and shall be supplied with a positive latch to maintain unit in an upright position. Grating shall have a 6-in. (152mm) viewing area on each lateral unhinged side for visual observation and limited maintenance. Grating support ledges on 300 lbs. psf (1464 kg. per sq. meter) loaded access covers shall incorporate nut rail with a minimum of four (4) stainless steel spring nuts. A padlock hasp for owner-supplied padlock shall be provided.
 - 1) Secondary protective grating panel shall be 1 inch (25mm) thick aluminum “I” bar grating.
 - 2) Grating panel color and finish shall be Safety Orange powder- coating.
 - 3) Grating panel shall be hinged with tamper proof stainless steel bolts, and shall be supplied with positive latch to maintain unit in an upright position.
 - 4) A 6-in. (152mm) viewing area shall be provided on each lateral unhinged side of grating panel, for visual observation and limited maintenance procedures.
 - 5) The grating support ledges shall incorporate nut rail feature supplied with minimum of four stainless steel spring nuts for mounting pump brackets and/or cable holders.
 - 6) A padlock hasp for owner-supplied padlock shall be provided.

2.5 MATERIALS

A. Concrete Reinforcement:

- 1. Provide Reinforcement, accessories and connection materials required in accordance with the final design as approved by the engineer.

2.6 FABRICATION

A. Comply with ACI 318 and NPCA Quality Control Manual for Precast and Prestressed Concrete Plants.

- B. Fabricate Structure and openings to size and configuration as indicated on Drawings.
- C. Reinforcing:
 - 1. Provide reinforcing in accordance with ASTM-C748, ASTM A-185(Wire) and A0615 (Bar).

2.7 MIXES

- A. Concrete:
 - 1. Normal Weight: Select proportions according to ACI 2111.1 and 318.
 - 2. Concrete Criteria:
 - a. Compressive Strength: 5,000 psi at 28 days.
 - b. Mix Design as approved by Engineer.
 - c. Reinforcing Steel ASTM A615, Grade 60

2.8 FINISHES

- A. Concrete:
 - 1. Formed Surfaces Not Exposed to View: As formed.
 - 2. Unformed Surfaces:
 - a. Finish with vibrating screed or hand float.
 - b. Items Permitted: Color variations, minor indentations, chips, and spalls.
 - c. Items Not Permitted: Major imperfections, honeycomb, or other such defects.
 - 3. Exposed-to-View Finishes:
 - a. Trowel Surfaces.
- B. Steel:
 - 1. T316 Stainless Steel
- C. Joint Sealants and Joint Gaskets:
 - 1. Gasket Joints for Circular Concrete Pipe:
 - a. Comply with ASTM C443.
 - b. Gaskets: Oil-resistant rubber.
 - 2. External Sealing Bands:

- a. Comply with ASTM C877.
 - b. Material: Type I, rubber and mastic
- D. Pipe Entry Connectors: Link-Seal, or approved equal.
- E. Grout:
1. Cement Type: Portland cement, sand, and water mixture with stiff consistency to suit intended purpose.
 2. Nonshrink Type:
 - a. Comply with ASTM C1107/C1107M.
 - b. Minimum Compressive Strength: 2,400 psi in 48 hours, and 7,000 psi in 28 days.
- F. Interior Coatings:
1. Provide interior wet well protective coatings, on precast pump station wet wells in accordance with Section 04301 – Corrosion Protection for Concrete Wastewater Structures.

2.9 SOURCE QUALITY CONTROL

- A. Certificate of Compliance:
1. If manufacturer is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at manufacturer's facility conforms to Contract Documents.
 2. Specified shop tests are not required for Work performed by approved manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that items provided by other Sections of Work are properly sized and located.
- B. Verify correct size and elevation of excavation.
- C. Verify that subgrade and bedding are properly prepared, compacted, and ready to receive Work of this Section.

3.2 INSTALLATION

- A. According to ASTM C891.
- B. Conduct operations not to interfere with, interrupt, damage, destroy, or endanger integrity of surface structures or utilities in immediate or adjacent areas.

- C. While lowering structure into excavations and joining pipe to units, take precautions to ensure that interiors of pipeline and structure remain clean.
- D. Install Precast Structure to elevation and alignment as indicated on Drawings.
- E. Excavating:
 - 1. Excavate to indicated locations and depths as shown on drawings.
- F. Base and Alignment:
 - 1. Install Structure supported at proper grade and alignment on compacted crushed-stone bedding and support system as indicated on Drawings.
- G. Assembly of Multi-section Structures:
 - 1. Lower each section into excavation.
 - 2. Clean joint surfaces.
 - 3. Install watertight joint seals according to manufacturer instructions.
- H. Connections:
 - 1. Connect pipe to structure and seal watertight.
 - 2. Cut pipe flush with interior of structure.
- I. Backfill excavations for vaults and chambers Suitable or Select material as specified in Section 02221 Trench Excavation, Bedding, and Backfill.

3.3 TESTING PUMP STATION WET WELLS

- A. General: Test using water whenever possible prior to backfilling to assist in locating leaks. Make joint repairs on both outside and inside of joint to ensure permanent seal. Test wet wells with top slab set in place, prior to backfilling, and prior to installing wet well protective coating, as approved by Engineer.
- B. Leak testing shall be in accordance with ACI-350.1-01. ACI Tightness Criteria designations are shown below:

Designation	Tightness Criterion (Acceptable Leakage)
HST-NML	No measurable loss
HST-025	0.025% per day
HST-050	0.050% per day
HST-075	0.075% per day
HST-100	0.100% per day
HST-VIO	Visual inspection only

- C. Leak Testing Schedule
 - 1. Pump Station Wet wells: HST-100

D. Leak Testing Procedure:

1. Fill hydraulic structure to be subjected to leakage tests with water at a rate not to exceed 4 feet per hour. Structure shall be filled to the design maximum liquid level line or 4 inches below any fixed overflow level, whichever is lower. Repair any running leaks which appear during filling before continuing.
2. The water shall be kept at the test level of unlined concrete tanks for at least three days prior to the actual test.
3. Perform the HST-VIO test for 24 hours. If no flow or seepage of water from the structure is present on the exterior surfaces, proceed with the designated test. If the structure does not pass the HST-VIO test, repair all visible leakage and repeat this step until the structure passes.
4. Measure the vertical distance from a fixed point on the structure to the water surface at 24-hour intervals for a five-day period. Record the water temperature at a depth of 18 in. below the water surface at the time of water surface measurement. In uncovered tanks, evaporation and precipitation shall be measured.
5. During the test period, examine all exposed portions of the structure and mark all visible leaks or damp spots. Such leaks or damp spots shall be repaired later.
6. If the drop in water surface in a 24-hour period, when adjusted for evaporation and precipitation, exceeds the tightness criterion for, the structure shall be considered to have failed the test. The structure shall also be considered to have failed the test if water is observed flowing or seeping from the structure or if moisture can be transferred from the exterior surface to a dry hand.
7. If the structure fails the test, drain the structure, repair leaks and damp spots, refill the structure, and repeat the test. Continue this process until the drop in water surface in a 24-hour period meets the tightness criterion.
8. Repair all visible spots, whether leakage is excessive or not, in a manner satisfactory to the Engineer.
9. Repairs and additional tests shall be made by the Contractor at no additional cost to the Owner.
10. Apply specified coatings only after acceptance of leakage testing by the Engineer.
11. Testing shall be performed prior to application of protective coating specified in Paragraph 2.8.F.

END OF SECTION 04305

04306 IDENTIFICATION AND SIGNAGE FOR UTILITIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Plastic utility markers.
2. Plastic ribbon tape for placement above direct-buried utility.
3. Trace wire for placement above direct-buried utility.

B. Related Requirements:

1. Section 02221 Trench Excavation, Bedding, and Backfill
2. Section 02733 Sanitary Sewer Service Connections
3. Section 02730 Sanitary Sewer Systems
4. Section 04531 Sanitary Sewer Force Mains

1.2 SUBMITTALS

- A. Product Data: Submit manufacturer catalog information for each specified product.
- B. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- C. Qualifications Statement:
1. Submit qualifications for manufacturer.

1.3 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of tagged valves.

1.4 QUALITY ASSURANCE

- A. Perform Work according to AWWA and SCDHEC standards.

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' experience.

PART 2 - PRODUCTS

2.1 TEMPORARY MARKER POSTS

1. Provide temporary PVC marker posts at service lateral cleanout locations. See Metro standard Drawings for additional information.

2.2 RIBBON TAPE

- A. Detection Tape: Detectable mylar encased aluminum foil marking tape will be installed over all sewer pipe and sewer laterals. Tape will be “safety orange” in color, at least 1-1/2-inches wide and shall bear the printed identification “Caution Buried Sewer Line Below” (reverse printed), so as to be readable through the mylar. Surface printing on the tape shall equal to Lineguard Type II Detectable.

2.3 TRACE WIRE

- A. Description: Sewer Lines and Force Mains require installation of tracer wire. Tracer wire shall be 12 AWG Solid UL/UF and run along the top of pipe, in a continuous length between valves, air release valves, and stub outs. The tracer wire shall be secured to the pipe in intervals of 10’ (maximum) with wire or tape. Splices shall be made using crimped copper sleeves. Twisting wires together shall not be allowed. A minimum of 2’ of extra wire shall be coiled in valve boxes and valve vaults. **Tracer wire is to be certified by a licensed electrical contractor or corrosion contractor for continuity. Final acceptance will not be granted until certification is received by inspector and/or engineer.**

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Pipeline Marker Posts, Utility Markers, and Marking Flags: According to manufacturer instructions.
- B. Ribbon Tape and Trace Wire:
 1. Continuous over top of pipe.
 2. If multiple pipes occur in common trench, locate tape above centerline of trench.
 3. Coordinate with trench Work as specified in Section 02221 – Trench Excavation, Bedding, and Backfill.

END OF SECTION 04306

04332 SUBMERSIBLE SEWAGE PUMPING STATION

PART 1 - GENERAL

1.1 SUMMARY

- A. The contractor shall provide pumps, pump controls, valve package, and appurtenances as shown on the plans and as specified herein. The pumps and controls shall be furnished by one supplier. The valve package may be offered by a secondary supplier but the entire valve package itself must be provided by a single supplier. All materials and equipment shall be U.L. listed for its intended application in this project, including but not limited to all motor controls and operator control panels.

1.2 REFERENCE STANDARDS

- A. American Bearing Manufacturers Association:
 - 1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
- B. ASTM International:
 - 1. ASTM A48 - Standard Specification for Gray Iron Castings.
 - 2. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
 - 3. ASTM A153/ (A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware).
 - 4. ASTM A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength.
 - 5. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort.
 - 6. ASTM D2241 - Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).
 - 7. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
- C. National Electrical Manufacturers Association:
 - 1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- D. National Fire Protection Association:
 - 1. NFPA 70 - National Electrical Code (NEC).
- E. UL, Inc.
 - 1. UL 83 - Thermoplastic-Insulated Wires and Cables.

1.3 SUBMITTALS

A. Shop Drawings:

1. Shop drawings shall be submitted for review and shall include complete data to show function, physical description and compliance with the Plans and Specifications, including outline drawings showing equipment and shipping dimensions and weights, location of accessories, and clearances required; wiring and schematic diagrams including accessories, spare parts list, materials, written functional control description, functional control schematic, description of all components, characteristic pump curves and motor efficiency rating. Any changes to structures and other features which are necessary to accommodate the equipment supplied by the Contractor shall be clearly shown on the submittal and marked as a change.

PART 2 - PRODUCTS

2.1 SUBMERSIBLE PUMPS:

- A. Raw wastewater submersible pumps shall be provided and installed as shown on the plans, complete with motors, controls and all appurtenances required for an operational system. A third identical pump with motor and power leads shall be provided and delivered to the Owner as a spare. All pumps shall be by one manufacturer supplied by an authorized distributor in South Carolina. The controls shall be provided by the pump manufacturer or the controls to be used must be approved by the pump manufacturer.
 1. The pumps shall be Sulzer/ABS, Flygt, or approved equal.
 2. Pump shall be submersible non-clog wastewater pumps and motors.
 3. List reference standards included within text of this Section, with designations, numbers, and complete document titles.
 4. LEED requires compliance with specific editions of referenced standards. Comply with the latest reference standard edition, except when a specific date is required by code. Consider including publication dates for referenced standards in this Section to ensure the correct standard is used for LEED compliance.
 5. Each pump, shall have necessary characteristics to meet the following conditions (deviations evaluated on a case-by-case basis):
 - a. Pumping capacity of _____ GPM at _____ feet of head (TDH).
 - b. Overall minimum efficiency of 50% at above conditions
 - c. Maximum pump speed of 1800 RPM
 - d. Minimum solids passage 3 inches in diameter
 - e. Minimum motor efficiency 85%
 - f. Minimum L10 bearing life shall be 50,000 hours at any point along the usable portion of the pump curve at maximum motor speed.

6. **Volute/Casing and Impeller:** All major parts of the pumping units including the volute, impeller motor frame and discharge elbow shall be constructed of gray cast iron, ASTM A-48, Class 35B, with smooth surfaces devoid of blow holes or other irregularities. The volute shall be of non-concentric design with smooth passages large enough to pass minimum 3 inch solids that may enter the impeller. All exposed bolts and nuts shall be stainless steel or brass. The impellers shall be dynamically balanced. The impellers design may be single or multi-vane design having a long throughlet without acute turns. Impellers shall be keyed to the shaft or have a slip fit connection onto the motor shaft, driven by a shaft key. All units utilizing wear rings shall be equipped with a single or dual replaceable stainless steel wear ring.
7. **Pump Design** shall allow the pump to be automatically and firmly connected to the discharge elbow, guided stainless steel guide bar(s) extended from the top of the station to the discharge elbow. There shall be no need for personnel to enter the wet-well. No portion of the pump shall bear directly on the sump floor.
8. **Pump Seal:** Provide two totally independent mechanical shaft seals, installed in tandem, each with its own independent single spring system acting in a common direction. Install the upper seal in an oil-filled chamber with drain and inspection plug (with positive anti-leak seal) for easy access from external to the pump. Provide seals requiring neither routine maintenance nor adjustment, but capable of being easily inspected and replaced. Provide seals which are non-proprietary in design, with replacements available from a source other than the pump manufacturer or its distributors. Do not provide seals with the following characteristics: conventional double mechanical seals with single or multiple springs acting in opposed direction; cartridge-type mechanical seals; seals incorporating coolant circulating impellers, seals with face materials other than those specified.
9. **Motor** shall be 460 volt, 3 phase, 60 Hz, induction type with a squirrel cage rotor, shell type design, housed in an air-filled, watertight chamber. Provide a motor which is squirrel cage, induction in design, housed in a completely watertight and air filled chamber, with a min 1.15 service factor. The motor shall be adequately sized and rated for continuous operation at a maximum fluid temperature of 104° F (40° C). The motor stator shall be wound using Class H monomer-free polyester resin insulation resulting in an overall motor rating of 311 Degrees F (155 degrees C), Class F insulation. The stator windings shall be trickle impregnated resulting in a winding fill factor of at least 95%. The use of a multiple step “dip and bake” type stator insulation method shall not be acceptable. The rotor bars and short circuit rings shall be made of aluminum. The motor and pump set complete shall be designed and manufactured by the same company. Provide adequately rated motor with sufficient surface area for ambient only cooling suited for the intermittent mode of operation in wet well wastewater applications, submerged or partially submerged, without damage. Motors containing di-electric oils used for motor cooling and/or bearing lubrication or motors where the pumped media or externally provided fresh water is directed through the motor shell for cooling are not acceptable. Provide motors which are FM listed for use in Class I Division 1 Groups C&D hazardous locations as defined by the National Electric Code.
10. **Motor and Detector Cables** shall be suitable for submersible pump applications. Provide sufficient length of power/control cable with each pump, suitable for submersible wastewater application, sized in accordance with NEC requirements. Provide cable

terminal box on side or top of motor housing, with cable entry sealed to insure that no entry of moisture is possible into the high-voltage motor/ terminal area even if the cable is damaged or severed below water level. Cable seal shall include a compressed rubber grommet to seal the cable exterior and grommet system to seal the interior passages. A strain relief device, in direct contact with both the cable and the cast iron entry housing, shall be provided. The cable entry shall be rated by Factory Mutual (or UL) for submerged operating depths to 65 feet.

11. Protection:

- a. Thermal Protection: Each pump motor shall incorporate three normally closed thermal sensors (switches or thermostats) imbedded in the windings to detect temperature. These sensors shall be wired in series. If the pump motor temperature should rise to a level which could cause damage, an open sensor contact shall cause the motor starter to drop out and cause the appropriate amber pump failure light and alarm to activate. The pump shall remain locked out until the motor has cooled and the circuit has been manually reset.
- b. Moisture Detection: Each motor shall also include a system to detect moisture in the stator housing and/or seal chamber which shall be connected to the pump controls. Moisture detection shall cause the appropriate amber moisture detection light and alarm to activate.
- c. Seal Leak Detection: Provide a detector in the motor's stator cavity which allows a control panel mounted relay to indicate leakage into the motor. In addition, on motors 40HP and larger provide 3 probe options (seal/motor/connection chambers) to indicate leakage past the inner mechanical seal prior to its entrance into either the motor stator cavity or the lower bearing. Electronic probes which depend on sensing resistance value changes in seal oil will not be acceptable as seal leak indicators.
- d. Motor Sensor Monitoring Relay: The pump supplier shall furnish all relays required for monitoring all motor sensors. The relays shall be installed by others in the motor control panel and properly wired in accordance with pump manufacturer's instructions. Relays shall mount in standard 12-pin socket bases (provided) and shall operate on available control voltage of 24-240 VAC. If relays require an input voltage that is not available in the motor control panel an adequate transformer (with fused input) shall be provided by the pump supplier. Relays shall have a power consumption of no more than 2.8 watt, and shall be UL approved. Relays shall be modular in design, with each relay monitoring no more than two motor sensor functions.

12. Stainless steel kellums grips shall be installed on power cables for the pumps so as to adequately support the cables to prevent falling and being pulled into the pump when running. Multiple grips/locations may be required per pump.

2.2 CONTROLS:

- A. Controls shall be provided with the pumps and shall be coordinated with the pump manufacturer to meet the requirements herein. Service requirements for control shall be as stated in paragraph 2 below. The pump control panel shall include breakers for auxiliary equipment, an ultrasonic liquid level monitoring/control system, a pump station management system, a soft-start/soft-stop starter or variable frequency drive (as directed by Metro) for each pump motor, an emergency backup full voltage starter (for one pump motor) and all items required for a complete system to operate on 480 volts, 60 Hz, three phase power. The system shall be complete, requiring only connection of power, motor and control wiring.
- B. Normal Operation: Liquid levels will be monitored by mercury floats to control operation of the submersible pumps according to level variation. The system shall automatically alternate starting between the two pumps. At the end of a pump cycle, the pump controls shall rotate lead and lag pump selection. If for any reason one pump is temporarily out of service, the controls shall automatically rotate lead status to the remaining pump. The following tasks shall be performed, with all normally operated controls, reset buttons, indicator lights and timers located on the face of the control panel, as described.
1. Start and stop the lead pump at the selected wet well levels, which can be adjusted by the level controller.
 2. Provide a “Hand-Off-Automatic” switch for each pump on the face of the control panel. “Hand” position shall override all controls except high motor temperature shut down.
 3. Two amber indicator lights for each pump (4 required) shall be provided on the face of the pump control panel to indicate when a pump to moisture detection in the motor or high motor temperature.
 4. When a pump fails to start or has a warning indication due to high motor temperature or moisture detection in the motor, the control system shall automatically rotate to the net pump selection when the “pump start” liquid level is reached. These alarm circuits shall signal the autodialer so operations personnel will be notified of the alarm condition.
 5. If a high water condition is detected by the liquid level monitoring/control system, it shall activate the autodialer. The autodialer shall also be activated during a total power failure.
 6. One mercury float switch (backup high level alarm) shall be installed in the pump station wet well to activate an audible alarm, an alarm light and shall be directly wired to and signal the autodialer. An alarm silence button shall be provided on the face of the pump panel door to acknowledge alarm and silence the horn. The alarm light and horn shall be mounted on the side of the Control Building in a convenient location (coordinate with Engineer/Owner). A second float switch shall be provided for low level (pump off) control during backup operation (see Paragraph C). The float switches shall be Eco-Float GS 15000 by Anchor Scientific or equal, and shall be mounted on a stainless steel chain with 15 lb weight.

7. The alarm horn and light (see 6 above) shall be Adapta-Beacon Model 51R-N5-40W with flashing red light. Unit shall operate on 120 volt power. Unit is available from Edwards Signaling Products, (203) 699-3300.
 8. As described in paragraph 3 (h) above, the control panel shall have circuitry to lock out a pump due to high temperature. The autodialer shall be signaled during a high temperature condition. This alarm condition shall not activate the local audible and visible alarm.
 9. In automatic operation, the liquid level controller shall start the lead pump when the “lead pump on” water level is reached. If the liquid level drops to the “pump off” water level, the lead pump shall stop. If the water level continues to rise after the lead pump is started, the standby pump shall be started when the “lag pump on” level is reached. If the level continues to rise, the autodialer shall be signaled when the “high level alarm” level is reached.
- C. Backup Operation: In the event that normal operations are not functional, the system shall have the capability of maintaining pumping operations by backup systems. These systems shall be provided with all necessary components for functions intended.
1. An automatic transfer switch and standby generator unit shall be provided to power the station in the vent of commercial power loss. The components are described on the drawings and specified in the electrical specifications.
 2. The liquid level/control unit shall have backup capability to control the emergency full-voltage starter (see below).
 3. One full-voltage emergency starter shall be provided of proper size and type to allow operation of one of the pumps should the primary starters be off line. This starter shall be housed in its own cabinet section, and shall have all required power switching and operational devices necessary for the complete system. This starter system shall be capable of manual operation and control by either the Pulsar unit or by the two backup float switches.
- D. Alarms shall include devices necessary to signal high water in the wet well, high motor temperature, loss of one phase of power, and other conditions normally monitored by the equipment supplier. The backup float switch shall activate the local audible/visible alarm and signal the autodialer. The moisture detection and high motor temperature alarms shall be indicated with amber pilot lights on the face of the pump panel door. Auxiliary alarm circuits for high water in wet well, loss of liquid flow, high motor temperature and loss of one phase of power shall be wired to the autodialer. The autodialer shall also monitor for power failure.
- E. Components of the control panel shall include the starters for both pumps and strip of 120/240 volt branch circuit breakers for distribution of 120/240 volt power as shown on the construction drawings.
1. Control panel components shall be designed to be compatible with the starters for each pump.
 2. Control panel shall include necessary components to allow functions described in (b) above backup operation.

3. Suitable transformers shall be provided in the pump control panel to provide single phase power, including any power required by the liquid level ultrasonic transducer and/or related controller, transmitter, etc. Single phase 120 volt power distribution shall be by a strip of single phase breakers. All control wiring shall be 120 volt single phase power.
 4. Elapsed time meters (six digit non-reset type) shall be connected to each motor to record total running time for each pump in hours and tenths of an hour. Meters shall be mounted on the face of the pump control panel.
 5. Pump controls shall include continuous power phase monitoring that will stop the pumps and signal the autodialer in the case of losing one phase of power.
- F. Wiring, design, workmanship and wiring diagrams of the control panel shall be in compliance with standards and specifications of the Joint Industrial Council (JIC), National Machine Tool Builders Association (NMTBA), and National Electric Code (NEC). All wiring shall be color coded, minimum 14 gauge in the panel. Control wires in the panel shall be bundled and tied with bundles flexible at the hinged side of the enclosure to allow the door(s) to open fully. All wires, connections and terminal strips shall be numbered and identified on the wiring shop drawings and service manuals. Internal components shall be identified by nameplates. Exterior controls, switches, indicators and components shall be permanently identified with engraved plastic nameplates. This panel shall be constructed and labeled as having been constructed in accordance with Underwriters Laboratories standards. The control panel design shall consist of electro mechanical devices and not a solid state card type design.
- G. The Control Panel Enclosure shall be NEMA 4X with 304 stainless steel. Control compartments shall be removable from panels on which components are mounted. Back panels shall be secured to the enclosure with collar studs. All control units and wiring shall be accessible from the operator side (front) of the panel. No rear or side access shall be required for component access or maintenance. Steel panels shall be phosphatized before painting and finished with a rust inhibiting primer and two coats of exterior grade baked enamel. The control panel enclosure door shall be latched with a single handle.
1. Autodialer system: The autodialer shall be SCADA - High Tide Technologies (900 or 1100 Modem). SCADA shall monitor pump 1&2 run, 1&2 fail, high level, phase fail, 1&2 seal fail, 1&2 HOA switch in auto, generator run.
- H. Lightning Protection: The control panel shall be provided with a lightning arrestor with surge protector. This equipment shall be Phoenix Contact, Inc. of Middleton, PA, (800) 888-7388, or approved equal.
- I. Controls shall be provided by the pump station supplier.
- 2.3 ELECTROMAGNETIC FLOWMETER:
- A. If required, pump stations may be equipped with a discharge flow meter on the discharge force main.
 - B. Flanged type electromagnetic flowmeter to be furnished pump station manufacturer and installed by contractor. The flowmeter materials shall be suitable for raw wastewater service. The magnetic flowmeter will maintain an accuracy of $\pm 0.5\%$ of flow rate or better when mounted as close as one pipe diameter from the flange of the magmeter when located next to elbows in the

line sizes up to 18". It will also have no downstream piping requirements for maintaining its published accuracy specification. The output signal shall be integrated with mission control. The magnetic flowmeter shall be the LF654 series flow tube and the LF620 series converter as manufactured by Toshiba. Alternative magmeters by Rosemount or approved equal may also be submitted for Metro review provided they meet the operational and space requirements of the pump station.

2.4 VALVE PACKAGE

A. Valves and Piping

1. Check Valve: Each pump shall be equipped with a full flow type check valve capable of passing a 3" spherical solid. Valve shall be constructed with flanged ends and fitted with an external lever and torsional spring. Valve seat shall be constructed of stainless steel, secured to the body to ensure concentricity, sealed by an O-ring, and shall be replaceable. The valve body shall be cast iron incorporating a clean-out port large enough to allow removal and/or replacement of the valve clapper without removing valve or piping from the line. Valve clapper shall have a molded neoprene seating surface incorporating low pressure sealing rings. Valve hinge pin and internal hinge arm shall be stainless steel supported on each end in brass bushings. Shaft nut shall have double O-rings which shall be easily replaceable without requiring access to interior of valve body. All internal hardware shall be stainless steel. Valve shall be rated at 175 PSI water working pressure, 350 PSI hydrostatic test pressure. Valves other than full flow type or valves mounted in such a manner that prevents the passage of a 3" spherical solid shall not be acceptable.
2. Each discharge line shall be equipped with a 2-way plug valve to permit isolation of the pumps from the common discharge header. The plug valve shall be non-lubricated type. Valve body shall be cast iron with flanged end connections drilled to 125 pound standard. Valve shall be furnished with a drip-tight shutoff plug mounted in stainless steel or teflon over phenolic bearings, and shall have a resilient facing bonded to the sealing surface. Valves shall have ports designed to pass 3" spherical solids.
3. Piping
 - a. Flanged header pipe shall be centrifugally cast, ductile iron, complying with ANSI/AWWA A21.51/C115 and class 53 thickness.
 - b. Flanges shall be cast iron class 125 and Comply with ANSI B16.1.
 - c. Pipe and flanges shall be threaded and suitable thread sealant applied before assembling flange to pipe.
 - d. Bolt holes shall be in angular alignment within 1/2° between flanges. Flanges shall be faced and a gasket finish applied.
 - e. All pipes connected to the pump station shall be supported according to good commercial practice.

PART 3 - EXECUTION

3.1 INSTALLATION:

- A. The contractor shall install pumps and controls as shown on the plans and as recommended by the equipment manufacturer, for a complete operating facility including all wiring and piping.

3.2 SERVICE:

- A. The Contractor shall provide for the services of a qualified service representative to include start-up services and operation-maintenance instruction. The manufacturer shall provide detailed instructions for the proper installation of equipment and the contractor shall furnish two complete copies of the installation and start-up manual to the Engineer prior to installation of the pumps, controls, and accessories. The manufacturer's representative shall provide the necessary time required to insure proper installation, start-up and instruction. Service shall be no less than two (2) 8-hour days, exclusive of travel time to and from the project site, and divided into two (2) trips to the site. The first trip shall be for the final inspection, minor adjustments, initial operation services and initial instruction. The second trip about 30 days later, shall be for final adjustments and follow-up operating instruction. The Owner and Engineer shall be notified 48 hours in advance of each trip. Service and start-up shall be coordinated so that pump and controls service personnel are on the job together.
- B. Service Manual shall be furnished for each type of equipment specified in this section. Manual shall contain a description of equipment, complete accessory and parts list, and complete installation, operation and maintenance instructions. Four copies of manual shall be submitted for review. After review of manual, three additional copies shall be furnished.
- C. Changes in structures and other features which are necessary to accommodate equipment supplied by the Contractor shall be made at no additional cost to Owner. No equipment structure shall be constructed until certified equipment dimensions and requirements are available to the Contractor.
- D. Testing shall be performed by the pump manufacturer prior to shipping. Each pump shall be tested at the manufacturer's testing facility in accordance with the latest code of the Hydraulic Institute to determine actual head vs. capacity and kilowatt draw required. Certified pump curves shall be submitted to the Engineer in triplicate. Results of the tests shall be approved by the Engineer prior to shipment.

3.3 WARRANTY: The authorized pump / package shall warrant the pumps to be supplied to the owner for a period of five (5) years under normal use. The warranty period shall start from the date of initial operation by the equipment representative, as described under Service above. The warranty must include 100% coverage of the manufacturer's shop labor and parts including seals for the first year, and then pro-rated coverage through the fifth year.

3.4 SPARE PARTS:

- 1. One (1) set of pump seals
- 2. One (1) pump for each type of pump used

END OF SECTION 04332

04531 SANITARY SEWER FORCE MAINS

PART 1 GENERAL

1.1 SUMMARY

- A. Work consists of the furnishing and installing of sanitary sewer force mains and appurtenances.
- B. Related Sections
 - 1. Section 02221 - Trench Excavation, Bedding and Backfill

1.2 SUBMITTALS

- A. Submit product data for pipe, fittings, valves, and restrained joints
- B. Submit material certifications for pipe, which certifies compliance with, specified requirements.

PART 2 PRODUCTS

2.1 DUCTILE IRON PIPE (DIP)

- A. Pipe shall be minimum thickness Class 50 or pressure class 350 (Class 53 for flanged joints) in compliance with ASTM A377, ANSI A21.50, and ANSI A21.51. Pipe shall be furnished with push-on, mechanical or flanged joints.
- B. Flanged joints for flanged pipe and fittings shall be furnished with 125 pound flanges drilled in accordance with ANSI B16.1. The flanges shall be suitable for working pressures of 150 psi.
- C. Fittings shall be manufactured of ductile iron pipe and rated as a minimum to equal the pressure rating of the pipeline. Fittings shall be furnished with mechanical, or flanged joints.
- D. The interior of all pipe and fittings shall be coated with Tnemec 431 per manufacturer's specifications and in accordance with AWWA C210. All field touchups to be completed per manufacturer's specifications. Exterior of all pipe fittings and specials shall be coated with asphaltic pipe coating in accordance with ANSI/AWWA C151/A21.51. Metro may require, in certain circumstances, for the exterior to be coated with Tnemec 431.
- E. Gaskets for flanged pipe shall be suitable for ANSI A21.10 or 125 pound ANSI B16.1 flanges. Gaskets shall be neoprene and shall have a minimum thickness of 1/16" for 8" diameter and smaller pipe and 3/32" for 10" diameter and larger. Rubber gaskets for mechanical and push-on joints shall conform to the requirements of ANSI A21.11.
- F. Tracer wire
 - a. Provide minimum 12-gage solid copper tracer wire encased in 30 mil HDPE insulation for all force mains.
 - b. Provide tracer wire connection points at each ARV, valves and tracer wire boxes.

2.2 RESTRAINED JOINT DUCTILE IRON PIPE

- A. Pipe shall comply with all paragraphs of Section 2.1 and shall be furnished with mechanical joints.

2.3 PVC PIPE

- A. PVC Pressure Sewer Pipe and Fittings, 4" – 16":

- 3. Comply with AWWA C900.
- 4. Minimum Class 200 (DR 18) or as designed by engineer.
- 5. Joints: elastomeric-gasket bell-end pipe.
- 6. Joint Restraint:
 - a. Provide restraint for C900 PVC pipe by mechanical means separate from the mechanical joint gasket sealing gland.
 - b.
 - c. Restraint device to be a two-piece configuration with a serrated inside surface to provide contact around full pipe circumference.
 - d. Restraint device body to be manufactured from steel (ASTM A285 Grade C) with fusion epoxy coated surfaces except the serrations.
 - e. Comply with AWWA C111, ANSI 21.11.
 - f. Pressure rating to match PVC pipe on which it is used with capability to withstand test pressure of 2 times rated pressure.
 - g. Finish fusion applied epoxy coating per AWWA C-213.

2.3 JOINT RESTRAINT

- A. Provide joint restraints per approved materials list.

2.4 REPAIR COUPLING

- A. Provide repair couplings per approved materials list.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Ductile Iron Pipe shall be installed in accordance with AWWA C600.
- B. PVC Pipe shall be installed in accordance with AWWA C900.
- C. Thrust Blocks are not allowed.**
 - (1)
- D. Pipe shall be laid with bell ends facing in the direction of pipe laying, beginning at the bottom of the slope

and proceed upward with the bell ends of the new pipe upgrade.

- E. Force mains in relation to water lines must conform to subsection 67.300.A.14.e of the SC DHEC "Standards for Wastewater Facility Construction: R.61-67".
- F. Pipe shall be laid accurately to uniform line and grade, and as designated on the drawings. Abrupt changes in grade or alignment required to install the pipe as shown on the drawings, to avoid interference with existing construction, or to parallel the profile of existing grades at ground level shall be accomplished with fittings and not with excessive joint deflection.
- G. Bell holes shall be excavated for each joint to assure bedding supports the barrel of the pipe and to facilitate making a perfect joint. Preparatory to making pipe joints, all surfaces of the portion of the pipe to be jointed or of the factory-made jointing materials shall be clean and dry. Gaskets shall be clean, flexible and, where lubrication is required, be lubricated with a lubricant recommended by the manufacturer.
- H. Trenches shall be kept free from water and when work is not in progress, all open ends of the pipe and fittings shall be securely closed so that no trench water, earth, or other substances will enter the pipe or fittings.

3.2 FIELD QUALITY CONTROL

- A. The testing requirements in this section apply to newly installed force mains and do not apply to small repairs to existing force mains.
- B. All testing shall be performed in the presence of the Owner. Trench must be completely backfilled and compacted prior to flushing or testing.
- C. Flushing
 - 1. All piping shall be thoroughly flushed prior to pressure testing. Flushing shall be accomplished by providing a flushing velocity of no less than 2 1/2 feet per second in the pipeline.
- D. Pressure Test
 - 1. Test each valved section of new piping to a hydrostatic pressure of 150 pounds per square inch. Each valve section shall be independently tested in accordance with AWWA C600 for DIP and AWWA C900 for PVC. The pressure tests shall be sustained for a minimum of 2 hours.
 - 2. Before applying the specified test pressure, all air shall be expelled from the pipe.
 - 3. Tests may be made of isolated portions of such piping as will facilitate general progress of the installation. Any later alterations made in the piping systems will subsequently necessitate retesting of such affected portions of the piping systems.
 - 4. Any defective material or defects in workmanship that develop during the tests shall be remedied and the subject piping shall be retested.
 - 5. Do not test against closed valves at pressures higher than the allowable seating pressures for individual valves. Contractor may test open valves at pressures up to that specified for the valve bodies. In sections of the line where the test pressures are greater than the allowable seating pressures for the valves, the Contractor shall provide temporary plugs to test against.
- E. Leakage Test

1. The leakage test, which may be performed at the same time as the pressure test, shall be sustained for not less than two hours. The leakage shall be defined as 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 pipe line has been expelled and the pipe has been filled with water. Leakage test pressure shall be 150 psi.
2. No pipe line installation will be accepted if the leakage is greater than that determined by the following formula and as set forth in the table below:

$$L = (D \times N \times P^{1/2}) / 7,400$$

L = Allowable leakage (gal/hr)
N = Number of joints in length of line tested
D = Nominal diameter of pipe (in.)
P = Average test pressure (psi)

END OF SECTION 04531

04600 ELECTRICAL

PART 1 - GENERAL

1.1 SUMMARY

- A. The contractor shall provide electrical equipment and materials as shown on the plans and as specified herein, including all items which may be reasonably implied in order to provide a complete and operational system.
- B. All work shall be in accordance with the most current edition of the National Electric Code, as well as local inspection department requirements that has jurisdiction.
- C. All work must be performed using a licensed electrician.
- D. Obtain necessary permits and pay associated fees prior to starting work.
- E. Make necessary arrangements with the utility for power service and arrange for temporary power as required.

1.2 SUBMITTALS

- A. Shop Drawings shall be submitted for review and shall include the following:
 - 1. Materials list of items proposed to be provided under this Section.
 - 2. Manufacturer's specifications, other data and shop drawings needed to prove compliance with the specified requirements. Provide the following approval drawings:
 - a. Service Entrance Disconnect Switch
 - b. Main Breaker.
 - c. Automatic Transfer Switch
 - d. Manual Transfer Switch
 - e. Combination Power Center.
 - f. Wiring devices and cover plates.
 - g. Conduit and fittings.
 - h. Conductors.
 - i. Connectors.
 - j. Lighting fixtures.
 - k. Surge Suppression Device.
 - l. Test Instruments to be used for ground resistance test and insulation tests.
 - 3. Manufacturer's recommended installation procedures which, when approved by the Engineer, will become the basis for accepting or rejecting actual installation procedures used on the Work.

- B. Manual: Upon completion of this portion of the Work and as a condition of its acceptance, provide operation and maintenance manuals in accordance with these Specifications. Include within each manual:
 - 1. Copy of the approved Record Documents for this portion of the Work indicating actual as-built conditions.
 - 2. Copies of all circuit directories.
 - 3. Copies of all warranties and guaranties.

1.3 WARRANTY

- A. Provide standard one (1) year warranty on all labor and materials.
- B. Provide a five (5) year warranty on all LED fixtures.
- C. Provide minimum five (5) year warranty on Surge Protection Devices, incorporating unlimited replacements of suppressor parts if destroyed by transients during the warranty period.
- D. Provide standard five (5) year parts and labor warranty on automatic transfer switch.

1.4 POWER SUPPLY

- A. Three phase power is required for all sites unless otherwise approved by Metro.
- B. For pump stations utilizing pumps 20 hp and less, a 120/208 volt, 3 phase service shall be provided unless otherwise approved by Metro.
- C. For pump stations utilizing pumps great than 20 hp, a 277/480 volt, 3 phase service shall be provided unless otherwise approved by Metro.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Provide only materials that are new, of the type and quality specified. Where Underwriters' Laboratories, Inc. have established standards for such materials, provide only materials bearing the UL label. Materials called for are to be considered as standard that, however, implies no right on the part of the Contractor to substitute other materials and methods without written authority from the Engineer.

2.2 RACEWAYS

- A. Applicable Standards:
 - 1. ANSI C80.5: Rigid Aluminum Conduits.

2. ANSI/NEMA FB1: Fittings and Supports for Conduit and Cable Assemblies.
 3. UL 651-2011: Schedule 40 PVC and schedule 80 Rigid PVC Conduit.
 4. UL 514B: Flexible conduit fittings.
 5. NEMA FB 1: Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing and Cable.
 6. ASTM F512: Polyvinyl Chloride (PVC) Conduit.
 7. FS-WW-C-540C: Federal Specification for Rigid Aluminum Conduit.
 8. FS WW-C 566: Federal Specification for Flexible Metal Conduit.
- B. Provide conduit and fittings conforming to the above standards.
- C. Rigid aluminum conduit:
1. Provide threaded type fittings and form 8 conduit bodies with material to match conduit.
 2. Provide seal fittings for rigid aluminum conduit where indicated on the plans equal to Crouse-Hinds series EYSX. Provide sealing compound and fiber by Crouse-Hinds or approved equal:
 - a. Sealing Compound: Chico A.
 - b. Sealing Fiber: Chico X.
 3. Provide thread type fittings and conduit bodies with matching material.
 4. Provide standard aluminum electric conduit couplings
 - a. Do not use pipe couplings or sleeves.
 5. Provide aluminum fittings.
 6. Do not imbed aluminum conduit concrete containing chlorides, unwashed beach sand, sea water, or coral bearing aggregates without PVC coating, heat shrink or two coats of bitumastic.
 7. Use strap wrenches for tightening aluminum conduit.
 - a. Do not use Pipe wrenches, channel locks, chain wrenches, pliers, etc.
 8. Clean and coat all threads on aluminum conduit and fittings with “No-Oxide” compound before using.
 9. Completely cover Aluminum conduit installed in concrete or below grade with two (2) coats of bitumastic paint or PVC coating.
 10. Terminate aluminum conduit entering below grade pullboxes with grounding type bushings and connected to a 3/4" x 10" copperclad rod with a #6 bare copper wire.
 11. All risers from underground, concrete pads:
 - a. Provide heat shrink tubing (Raychem or equal), PVC coating or two coats of bitumastic paint to a point not less than 6 inches above grade or surface of slab.
- D. Provide watertight aluminum flexible conduit for flexible installations.
- E. Conduit/Cable supports – properties:

1. Provide aluminum supports for all exposed metallic conduit as manufactured by Unistrut or approved equal.

F. All conduits to conform to the following specifications:

1. Installations under concrete slab: Schedule 40 PVC
2. Exposed locations: Rigid aluminum conduit.
3. Installations in concrete-encased duct banks: Schedule 40 PVC.
4. Installations underground exposed to earth: Rigid aluminum conduit with PVC or other coating.

2.3 CONDUCTORS

A. Applicable standards:

1. NEMA WC 3: Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
2. NEMA WC 5: Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
3. UL 44 – 2018: Rubber-Insulated Wires and Cables.
4. UL 83 – 2017: Thermoplastic-Insulated Wires and Cables.
5. UL 854 – 2004: Service Entrance Cables.

B. Conductors Acceptable Manufacturers:

1. Okonite.
2. Pirelli.
3. Southwire.
4. Superior Essex.
5. Belden.

C. Connectors Acceptable Manufacturers:

1. ILSCO
2. Polaris

D. Conductor types:

1. Low voltage conductors (0 to 600V):
 - a. For secondary service entrance, feeders, underground, under floor, in damp or wet locations, and to any process associated equipment provide copper, 600V, 90°C, Type XHHW.
 - b. For all other low voltage conductors, provide copper, 600V, 75°C, Type THWN.
 - c. Provide stranded conductors for sizes #12 and larger.
 - d. Provide same type of equipment grounding conductors as specified above.
 - e. Provide all branch circuit wiring installed within ballast compartment of light fixtures rated 90°C, Type THHN.

- f. Analog Control/Communications (TSP or TST) – Provide tinned copper, polyethylene insulated, twisted pair or triplet, aluminum-polyester, overall shield with 20-gauge drain.
 - g. Provide analog signal conductors sized as shown on drawings with minimum size of 18-gauge.
 - h. For all discrete signal conductors, provide copper stranded, 600V, Type THWN with a minimum size of #14, unless otherwise noted.
 - i. For all control conductors installed in underground conduits provide cable listed as suitable for direct burial.
2. Splices, Connections and Terminations (0 to 600V):
 - a. For #8 AWG, use solderless pressure connectors with insulating covers for copper wire splices and taps. Use insulated spring wire connectors with plastic caps for #10 AWG and smaller.
 - b. Use insulated, mechanical connectors for copper wire splices and taps, #6AWG and larger. Tape connectors with electrical tape to prevent moisture infiltration.
 - c. Where connections are located in manholes or handholes use insulated submersible type.

2.4 GROUNDING AND BONDING

A. Applicable standards:

1. UL 467-2013: Grounding and Bonding Equipment.
2. NFPA 70: National Electrical Code.
3. ANSI/IEEE 32: Requirements, Terms and Test Procedures for Neutral Grounding Devices.
4. IEEE 80: Guide for Safety in Substation Grounding.
5. IEEE 81: Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System.
6. NETA ATS: Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems (International Electrical Testing Associates).

B. Grounding electrodes (Rod type):

1. Acceptable Manufacturers:
 - a. LTV Copperweld.
 - b. Line Material.
2. Material: Copper-clad steel.
3. Diameter: 3/4".
4. Length: 10'-0"
5. Type: Sectional.

C. Mechanical connectors:

1. Acceptable Manufacturers:
 - a. Burndy.
 - b. Robbins.

- c. Harger.
 - 2. Material: Bronze.
- D. Exothermically-welded connections:
 - 1. Acceptable Manufacturers:
 - a. Cadweld.
 - b. Or Approved Equal
- E. Grounding Electrode Conductor:
 - 1. Material: Bare, soft-drawn, stranded, copper.
 - 2. Minimum size: Meet NFPA 70 requirements.
- F. Bonding Material:
 - 1. Material: Bare, soft-drawn, stranded, copper.
 - 2. Minimum size: Meet NFPA 70 requirements.
- G. Regulatory requirements:
 - 1. Products: Listed and classified by UL as suitable for the purpose specified and indicated.
- H. Ground Access Wells:
 - 1. Provide 12"x12"x12" polymer concrete ground access well where indicated on plans.
 - 2. Provide engraved cover with "ground" indicator.
 - 3. Rated for a minimum of 20,000 lbs.
 - 4. Provide Harger GAW series or approved equal.

2.5 SURGE PROTECTIVE DEVICE

- A. Applicable standards:
 - 1. UL SPD Type 4CA
 - 2. IEC 61643-11 2011
 - 3. EN 61643-11 2012
- B. Acceptable Manufacturers:
 - 1. Phoenix Contact
 - 2. Or Approved Equal
- C. Surge Protective Device:
 - 1. Install Surge Protective Device on din rail in NEMA 4X 316 stainless steel enclosure
 - 2. Provide din rail mounted input fusing and maintenance disconnect.
 - 3. Lead lengths shall not exceed 18".

4. Installation shall be in accordance with manufacturer's instructions.
5. Provide SPD with one set of NO/NC dry contacts.
6. Provide SPD with protection-indicating LED's.
7. Provide UL nominal discharge current rating of 20KA.

8. Provide SPD that meets or exceeds the following criteria:
 - a. Maximum UL Suppression Voltage Rating (SVR) and Maximum Operating Voltage (MCOV):

System Voltage	L-N	L-G	N-G	L-L	MCOV
208/120V 3Ø	175	175	150	350	175
480/277V 3Ø	320	320	260	640	335

2.6 OUTLET BOXES/RECEPTACLES/SWITCHES

A. Applicable standards:

1. ANSI/NEMA OS 1: Sheet-steel Outlet Boxes, Device Boxes, Covers and Box Supports.
2. NEMA 250: Enclosures for Electrical Equipment (1000 Volts Maximum).
3. NEMA FB 1: Type FD, Cast Ferroalloy Boxes.
4. UL 508: UL Standard for Safety Industrial Control Equipment.

B. Types and properties:

1. Outlet boxes:
 - a. Cast aluminum boxes where exposed. (NEMA FB1; deep type, gasketed cover, threaded hubs).
 - b. Provide rubber or neoprene gasketed covers of similar metal.

C. Pull and junction boxes:

1. Sheet metal boxes:
 - a. Outdoor location installations: Provide NEMA 4X 316 stainless steel.

D. Receptacles/Switches:

1. Hubbell Cat. No. GF-5362, Pass & Seymour equivalent, Leviton equivalent, or equal, for 20A, 120V, duplex, ground fault circuit interrupting type.
2. Wall Switches, Single Pole, 20 A, 120-277V equivalent to Hubbell No. 1221, Pass & Seymour No. 20AC1, Leviton equivalent, or equal. Switches rated 30 A, 120-277V shall be Leviton 3031, Hubbell equivalent, Pass & Seymour equivalent, or equal.

2.7 LIGHTING

A. Applicable standards:

1. FS W-F-414: Fixture, Lighting.

B. Canopy fixtures:

1. Provide 4' enclosed wet location surface mounted fixture with stainless steel mounting bracket and latches.
2. Nominal lumens: 6200
3. Minimum CRI & CCT: 82 CRI, 5000K.
4. H.E. Williams 96-4-L62/850-HIAFR-DRV-UNV or equal.

C. Flood lights:

1. Provide LED wide area floodlight (107 degrees) with wet location listing
2. Nominal lumens: 7400
3. Minimum CRI & CCT: >70 CRI, 5000K.
4. Cree #C-FL-A-RTF1-7L-50K-DB or equal

2.8 DISCONNECT SWITCHES

A. Applicable standards:

1. FS W-S-865: Switch, box (enclosed), surface-mounted.
2. NEMA KS 1: Enclosed switches.

B. Acceptable manufacturers – disconnect/safety switches:

1. General Electric.
2. Square D.
3. Eaton.

C. Disconnect Switches:

1. Non-fusible (disconnect) switch assemblies: NEMA KS 1; type HD; quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position.
 - a. Provide override screw to permit opening front cover with switch in ON position.
 - b. Provide the handle lockable in OFF position.
 - c. Provide enclosure types as indicated on Drawings.

D. Provide NEMA 4X 316 stainless steel enclosures.

E. Service entrance disconnect switch shall be suitable for service entrance.

2.9 MAIN CIRCUIT BREAKERS

A. Applicable standards:

1. FS W C 375: Circuit Breakers, Molded Case, Branch Circuit and Service.
2. NEMA AB 1 93: Molded Case Circuit Breakers and Molded Case Switches.
3. UL-489: Molded Case Circuit Breakers and Circuit Breaker Enclosures.

4. UL-50: Cabinets and Boxes.
5. NEMA-250: Enclosures for Electrical Equipment.

B. Acceptable manufacturers:

1. General Electric.
2. Square D.
3. Eaton.

C. Enclosed Circuit Breakers:

1. Enclosed Molded-Case Circuit Breaker: NEMA AB 1, lockable handle. Handle lockable in OFF position. Provide enclosures type as indicated on Drawings.
2. Provide frame size, trip rating, interrupting rating, and auxiliary devices as required for application.
3. Provide NEMA 4X 316 stainless steel enclosures.

2.10 COMBINATION POWER CENTERS

A. Applicable standards:

1. UL 1062: Standard for Unit Substations.

B. Acceptable manufacturers:

1. General Electric.
2. Square D.
3. Eaton.

C. The combination power center consists of an encapsulated dry type transformer, primary and secondary main circuit breakers, and secondary panelboard all in one enclosure.

1. Transformer Rating: KVA, primary voltage, secondary voltage, frequency and number of phases shall be as shown on the Drawings.
2. Branch Circuits: Molded case circuit breakers, plug in thermal magnetic type with number of poles and trip ratings as shown on the Drawings.
3. Enclosure: Weatherproof, NEMA 4X with 304 stainless steel.

2.11 MANUAL TRANSFER SWITCH

A. Applicable standards:

1. UL 50: Standard for Enclosures for Electrical equipment.

B. Acceptable manufacturers:

1. Trystar or approved equal.

- C. Rotary Manual Transfer Switch:
1. Docking Station shall have integrated Rotary Manual Transfer Switch (MTS).
 - a. MTS shall be three positions. Stationary Generator-Off-Portable Generator.
 - b. MTS shall be located behind pad lockable door to prevent any tampering by unauthorized personnel.
 - c. MTS shall be fully rated for manual transfer under load. MTS' that require a no load manual transfer do not meet these specifications.
- D. Enclosures:
1. Surface mount, NEMA 4X rain-tight, aluminum enclosure with rake system for cable entry at the bottom.
 2. Cable entry area at the bottom of the enclosure shall be covered by a hinged trap door.
 - a. It shall be possible to close and lock the front door to the enclosure with the trap door open, and power cables connected through the bottom of the enclosure. The enclosure shall maintain NEMA 4X with 304 stainless steel integrity with power cables connected.
 3. Front Cover:
 - a. Hinged.
 - b. Gasketed.
 - c. Pad-lockable latch.
 4. Finishes:
 - a. Paint after fabrication. Powder coated Hammer Gray.
- E. Phase, Neutral, and Ground Buses:
1. Material: Silver-plated, Tin-plated or Hard-drawn copper, specified upon order.
 2. Equipment Ground Bus: bonded to box.
 3. Isolated Ground Bus: insulated from box.
 4. Ground Bus: 25%, 50% or 100% of phase size.
 5. Neutral Bus: Neutral bus rated 100 percent of phase bus.
 6. Round edges on bus.
- F. Inputs connectors shall be Camlok style mounted on 45° angle plate or on gland plate.
- G. Output connectors shall be broad range set-screw type, located behind an aluminum barrier.
- H. Lockable rake system with reinforced support struts to reduce cable theft.
- I. Voltage & Phase shall be as shown on project one-line drawing. Camlocks provided for incoming generator power shall be color coded as appropriate for the specified voltage.
- J. Amperage rating shall be as shown on project one-line drawing.
- K. Provide auxiliary contacts on switch to switch start signal from stationary generator to portable generator.

2.12 AUTOMATIC TRANSFER SWITCH – Furnished by Generator Supplier

A. Applicable standards:

1. UL 1008: Standard for Automatic Transfer Switches.
2. NFPA 70: National Electrical Code.
3. NFPA 99: Essential Electrical Systems for Health Care Facilities.
4. NFPA 110: Emergency and Standby Power Systems.
5. IEEE 446: IEEE Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications.
6. NEMA ICS10-2005: AC Automatic Transfer Switches.

B. Acceptable manufacturers:

1. American Switch Company (ASCO).
2. Caterpillar.

C. The following specifications are based on the Caterpillar series power transfer switch and should be considered as a minimum for features and quality.

D. Provide a stand-alone automatic transfer switch rated for site voltage (277/480 volt or 120/208 volt, 3-phase, 4-wire, wye, 60 Hz). Provide unit enclosures as shown on drawings with NEMA 4X 304 stainless steel as a minimum.

E. Provide switch as true double throw, mechanically held, electrically operated, utilizing a reliable field proven, single-solenoid operator with contacts easily accessible for inspection and preventive maintenance.

F. Provide 3-pole switch with solid neutral as shown on drawings.

G. Provide amperage and voltage ratings as shown on drawings.

H. Provide the following features:

1. Microprocessor Controls.
2. Optically isolated RS-485 Serial Communication Interface.
3. In-phase Monitor.
4. Selective Load Disconnect.
5. Engine Exerciser.
6. Solid Neutral.
7. Switch Position Lights.
8. Source Availability Lights.
9. Source Availability Contacts.
10. Test Switch.
11. Time Delay Bypass Switch.
12. One (1) NO and one (1) NC Contacts Rated 10 amps 250VAC.
13. 60 or 50 Hz Selectable.
14. 3- phase or 1- phase Selectable.
15. Two (2) NO and two (2) NC Auxiliary Contacts.
16. Manual Transfer Option.

17. Strip Heater with Thermostat.
18. Deluxe Exerciser.
19. Time Delay Adjustments:
 - a. Override Momentary Normal Outage - 1-3 Seconds.
 - b. Transfer to Emergency - 0-5 Minutes.
 - c. Override Momentary Emergency Outage - 4 Seconds.
 - d. Retransfer to Normal - 1 Second – 30 Minutes.
 - e. Unloaded Running Time Cool Down - 5 Minutes.
20. Voltage and Frequency Settings:
 - a. Normal Source Voltage:
 - 1) PU - 90%-95%.
 - 2) DO - 70%-85%.
 - b. Emergency Source Voltage:
 - 1) PU - 90%.
 - 2) DO - 75%.
 - c. Emergency Source Frequency:
 - 1) PU - 95%.
 - 2) DO - 85%.

2.13 LABELING

- A. Mark all electrical equipment with black phenolic material having engraved letters with white core having one-half inch (1/2") engraved lettering to match designations on one-line diagram.
- B. Mark all electrical 480, 208 and 240-volt equipment with red laminated plastic nameplates having one-half inch (1/2") engraved lettering, reading 480 VOLTS, 208 VOLTS, or 240 VOLTS.
- C. Attach plates to equipment with weatherproof, UV resistant adhesive transfer tape 3M VHB or equal
- D. Arc Flash Labels: Provide labels as required by NFPA 70E.

PART 3 - EXECUTION

3.1 SURFACE CONDITIONS

- A. Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the Work. Do not proceed until unsatisfactory conditions are corrected.

3.2 PREPARATION

- A. Coordination:

1. Coordinate as necessary with other trades to assure proper and adequate provision in the work of those trades for interface with the work of this Section.
2. Coordinate the installation of electrical items with the schedule for work of other trades to prevent unnecessary delays in the total Work.

3.3 ELECTRICAL SERVICE

- A. Verify location of utility transformer pad and install per utility company specifications, providing all materials and labor required for a complete installation. Verify location of utility company secondary delivery point and report any discrepancies to the Engineer immediately.

3.4 TRENCHING AND BACKFILLING

- A. Perform trenching associated with the work of this Section in strict accordance with the provisions of the National Electric Code.

3.5 CONDUCTORS

- A. Terminate #14 AWG stranded conductors where indicated for control, using insulated compression-type spade lugs.
- B. Terminate #12 AWG stranded conductors using insulated compression-type spade lugs.
- C. The conductor lengths for parallel circuits must be made equal.
- D. Neatly train and lace all wiring inside boxes, equipment, and panel boards.

3.6 COLOR CODE AND MARKERS

- A. Provide color-coding for #12 and #10 conductors as follows:

	277/480-Volt	120/208(240)-Volt
Phase "A"	Brown	Black
Phase "B"	Orange	Red
Phase "C"	Yellow	Blue
Neutral	White with Tracer	White
Ground	Green	Green

- B. Mark all conductors #8 and larger and all feeders with plastic tape to match the above color-coding.

3.7 SPLICES, CONNECTIONS, AND TERMINATIONS IN 600V. CONDUCTORS

- A. Splice only in accessible junction boxes.

- B. Thoroughly clean wires before installing lugs and connectors.
- C. Terminate spare conductors with electrical tape or wire nuts.

3.8 RACEWAYS AND FITTINGS

- A. Apply thread compound to all field-cut threads prior to installation.
- B. Cut all conduits square using a saw or pipe cutter and de-burr cut ends.
- C. Install the conduit to the shoulder of fittings and couplings and fastened securely.
- D. Use conduit hubs, or sealing locknuts, for fastening conduit to cast boxes and for fastening conduit to sheet metal boxes in damp or wet locations.
- E. No more than the equivalent of three 90-degree bends may be installed between boxes.
- F. Use conduit bodies to make sharp changes in direction, as around beams.
- G. Use hydraulic one-shot conduit bender or factory elbows for bends in conduit larger than 2" size.
- H. Size all conduits for conductor type installed with 3/4" being the minimum size conduit allowed.
- I. Provide suitable pull string or #12 AWG insulated conductor in empty conduit, except sleeves and nipples.
- J. Install exposed raceways on channel so as to provide a minimum spacing of 1/2" between raceway and the surface to which it is mounted.
- K. Bends:
 - 1. Where emerging from concrete slabs, all conduit bends shall be made entirely within the structure (i.e.: the conduit shall emerge perpendicular to the surface and the bend shall be covered).
- L. Refer to National Electric Code for minimum cover of underground conduits.
- M. Sealing Conduit:
 - 1. Install watertight conduit hubs on all conduits terminating in the top or sides of NEMA 4X enclosures.
 - 2. Use a sealing locknut having an integral gasket on conduits terminating in the bottom of NEMA 4X enclosures.
 - 3. Seal all conduits terminating in NEMA 4X enclosures with duct seal.
 - 4. Install sealing compound and fiber, per manufacturer's recommendation, in hazardous location conduit sealing fittings. Tighten plugs per manufacturer's recommended torque.

- N. Conduit installations in hazardous locations as defined by Article 500 of the NEC must conform to the special requirements of Articles 501, 502, and 503 of the NEC.
- O. Ensure all threads are fully installed into fittings, boxes, enclosures and equipment per NEC and UL listing requirements to provide mechanical integrity, grounding and sealing. Provide fittings and adapters to ensure full length of conduit or conduit fitting threads are installed per code and listing requirements.
- P. Provide plastic threaded type bushings for all conduits terminated in enclosures.

3.9 CONDUIT SUPPORTS

- A. Provide UL listed vinyl end caps for all ends of strut-type metallic conduit supports.
- B. Provide all miscellaneous materials and supports as required by the NEC and these specifications to provide support for conduits, raceways, boxes, fittings and equipment.

3.10 GROUNDING AND BONDING

- A. Ground and bond the electrical system and motors in accordance with Article 250 of the NEC.
- B. Install electric bond around panels, cabinets, pull boxes, enclosures, etc., to incoming and outgoing sub-feed raceways by use of grounding type bushings.
- C. Provide separate, insulated, green equipment grounding conductor within each feeder and branch circuit raceway. Terminate each end on suitable lug, bus, or bushing.
- D. Provide grounding type bushings for conduits 1" or larger and bond to ground bar or lug of enclosure.
- E. Bond neutral and ground at service entrance only.
- F. Provide exothermic-type weld grounding connections that are buried or otherwise normally inaccessible, and excepting specifically those connections for which access is required for periodic testing.
- G. Make each grounding connection strictly in accordance with the manufacturer's written instructions. Failure to follow manufacturer's written instructions shall result in immediate rejection.
- H. Welds which have "puffed up" or which show convex surfaces, indicating improper cleaning, are not acceptable. Provide grounding connection devices compatible with the conductor(s) and/or rods being joined.
- I. Maximum acceptable resistance to earth ground is 5 Ohms. Provide testing of the service entrance system ground and verify the resistance to earth ground is within the specified requirements. If the existing service entrance ground does not meet the specified requirements, install additional rod electrodes as required to achieve specified resistance to ground.

3.11 MOUNTING OF CONTROL PANELS AND ELECTRICAL EQUIPMENT

- A. Mount floor and wall mounted equipment utilizing Type 316 stainless steel anchors and fasteners of the size and number recommended by the manufacturer.
- B. Provide 316 stainless steel fasteners for all other installation types.
- C. Install and check all equipment in accordance with the manufacturer's recommendations.
- D. Ensure that equipment mounting pad locations are level to within 0.125 inches per three foot of distance in any direction. Notify Engineer immediately if any discrepancies are found in the field.
- E. Ensure that all equipment bus bars are torqued to the manufacturer's recommendations.
- F. Assemble all equipment shipping sections, remove all shipping braces and connect all shipping split mechanical and electrical connections.
- G. Provide typed circuit directory with protective plastic sleeve secured to inside of panel door for each branch circuit panelboard.

3.12 TESTING AND INSPECTION

- A. Test all 600-Volt service entrance and feeder wiring using an instrument, which applies a voltage of approximately 500 volts DC to provide a direct reading of resistance.
- B. Perform test on ground system utilizing Fall-Of-Potential method. Meg grounding systems to measure ground resistance, and provide not more than 5 ohms resistance, adding ground rods as necessary to achieve that level.
- C. Conduct all tests in presence of Metro's representative. Identify and properly record all readings. Submit readings to Metro for acceptance.
- D. Test system in the presence of the Engineer and operate to his complete satisfaction in accordance with true intent of plans and specifications. Defray cost of all adjustments necessary to bring system up to standards set forth by Contract Documents at no additional cost.
- E. Thoroughly indoctrinate the Owner's operation and maintenance personnel in the contents of the operations and maintenance manual.

3.13 HAZARDOUS LOCATIONS

- A. Wiring and equipment in hazardous locations, as defined by the NEC, shall conform to the special requirements of the NEC, unless otherwise indicated or specified.

3.14 CLEANING AND PAINTING

- A. Collect and remove from the premises all debris, scraps and other waste material after completion of work.
- B. Tamp and level all trench work.
- C. Remove excess dirt and debris, when and as directed by the Engineer.
- D. Thoroughly clean all electrical equipment, lighting fixtures, exposed conduit, enclosures and boxes of all foreign materials and touch up in accordance with manufacturer recommendations otherwise.
- E. Clean any exposed threaded area of raceway of cutting oil and paint with a cold galvanizing compound prior to final finish painting.

END OF SECTION 04600

04632 STANDBY ELECTRICAL POWER SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. Work included: Provide an engine driven standby electric generator system, as specified herein, and as needed for a complete and proper installation including, but not necessarily limited to:
1. Diesel engine.
 2. Engine instruments and controls.
 3. Alternator.
 4. Control panel.
 5. Exhaust silencer.
 6. Weather-protective, sound attenuated, non- walk-in enclosure.
 7. Associated accessories and other items and services required to complete the system whether particularly mentioned or not.
 8. Fuel tank (filled on site).
 9. Automatic transfer switch (Specified in 04600)
- B. Related work:
1. Section 04600 – Electrical.
- C. Applicable Standards
1. NFPA 70: National Electrical Code
 2. NFPA 110: Standard for Emergency and Standby Power Systems
 3. UL508: Standard for Industrial Control Equipment
 4. UL2200: Standard for Stationary Engine Generator Assemblies
 5. UL142: Standard for Steel Aboveground Tanks for Flammable and Combustible Liquids
 6. CSA C22.2 No. 14: Industrial Control Equipment
 7. CSA C282: Emergency Electrical Power Supply for Buildings
 8. CSA C22.2 No. 100: Motors and Generators
 9. EN61000-6: Electromagnetic Compatibility
 10. EN55011: Limits and Methods of Measurement of Radio Disturbance Characteristics of Industrial, Scientific and Medical (ISM) Radio-frequency Equipment
 11. FCC Part 15 - Radio Frequency Devices - Subpart B-Unintentional Radiators
 12. ISO 8528: Reciprocating Internal Combustion Engine Driven Alternating Current Generating Sets
 13. IEC 61000: Electromagnetic Compatibility

1.2 SUBMITTALS

- A. Shop Drawings shall be submitted for review and shall include the following:
1. Materials list of items proposed to be provided under this Section.

2. Manufacturer's specifications and other data needed to prove compliance with the specified requirements.
3. Shop Drawings in sufficient detail to show fabrication, installation, anchorage, and interface of the work of this Section with the work of adjacent trades.
4. Manufacturer's recommended installation procedures which, when approved by the Metro representative, will become the basis for accepting or rejecting actual installation procedures used on the Work.
5. Load Calculations: Generator shall be sized for both pumps running fully loaded (step started). Base computations on reduced-voltage starters with 350% current limit setting and variable frequency drives with 6-pulse rectifiers. The maximum voltage drop shall be 20%.

1.3 WARRANTY

- A. There shall be one source responsibility for warranty; parts and service through a local representative with factory trained service personnel. Extended Warranty Coverage shall be provided for a period of 4 years and shall include no deductible. Extended Warranty Coverage provides for 100 percent of usual and customary parts and labor costs for failures due to defects in materials and workmanship to the "as shipped consist" from the factory, excluding filters, fluids, vee belts, hoses, power take-offs, paint, batteries and clutches. Provide for a rental power unit due to unscheduled failures causing unexpected downtime to the customer in excess of 48 hours from the time of diagnoses. All repairs will be performed by factory trained dealer service personnel and allows for repairer travel and mileage for all repairs up to 8 hours and 320 miles per incident.
 1. Upon placing the generator in service provide a 30-day initial operating period.
 2. The warranty will begin upon successful completion of the initial operating period.

1.4 RULES AND PERMITS

- A. The entire installation shall be in accordance with NFPA, and all local codes.
- B. Furnish the Owner with certificate of inspection and final approval from all authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS

1. Caterpillar
2. Detroit Diesel
3. Stateline

2.2 GENERAL

A. Provide new and current system equipment consisting of:

1. Engine driven electric generating set to provide standby power.
2. Engine start-stop control system mounted on the generating set.
3. Mounted accessories as specified.

2.3 SYSTEM

- A. Provide generator rated for continuous standby service at site voltage, 3-phase, 4-wire wye. Continuous standby service constitutes full load operation without interruption for a minimum period of 14 days.

2.4 ENGINE

- A. Provide fuel filter and fuel transfer pump at engine.
- B. Provide water-cooled with mounted radiator, fan and water pump.
- C. Provide intake and exhaust valves made of heat resisting alloy steel with exhaust valve seat inserts.
- D. Supply full pressure lubrication by lube oil pumps.
- E. Provide air cleaner, fuel and oil filters with replaceable elements, and lube oil cooler.
- F. Govern engine speed by electronic governor to maintain the alternator frequency within one (1) hertz from no load to full load alternator output.
- G. Provide remote, 2-wire starting by a solenoid shift, electric starter.
- H. Directly connect the starter to the engine flywheel housing.

2.5 ALTERNATOR

- A. Provide brushless, 4-pole, revolving field design with temperature compensated solid-state voltage regulator and rotating rectifier exciter system.
1. Provide rotor driven through a semi-flexible driving flange to ensure permanent alignment.
 2. Provide alternator with frequency regulation not exceeding 3 Hz from no load to rated load.
 3. Provide alternator with voltage regulation within +/-2% of rated voltage, from no load to full rated load.
 4. Provide alternator with recovery to stable operation occurring within 2 seconds.
 - a. Stable operation is defined as operation with terminal voltage remaining constant +/-1% of rated voltage.

5. Provide alternator with a rheostat providing a minimum of +/-5% voltage adjustment from rated value.
6. Provide alternator with temperature rise within NEMA MG1-22 definition.
7. Provide alternator utilizing 3-phase filtered sensing voltage regulation and having an independent power supply for the excitation system (i.e. permanent magnet generator, Auxiliary Winding, Regulator Exciter Principle (AREP) and series boost type excitation system).
8. Provide alternator with a sub-transient reactance of 0.12 per unit, or lower, based on steady-state rating.
9. Provide alternator with Class H insulation.
10. Provide alternator producing a voltage waveform for proper operation of variable frequency PWM drives that produce line to neutral total harmonic distortion to 5% maximum with a maximum 3% distortion in any single harmonic order.
11. Equip alternator with a single-phase space heater. Coordinate voltage with electrical installation.

2.6 CONTROLS

- A. Provide a fully solid-state, microprocessor based, generator control panel wired, tested and shock mounted on the generating set by the manufacturer of the generating plant.
- B. Provide the following functionality integral to the control panel:
 1. A minimum 64 x 240 pixel (28mm x 100mm) white backlight graphical display with text based alarm/event descriptions.
 2. A minimum of 3-line data display.
 3. Audible horn for alarm and shutdown with horn silence switch.
 4. Standard ISO labeling
 5. Multiple language capability
 6. Remote start/stop control
 7. Local run/off/auto control integral to system microprocessor
 8. Cooldown timer
 9. Speed adjust
 10. Lamp test
 11. Push button emergency stop button
 12. Voltage adjust
 13. Voltage regulator V/Hz slope – adjustable
 14. Power Factor Control for paralleling units
 15. Password protected system programming
- C. Provide the panel with the following Digital indications:
 1. AC voltage, 3-phase (L-L and L-N)
 2. AC amps (3-phase and total)
 3. KW (total and per phase)
 4. KVA (total)
 5. KVAR (total)
 6. KWHR (total)
 7. KVARHR (total)

8. PF (average total and 3-phase)
 9. % of rated (total)
 10. Frequency
 11. DC voltage
 12. System diagnostic
 13. Excitation voltage
 14. Excitation current
 15. Engine oil pressure
 16. Engine oil temperature
 17. Engine coolant temperature
 18. Engine RPM
 19. Battery volts
 20. Engine hours
 21. Engine crank attempt counter
 22. Engine successful start counter
 23. Service maintenance interval
 24. Real time clock
 25. Oil filter differential pressure
 26. Fuel temperature
 27. Fuel pressure
 28. Fuel filter differential pressure
 29. Fuel consumption rate
 30. Total fuel consumed
 31. Engine intake manifold temperature
 32. Engine intake manifold pressure
 33. Engine crankcase pressure
 34. Air filter differential pressure
 35. Boost pressure
 36. Oil filter differential pressure
- D. Provide alarm indication and subsequent shutdown for the following conditions (Store in the control panel the first and last occurrences of all alarms and shutdowns with a time, date, and engine hour stamp):
1. Low oil pressure alarm/shutdown
 2. High coolant temperature alarm/shutdown
 3. Loss of coolant shutdown
 4. Overspeed shutdown
 5. Overcrank shutdown
 6. High intake manifold temperature alarm/shutdown
 7. High exhaust manifold temperature alarm/shutdown
 8. High crankcase pressure alarm/shutdown
 9. High air inlet temperature alarm/shutdown
 10. Emergency stop depressed shutdown
 11. Low coolant temperature alarm
 12. Low battery voltage alarm
 13. High battery voltage alarm
 14. Control switch not in auto position alarm
 15. Battery charger failure alarm

16. Generator over voltage
 17. Generator under voltage
 18. Generator over frequency
 19. Generator under frequency
 20. Generator reverse power
 21. Generator overcurrent
 22. Loss of excitation alarm/shutdown
 23. Instantaneous over excitation alarm/shutdown
 24. Time over excitation alarm/shutdown
 25. Rotating diode failure
 26. Loss of sensing
 27. Loss of PMG
- E. Provide the ability to accept six (6) programmable digital input signals.
- F. Provide accessible through a single electronic service tool all engine, voltage regulator, control panel and accessory units. Provide the following maintenance functionality:
1. Engine running hours display
 2. Service maintenance interval (running hours or calendar days)
 3. Engine crank attempt counter
 4. Engine successful starts counter
 5. 20 events are stored in control panel memory
 6. Programmable cycle timer that starts and runs the generator for a predetermined time. The timer shall use 14 user-programmable sequences that are repeated in a 7-day cycle. Each sequence shall have the following programmable set points:
 - a. Day of week
 - b. Time of day to start
 - c. Duration of cycle
- G. Provide an annunciator to meet the requirements of NFPA 110, Level 1.
1. Network directly to the generator set control
 2. Include a lamp test pushbutton, alarm horn and alarm acknowledge pushbutton
 3. Provide the following individual light indications for protection and diagnostics:
 - a. Overcrank
 - b. Low coolant temperature
 - c. High coolant temperature warning
 - d. High coolant temperature shutdown
 - e. Low oil pressure warning
 - f. Low oil pressure shutdown
 - g. Overspeed
 - h. Low coolant level
 - i. EPS supplying load
 - j. Control switch not in auto
 - k. High battery voltage
 - l. Low battery voltage
 - m. Battery charger AC failure

- n. Emergency stop
 - o. Spare
 - p. Spare
- H. Equip unit with factory mounted terminal blocks and strips for all power, signal and control wiring connections.
- I. Provide the following dry contacts to interface with Metro's RTU:
- 1. Generator Running
 - 2. Generator Alarm

2.7 GENERATING SET MOUNTING

- A. Equip generator set with vibration isolators and mount on a welded steel base that will provide suitable mounting to any level surface.
- B. Equip unit with a reinforced sheet steel, minimum 16 gauge, sound attenuating, non-walk-in weather-protective housing.
- 1. Reinforce to be vibration-free in the operating mode.
 - 2. Provide housing with lockable removable panels on each side of the housing to access generator with a hinged door to access instrument panel.
 - 3. Provide housing complete with accessories listed below, be rust treated and painted standard color of manufacturer.
 - 4. Provide peaked roof for drainage.
 - 5. Provide corrosion resistant fasteners.
 - 6. Extend coolant and oil drain line connections outside of enclosure.
 - 7. Insulate enclosure to limit unit noise to 75 db at 7m.
 - 8. Mount enclosure over an integral welded steel base fuel tank complete with all fuel fittings, level indicator, vent, exterior lockable fill port and drains, etc., and necessary galvanized steel support framing so that the weight of the generator is not supported by the tank. Size tank to run the generator at full load for a minimum of 2 days.
 - a. Enclose tank in a welded steel secondary containment vessel having an audible spill alarm system powered from the generator battery system and alarmed on the generator control panel.
 - b. All welds, cuts, openings, etc., in the steel material, shall be cold galvanized as a minimum after fabrication.
 - 9. Provide tank underwriter's labeled (UL).

2.8 ACCESSORIES

- A. Provide the plant with all accessories needed for proper operation to include, but not be limited to:
- 1. A critical type silencer of schedule 40 steel mounted inside enclosure.

2. Stainless steel flexible exhaust connection.
 3. Sufficient exhaust piping of aluminized schedule 40 steel pipe and fittings, including end rain cap.
 4. Provide a 10-amp, automatic “float” type battery charger to maintain the batteries at normal capacity.
 - a. Provide 120V input with 12 or 24 VDC output to battery(s).
 - b. Provide cables, battery rack, AC compensation, current limit, DC ammeter to show battery voltage, equalizing switch, fused AC input and DC output, complete isolation of AC input and DC output.
 - c. Design as not to discharge the battery in event of failure.
 5. Provide engine mounted, thermostatically controlled, immersion type heater to ensure a minimum coolant temperature of 120° F in a minimum ambient temperature of -15° F.
 6. Engine Block Heaters sized per manufacturer’s requirements. Coordinate voltage with electrical installation.
- B. Radiator coolant shall be all weather, all season, environment friendly 50% solution antifreeze.
- C. Provide adequate fuel to fill tank
- D. Overcurrent Protection:
1. Furnish the engine/generator set with overcurrent output protection per the latest edition of NEC 445-4 at the engine/generator set.
 2. Provide Ground-Fault Protection of service entrance disconnects 1000 amperes or more at 277/480V per NEC 70 Part 230-95.

PART 3 - EXECUTION

3.1 SURFACE CONDITIONS

- A. Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the Work. Do not proceed until unsatisfactory conditions are corrected.

3.2 TESTING AND INSPECTION

- A. Provide personnel and equipment, make required tests, and secure required approvals from the governmental agencies having jurisdiction.
- B. Provide a service engineer to complete the initial start-up, make proper and complete adjustments of all adjustable devices, load switches, etc., and to also verify and approve all connections prior to any test operation of said equipment.
- C. An operational test of the standby power system shall be conducted by a representative of the manufacturer of this equipment in the presence of Metro’s representative. It shall be

demonstrated during these tests that the voltage sensitive and time delay devices perform at their specified settings.

- D. Perform 2 hour load bank test for generator at full load.

3.3 TRAINING

- A. Upon completion of the work of this Section, provide 2 hours of training for Metro personnel on operation and maintenance of the generator and the automatic transfer switch.

END OF SECTION 04632