



SANITARY SEWER STANDARDS AND PROCEDURES

STANDARD TECHNICAL SPECIFICATIONS

JANUARY 2021

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SECTION 01410 - REGULATORY REQUIREMENTS AND REFERENCES

The following specifications have been created as go-by specifications for Developers working inside the Metropolitan Sewer Subdistrict jurisdiction. They should be considered tentatively final with the potential for additional product requirements to be added in the future. Developers are instructed to modify the specifications to meet specific project needs and take full responsibility for the final products applicability, entire contents of the specification section, and for concordance with the other project documents. Areas shaded in gray have been identified as areas in need of further review or editing.

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



SECTION 01550 - VEHICULAR ACCESS AND TRAFFIC CONTROL

The following specifications have been created as go-by specifications for Developers working inside the Metropolitan Sewer Subdistrict jurisdiction. They should be considered tentatively final with the potential for additional product requirements to be added in the future. Developers are instructed to modify the specifications to meet specific project needs and take full responsibility for the final products applicability, entire contents of the specification section, and for concordance with the other project documents. Areas shaded in gray have been identified as areas in need of further review or editing.

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.

1.3 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



SECTION 01570 - ENVIRONMENTAL PROTECTION

The following specifications have been created as go-by specifications for Developers working inside the Metropolitan Sewer Subdistrict jurisdiction. They should be considered tentatively final with the potential for additional product requirements to be added in the future. Developers are instructed to modify the specifications to meet specific project needs and take full responsibility for the final products applicability, entire contents of the specification section, and for concordance with the other project documents. Areas shaded in gray have been identified as areas in need of further review or editing.

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



SECTION 01660 - MATERIAL STORAGE AND HANDLING

The following specifications have been created as go-by specifications for Developers working inside the Metropolitan Sewer Subdistrict jurisdiction. They should be considered tentatively final with the potential for additional product requirements to be added in the future. Developers are instructed to modify the specifications to meet specific project needs and take full responsibility for the final products applicability, entire contents of the specification section, and for concordance with the other project documents. Areas shaded in gray have been identified as areas in need of further review or editing.

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



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02100 - CLEARING AND GRUBBING

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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 public and private property and shall avoid removal of trees, interference with natural or installed drainage systems, landscaping or fencing unless deemed necessary by the Owner/Engineer. 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, and improved condition acceptable to the Owner. All project areas shall be graded so as to shed water to natural drainage areas. The areas affected by Construction shall be raked to a uniform surface free from rocks, clods of earth or other irregularities. All affected areas shall be left in a clean, neat condition.

3.2 GRUBBING

- A. Grub and remove all stumps, roots in excess of 1 1/2 in in diameter, matted roots, brush, timber, logs, concrete rubble and other debris encountered to a depth of 18 in below original grade or 18 in beneath the bottom of foundations, whichever is deeper.
- B. Refill all grubbing holes and depressions excavated below the original ground surface with suitable materials and compact to a density conforming to the surrounding ground surface in accordance with Section 02221.

3.3 DISPOSAL

- A. Cut tree trunks and limbs exceeding 4in in diameter shall be cut into 4ft lengths and stockpiled on site in the area designated on the Contract Drawings or approved by the Owner/Engineer.
- B. Dispose of material and debris from site preparation operations by hauling such materials and debris to an approved offsite disposal area. No rubbish or debris of any kind shall be buried on the site.
- C. Burning of cleared and grubbed materials or other fires for any reason will not be permitted.

END OF SECTION 02100



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

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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 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. Where the County/SCDOT requirements differ on manhole location, the County/SCDOT specifications shall prevail.
- 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.
- G. Where the County or SCDOT require additional measures or more stringent requirements, those requirements shall be implemented.

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.

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



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SECTION 02221 - TRENCH EXCAVATION, BEDDING AND BACKFILL

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NOTE: This section is considered appropriate for most utility projects in Streets and cross-country areas. This section is not to be used for deep excavations with complex sheeting/shoring requirements or for excavations in close proximity to existing structures. The Engineer is responsible replacing this section with a more appropriate section based on the complexity of the required excavations.

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 appurtenances, including bedding and backfill operations, drainage, disposal of surplus materials and restoration of trench surfaces and easements 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 02100 Clearing and Grubbing
- B. Section 02240 Dewatering and Drainage
- C. Section 02250 Sheeting and Bracing
- D. Section 02730 Sanitary Sewer Systems

1.3 JOB CONDITIONS

- A. Existing utilities:



1. Approximate location of certain underground lines and structures are shown on the plans for information only, other underground lines or structures may not be shown.
2. Locate these and other possible unknown utility lines using electronic pipe finder, or other approved means.
3. Locate, excavate and expose all existing underground lines in advance of trenching operations.
4. The Contractor will be held responsible for the workmanlike repair of any damage, at no cost to the Owner, done to any of these utilities in the execution of his work under this Section.
5. The Contractor shall familiarize himself with the existing conditions and be prepared to adequately care for and safeguard himself and the Owner from damage.

B. Notification of intent to excavate:

1. South Carolina Underground Utility Damage Prevention Act (S.C. Code Ann, 58-35-10, CT-SEQ, Supp. 1978) requires persons to ascertain the location of underground public utility property prior to excavation or demolition in certain situations. The Act also requires such persons to give timely notice of intent to excavate or demolish prior to commencing such operations. Failure to comply could subject the violator to a civil penalty of up to one thousand dollars (\$1,000) for each violation of the Act.
2. Notification of intent to excavate may be given by calling this toll-free number: 888-721-7877.

C. Protecting trees, shrubbery, and lawns:

1. Trees and shrubbery in developed areas and along the trench line shall not be disturbed unless absolutely necessary, and subject to the approval of the Owner/Engineer. Any such trees and shrubbery necessary to be removed shall be heeled in and replanted.

D. Clearing:

1. Perform all clearing necessary for installation of the complete work in accordance with Section 02100.
2. Clearing shall consist of removing all trees, stumps, roots, brush and debris in the rights-of-way obtained for the Work.
3. All timber of merchantable size shall remain the property of the Owner and shall be trimmed and cut in such lengths as directed and stacked along the edge of the right-of-way.
4. All other material, including trimmings from above, shall be completely disposed of in a satisfactory manner.

E. Removing and resetting fences:

1. Where existing fences must be removed to permit construction of utilities, remove such fences and reset the fences in their original location and condition in accordance with the property owner and as the Work progresses.
2. Provide temporary fencing or other safeguards as required to prevent stock and cattle from wandering to other lands.

F. Restoration of disturbed areas:



1. Restore all areas disturbed by construction activities to their existing or better condition. For existing areas with sod type grasses, replace with new sod. Existing sod may be reused where properly removed and stored and as approved by the Owner/Engineer.

1.4 MANHOLE EXCAVATION

- A. 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 at no cost to the Owner.

1.5 PIPELINES

- A. 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.

1.6 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

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

2.2 BACKFILL MATERIAL

- A. 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

- A. Stabilization stone shall be the same as bedding materials.



2.4 SELECT BACKFILL

- A. 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 TEST PITS

- A. Excavation of test pits may be required for the purpose of locating underground utilities or structures as an aid in establishing the precise location of new work.
- B. Test pits shall be backfilled as soon as the desired information has been obtained. The backfilled surface shall be maintained in a satisfactory condition for travel until resurfaced as specified.

3.2 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 12 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.

3.3 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 conventional mechanical excavation equipment and requires continuous, systematic drilling, blasting, wedging, sledging, cutting, barring, jack hammering, hoe ramming or expansive chemical splitting.
- 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 specified below 6-inches below the outside bottom of the pipe.



**Depth from Ground
Surface to Invert of Pipe**

0 to 12-ft
12-ft to 20-ft
20-ft to 24-ft

**Pay Width
(Nominal Pipe Diameter)
up to 16-in**

4-ft-0-in
5-ft-0-in
6-ft-0-in

- 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.

3.4 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.

3.5 GEOTEXTILES

- A. Subsurface Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:
1. Survivability: Class 3; AASHTO M 288.
 2. Survivability: As follows:



- a. Grab Tensile Strength: 120 lbf (534 N); ASTM D 4632/ D 4632M.
 - b. Tear Strength: 50 lbf (223 N); ASTM D 4533/D 4533 M.
 - c. Puncture Strength: 310 lbf 1 N); ASTM D 6241.
- 3. Apparent Opening Size: No. 70 (0.212-mm) sieve, maximum; ASTM D 4751.
 - 4. Permittivity: 0.1 per second, minimum; ASTM D 4751.
 - 5. UV Stability: 70 percent after 500 hours' exposure; ASTM D 4355/D 4355M.
- B. Product: Provide “Mirafi 140N,” by TenCate Geosynthetics – Nicolon Corporation, or equal.

3.6 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.

3.7 BRACING AND SHEETING

- A. 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.

3.8 PUMPING

- A. 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.

3.9 TRENCH EARTH DAMS

- A. 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.

3.10 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 pipelines 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.
- G. Any deficiency in the quantity or quality of material for backfilling the trenches, or for repairing 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.
- H. 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.



- I. No more than 350 feet of trench shall be open at any given time.
- J. All road surfaces shall be broomed and hose-cleaned immediately after backfilling. Dust control measures shall be employed at all times.

3.11 EXCAVATION BELOW GRADE AND REFILL

- A. Whatever the nature of unstable material encountered or the groundwater conditions, trench drainage shall be complete and effective.
- B. If the Contractor excavates below grade through error or for the Contractor's own convenience, or through failure to properly dewater the trench, or disturbs the subgrade before dewatering is sufficiently complete, he may be directed by the Owner/Engineer to excavate below grade as set forth in the following paragraph, in which case the work of excavating below grade and furnishing and placing the refill shall be performed at his own expense.
- C. If the material at the level of trench bottom consists of fine sand, sand and silt or soft earth which may work into the screened gravel notwithstanding effective drainage, the subgrade material shall be removed to the extent directed and the excavation refilled with a 6-in layer of SCDOT #57 stone, as approved by the Owner/Engineer. The composition and gradation of gravel shall be approved by the Owner/Engineer prior to placement. Gravel shall then be placed in 6-in layers thoroughly compacted up to the normal grade of the pipe.
 - 1. Payment for excavation below grade and refill shall be at the unit price bid in the Schedule of Prices for the Over Excavation of Unsuitable Soils and Refill bid Item. Payment shall only be made for removal and replacement of existing unsuitable soils. No payment will be made for removal and replacement of unsuitable soils resulting from improper excavation, improper dewatering or accidental overexcavation by the Contractor.
- D. Geotextile non-woven filter fabric may be substituted for filter layer if approved by the Engineer.

3.12 DISPOSAL OF MATERIALS

- A. Excavated material shall be stacked without excessive surcharge on the trench bank or obstructing free access to hydrants and other utilities. Inconvenience to traffic and abutters shall be avoided as much as possible. Excavated material shall be segregated for use in backfilling as specified below.
- B. It is expressly understood that no excavated material shall be removed from the site of the work or disposed of, except as directed by the Owner/Engineer. When removal of surplus materials has been approved by the Owner/Engineer, dispose of such surplus material in approved designated areas.
- C. Should conditions make it impractical or unsafe to stack material adjacent to the trench, the material shall be hauled and stored at a location approved by the Owner/Engineer. When required, it shall be re-handled and used in backfilling the trench.



3.13 TESTING

- A. 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 will back charge the Contractor for all retests.

3.14 RESTORING TRENCH SURFACE

- A. Where the trench occurs adjacent to paved streets, in shoulders, sidewalks, or in cross-country areas, thoroughly consolidate the backfill and shall maintain the surface as the work progresses. If settlement takes place, immediately deposit additional fill to restore the level of the ground.
- B. The surface of any driveway or any other area which is disturbed by the trench excavation and which is not a part of the paved road shall be restored to a condition at least equal to that existing before work began.
- C. In sections where the pipeline passes through grassed areas, and at the Contractor's own expense, remove and replace the sod, or loam and seed the surface to the satisfaction of the Engineer.

END OF SECTION 02221



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SECTION 02226 - UTILITY REMOVAL AND ABANDONMENT

The following specifications have been created as go-by specifications for Developers working inside the Metropolitan Sewer Subdistrict jurisdiction. They should be considered tentatively final with the potential for additional product requirements to be added in the future. Developers are instructed to modify the specifications to meet specific project needs and take full responsibility for the final products applicability, entire contents of the specification section, and for concordance with the other project documents. Areas shaded in gray have been identified as areas in need of further review or editing.

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 backfilled 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. 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. 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



SECTION 02240 - DEWATERING AND DRAINAGE

The following specifications have been created as go-by specifications for Developers working inside the Metropolitan Sewer Subdistrict jurisdiction. They should be considered tentatively final with the potential for additional product requirements to be added in the future. Developers are instructed to modify the specifications to meet specific project needs and take full responsibility for the final products applicability, entire contents of the specification section, and for concordance with the other project documents. Areas shaded in gray have been identified as areas in need of further review or editing.

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. The Work specified in this Section includes Designing, furnishing, installing, operating, monitoring, maintaining and removing temporary dewatering and drainage systems as required to lower and control water levels to at least 2 feet below the lowest level of the excavation to permit construction in the dry. Contractor shall obtain and pay for all permits required for temporary dewatering and drainage systems
- B. Furnish, maintain and remove temporary surface water control measures adequate to drain and remove surface water entering excavations.
- C. Retain the services of a professional engineer registered in the State of South Carolina to prepare dewatering and drainage system designs and submittals described herein.
- D. Work shall include the design, furnishing equipment and materials, installation, protection, and monitoring of geotechnical instrumentation required to monitor the performance of the dewatering and drainage system as required herein.
- E. Collect and properly dispose of all discharge water from the dewatering and drainage systems in accordance with the provisions of this Section. Under no circumstances shall water from dewatering systems be discharged into the existing or new sanitary sewer systems.
- F. Obtain and pay for all permits required for dewatering and drainage systems.
- G. Repair damage caused by dewatering and drainage system operations.
- H. Basic trench dewatering which does not require a design, permitting, deep wells, well points, or complex pumping is specified in the technical specification and will be paid for under the individual pipe items.

1.2 RELATED WORK

- A. Section 02100 – Clearing and Grubbing
- B. Section 02221 – Trench Excavation, Bedding and Backfill



1.3 SUBMITTALS

- A. Dewatering and drainage system designs shall be prepared by a licensed professional engineer retained by the Contractor. The Contractor shall submit an original and three copies of the licensed professional engineer's certification included herein. The Contractor shall also submit qualifications as required herein.
- B. The Contractor shall submit a dewatering and drainage system design plan. The plan shall include a description of the proposed dewatering system and include the proposed installation methods to be used for dewatering and drainage system elements and for observation wells. The plan shall include equipment, drilling methods, holes sizes, filter sand placement techniques, sealing materials, development techniques, the number and location of dewatering points and observations wells, etc. Include the dewatering system design calculations in the plan.
- C. The plan shall identify the anticipated area influenced by the dewatering system and address any impacts to adjacent existing and proposed structures. The submittal shall also include detailed plans for pre-construction surveys of existing structures in the vicinity of the dewatering system, settlement monitoring of existing structures during construction, and provisions to address settlement of existing structures resulting from dewatering activities.
- D. Coordinate dewatering and drainage submittals with the excavation and support submittals. The submittal shall show the areas and depths of excavation to be dewatered.
- E. Do not proceed with any excavation or dewatering activities until the dewatering submittals has been reviewed and approved by the Owner/Engineer.
- F. If visible contaminants, odorous waste or any other potentially hazardous material is encountered during the dewatering process, the Contractor shall stop work and store the contaminated water in approved containers. Contractor shall develop disposal plan, to be approved by the Owner/Engineer before work can proceed. The Contractor shall make every effort to limit the environmental impact of the contaminants.
- G. Preconstruction surveys as specified below.

1.4 QUALITY ASSURANCE

- A. Regulations: Perform all work in accordance with current applicable regulations and codes of all Federal, State and local agencies.
- B. The Contractor shall have at least 5 years of experience with work compatible to the Work shown and specified, employing labor and supervisory personnel who are similarly experienced in this type of Work.
- C. The Contractor's design engineer shall be registered in the State of South Carolina and have a minimum of 5 years of professional experience in the design and construction of dewatering and drainage systems and shall have completed not less than 5 successful dewatering and drainage projects of equal type, size, and complexity to that require for the work.



1.5 DESIGN REQUIREMENTS

- A. The Contractor is responsible for the proper design and implementation of methods for controlling surface water and groundwater.
- B. The primary purpose of the groundwater control system is to preserve the natural undisturbed condition of the subgrade soils in the areas of the proposed excavations. Prior to excavation, the Contractor shall lower the groundwater to at least 2-ft below the lowest excavation subgrade elevation. Additional groundwater lowering may be necessary beyond the 2-ft requirement, depending on construction methods and equipment used and the prevailing groundwater and soil conditions. The Contractor is responsible for lowering the groundwater as necessary to complete construction in accordance with the plans and specifications at no additional cost to the Owner.
- C. Design deep wells, well points and sumps, and all other groundwater control system components to prevent loss of fines from surrounding soils. Sand filters shall be used with all dewatering installations unless screens are properly sized by the Contractor's design engineer to prevent passage of fines from surrounding soils.
- D. Design review and field monitoring activities by the Owner/Engineer shall not relieve the Contractor of his/her responsibilities for the work.
- E. The Contractor shall perform pre-conditions surveys of facilities located within 50ft of the work. Pre-condition survey shall be performed to include detailed documentation of facilities to include, but not limited to, buildings, roadways, utilities, asphalt parking lots and driveways. Surveys shall document interior and exterior cracking, settlement and distresses which exist prior to any construction activities. Pre-condition shall be submitted to Owner/Engineer prior to beginning any construction activity.

1.6 DEFINITIONS

- A. Where the phrase "in-the-dry" is used in this Section, it shall be defined as an excavation subgrade where the groundwater level has been lowered to at least 2-ft below the lowest level of the excavation, is stable with no ponded water, mud, or muck, is able to support construction equipment without rutting or disturbance and is suitable for the placement and compaction of fill material, pipe or concrete foundations.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Pipe for observation wells shall consist of minimum 1-in I.D, Schedule 40 PVC pipe and machine slotted PVC well points, maximum slot size 0.020-in.
- B. Piping, pumping equipment and all other materials required to provide control of surface water and groundwater in excavations shall be suitable for the intended purpose.



- C. Standby pumping systems and a source of standby power shall be maintained at all sites.

PART 3 - EXECUTION

3.1 GENERAL

- A. Control surface water and groundwater such that excavation to final grade is made in-the-dry, the natural undisturbed condition of the subgrade soils are maintained, and softening and/or instability or disturbance due to the presence or seepage of water does not occur. All construction and backfilling shall proceed in-the-dry and flotation of completed portions of work shall be prohibited.
- B. Methods of groundwater control may include but are not limited to perimeter trenches and sump pumping, perimeter groundwater cutoff, well points, ejectors, deep wells and combinations thereof.
- C. Where groundwater levels are above the proposed bottom of excavation level, a pumped dewatering system will be required for predrainage of the soils prior to excavation, and for maintaining the lowered groundwater level until construction has been completed to such an extent that the structure, pipeline or fill will not be floated or otherwise damaged.
- D. It is expected that the type of system, spacing of dewatering units and other details of the work will have to be varied depending on soil/water conditions at a particular location.
- E. All work included in this Section shall be done in a manner which will protect adjacent structures and utilities and shall not cause loss of ground or disturbance to the pipe bearing soils or to soils which support overlying or adjacent structures.
- F. Install, monitor and report data from observation wells. Evaluate the collected data relative to groundwater control system performance and modify systems as necessary to dewater the site in accordance with the Contract requirements.
- G. Locate groundwater control system components where they will not interfere with construction activities adjacent to the work area or interfere with the installation and monitoring of geotechnical instrumentation including observation wells. Excavations for sumps or drainage ditches shall not be made within or below 1H:1V slopes extending downward and out from the edges of existing or proposed foundation elements or from the downward vertical footprint of the pipe.

3.2 SURFACE WATER CONTROL

- A. Construct surface water control measures, including dikes, ditches, sumps and other methods to prevent, as necessary, flow of surface water into excavations and to allow construction to proceed without delay.



3.3 EXCAVATION DEWATERING

- A. At all times during construction, provide and maintain proper equipment and facilities to promptly remove and properly dispose of all water entering excavations. Excavations shall be maintained in-the-dry. Groundwater levels shall be kept at least 2-ft below the lowest excavation level.
- B. Excavation dewatering shall maintain the subgrade in a natural undisturbed condition and until the fill, structure or pipes to be built thereon have been completed to such extent that they will not be floated or otherwise damaged by allowing water levels to return to natural elevations.
- C. Pipe, masonry, and concrete shall not be placed in water or be submerged within 24 hours after being installed. Water shall not flow over new masonry or concrete within four days after placement.
- D. In no event shall water rise to cause unbalanced pressure on structures until the concrete or mortar has set at least 24 hours. Prevent flotation of the pipe by promptly placing backfill.
- E. Dewatering shall at all times be conducted in such a manner as to preserve the natural undisturbed condition of the subgrade soils at the proposed bottom of excavation.
- F. If the subgrade of the trench or excavation bottom becomes disturbed due to inadequate dewatering or drainage, excavate below normal grade as directed by the Owner/Engineer and refill with structural fill, screened gravel or other material as approved by the Owner/Engineer at the Contractor's expense.
- G. It is expected that the initial dewatering plan may have to be modified to suit the variable soil/water conditions to be encountered during construction. Dewater and excavate, at all times, in a manner which does not cause loss of ground or disturbance to the pipe bearing soil or soil which supports overlying or adjacent structures.
- H. If the method of dewatering does not properly dewater the excavation as specified, install additional groundwater observation wells as directed by the Owner/Engineer and do not place any pipe or structure until the readings obtained from the observation wells indicate that the groundwater has been lowered a minimum of 2-ft below the bottom of the final excavation within the excavation limits.
- I. Dewatering units used in the work shall be surrounded by suitable filter sand and no fines shall be removed by pumping. Pumping from the dewatering system shall be continuous until pipe or structure is adequately backfilled. Stand-by pumps shall be provided.
- J. Water entering the excavation from precipitation or surface runoff shall be collected in shallow ditches around the perimeter of the excavation, drained to a sump and pumped from the excavation to maintain a bottom free from standing water.
- K. Drainage shall be disposed of in an approved area. Existing or new sanitary sewers shall not be used to dispose of drainage.



3.4 WELL POINT SYSTEMS

- A. Where necessary, install a vacuum well point system around the excavation to dewater the excavation. Each well point and riser pipe shall be surrounded by a sand or gravel filter. Sand or gravel shall be of such a gradation that, after initial development of the well points, the quantity and size of soil particles discharged shall be negligible. Well point systems shall be capable of operating continuously under the highest possible vacuum.
- B. Installation of well point systems shall be in accordance with the approved submittal and in the presence of the Owner/Engineer.

3.5 DEEP WELLS

- A. Where necessary, install a deep well system around the excavation to dewater or depressurize the excavation. Each well shall be surrounded by a sand or gravel filter with adequate gradation such that after development, the quantity and size of soil particles discharged are negligible. Sufficient number of wells shall be installed to lower or depressurize the groundwater level to allow excavation to proceed in-the-dry.
- B. Installation of deep well shall be in accordance with the approved submittal and in the presence of the Owner/Engineer.

3.6 OBSERVATION WELLS

- A. Install observation wells to monitor groundwater levels beneath and around the excavated area until adjacent structures and pipelines are completed and backfilled.
- B. Observation Well Locations and Depths:
 - 1. A minimum of 3 wells (one upstream and two downstream of the groundwater gradient) shall be installed around the excavation area. They shall be located in critical areas with respect to groundwater control to monitor performance of dewatering systems designed by the Contractor's Engineer.
 - 2. Observation wells required shall be installed to a depth of at least 10-ft below the deepest level of excavation, unless otherwise approved by the Owner/Engineer, and to whatever depth is necessary to indicate that the groundwater control system designed by the Contractor's Engineer is performing as intended. Additional observation wells may be required by the Owner/Engineer if deemed necessary to monitor the performance of the Contractor's groundwater control system.
 - a. Locations and depths of observation wells are subject to approval by the Owner/Engineer.
- C. Protect the observation wells at ground surface by providing a lockable box or outer protective casing with lockable top and padlock. Design the surface protection to prevent damage by vandalism or construction operations and to prevent surface water from infiltrating.



- D. Provide two copies of keys for each padlock to the Owner/Engineer for access to each well.
- E. Observation wells shall be developed so as to provide a reliable indication of groundwater levels. Wells shall be re-developed if well clogging is observed, in the event of apparent erroneous readings, or as directed by the Owner/Engineer.
- F. Submit observation well installation logs, top of casing elevation, and well locations to the Owner/Engineer within 24 hours of completion of well installation.
- G. Observation Well Maintenance
 - 1. The Contractor shall maintain each observation well until adjacent structures and pipelines are completed and backfilled. Clean out or replace any observation well which ceases to be operable before adjacent work is completed.
 - 2. It is the Contractor's obligation to maintain observation wells and repair or replace them at no additional cost to the Owner, whether or not the observation wells are damaged by the Contractor's operations or by third parties.
 - 3. Monitoring and Reporting of Observation Well Data
 - a. The Contractor shall begin daily monitoring of groundwater levels in work areas prior to initial operation of drainage and dewatering system. Daily monitoring in areas where groundwater control is in operation shall continue until the time that adjacent structures and pipelines are completed and backfilled and until the time that groundwater control systems are turned off.
 - b. The Contractor is responsible for processing and reporting observation well data to the Engineer on a daily basis. Data is to be provided to the Owner/Engineer on a form, which shall include the following information: observation well number, depth to groundwater, total depth of well, top of casing elevation, groundwater level elevation and date and time of reading.
- H. The groundwater level shall be kept at a minimum of 2-ft below the lowest subgrade level for a given excavation.

3.7 REMOVAL OF SYSTEMS

- A. At the completion of the excavation and backfilling work, and when approved by the Owner/Engineer, all pipe, deep wells, well points, pumps, generators, observation wells, other equipment and accessories used for the groundwater and surface water control systems shall be removed from the site. All materials and equipment shall become the property of the Contractor. All areas disturbed by the installation and removal of groundwater control systems and observation wells shall be restored to their original condition.
- B. Leave in place any casings for deep wells, well points or observation wells located within the plan limits of structures or pipelines or within the zone below 1H:1V planes extending downward and out from the edges of foundation elements or from the downward vertical footprint of the pipe, or where removal would otherwise result in ground movements causing adverse settlement to adjacent ground surface, utilities or existing structures.



- C. Where casings are pulled, holes shall be filled with sand. Where left in place, casings should be filled with cement grout and cut off a minimum of 3-ft below finished ground level or 1-ft below foundation level so as not to interfere with finished structures or pipelines.

END OF SECTION 02240



P.E. CERTIFICATION FORM

The undersigned hereby certifies that he/she is a professional Engineer registered in the State of South Carolina and that he/she has been employed by

_____ to design
(Company Name)

(Insert P.E. Responsibilities)

In accordance with Specification Section _____ for the

_____.
(Name of Project)

The undersigned further certifies that he/she has performed the said design in conformance with all applicable local, state and federal codes, rules and regulations; and, that his/her signature and P.E. stamp have been affixed to all calculations and drawings used in, and resulting from, the design.

The undersigned hereby agrees to make all original design drawings and calculations available to the Metropolitan Sewer Subdistrict or Owner's representative within seven days following written request therefor by the Owner.

P.E. Name

Company Name

Signature

Signature

P.E. Registration Number

Title

Address

Address



SECTION 02250 - SHEETING AND BRACING

The following specifications have been created as go-by specifications for Developers working inside the Metropolitan Sewer Subdistrict jurisdiction. They should be considered tentatively final with the potential for additional product requirements to be added in the future. Developers are instructed to modify the specifications to meet specific project needs and take full responsibility for the final products applicability, entire contents of the specification section, and for concordance with the other project documents. Areas shaded in gray have been identified as areas in need of further review or editing.

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. All excavation, trenching and related sheeting, bracing, etc., shall comply with the requirements of OSHA excavation safety standards (29 CFR Part 1926 Subpart P).
- C. Related Sections
 - 1. Section 02221-Trench Excavation, Bedding and Backfill
 - 2. Section 02240-Dewatering and Drainage

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. Furnish, put in place and maintain sheeting and bracing required by Federal, State or local safety requirements to support the sides of the excavation and prevent loss of ground which could endanger personnel, damage or delay the work or endanger adjacent structures. If the Owner/Engineer is of the opinion that at any point sufficient or proper supports have not been provided, he/she may order additional supports placed at the expense of the Contractor. Compliance with such order shall not relieve the Contractor from his/her responsibility for the sufficiency of such supports. Care shall be taken to prevent voids outside of the sheeting, but if voids are formed, they shall be immediately filled and rammed.



- B. When moveable trench bracing such as trench boxes, moveable sheeting, shoring or plates are used to support the sides of the trench, care shall be taken in placing and moving the boxes or supporting bracing to prevent movement of the pipe, or disturbance of the pipe bedding and the screened gravel backfill.
- C. When installing rigid pipe (D.I., etc.), any portion of the box extending below mid diameter shall be raised above this point prior to moving the box ahead to install the next pipe. This is to prevent the separation of installed pipe joints due to movement of the box.
- D. When installing flexible pipe (PVC, etc.), trench boxes, moveable sheeting, shoring or plates shall not be allowed to extend below mid-diameter of the pipe. As trench boxes, moveable sheeting, shoring or plates are moved, screened gravel shall be placed to fill any voids created and the screened gravel and backfill shall be re-compacted to provide uniform side support for the pipe.
- E. Permission will be given to use steel sheeting in lieu of wood sheeting for the entire job wherever the use of sheeting is necessary. The cost for use of sheeting will be included in the bid items for pipe and shall include full compensation for driving, bracing and later removal of sheeting.
- F. All sheeting and bracing shall be carefully removed in such manner as not to endanger the construction of other structures, utilities, or property, whether public or private. All voids left after withdrawal of sheeting shall be immediately refilled with sand by ramming with tools especially adapted to that purpose, by watering or otherwise as directed.
- G. No payment will be given for sheeting, bracing, etc, during the progress of the work. No payment will be given for sheeting which has actually been left in the trench for the convenience of the Contractor.
- H. Sheeting driven below mid-diameter of any pipe shall remain in place from the driven elevation to at least 1-ft above the top of the pipe.
- I. 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



SECTION 02300 - AUGER BORING

The following specifications have been created as go-by specifications for Developers working inside the Metropolitan Sewer Subdistrict jurisdiction. They should be considered tentatively final with the potential for additional product requirements to be added in the future. Developers are instructed to modify the specifications to meet specific project needs and take full responsibility for the final products applicability, entire contents of the specification section, and for concordance with the other project documents. Areas shaded in gray have been identified as areas in need of further review or editing.

PART 1 - GENERAL

1.1 SCOPE

- A. 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, railroads, and location(s) shown on the plans by auger boring/jack and bore as specified herein.
- B. 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 and all pertinent state and local laws, regulations and requirements, and applicable regulatory authority.

1.2 RELATED WORK

- A. Section 02221 - Trench Excavation, Bedding and Backfill
- B. Rock boring and tunneling methods must be reviewed and approved of by the Engineer prior to installation.

1.3 PRE-INSTALLATION MEETINGS

Retain "Pre-Installation Meeting" Paragraph below if Work of this Section is extensive or complex enough to justify a conference.

- A. Pre-Installation Meeting: Conduct conference at [Project site] <Insert location>.
 - 1. Review geotechnical data.
 - 2. Review existing utilities and subsurface conditions.
 - 3. Review coordination for interruption, shutoff, capping, and continuation of utility services.
 - 4. Review proposed excavation support and protection system.
 - 5. [Review proposed dewatering plan.]
 - 6. Review proposed equipment.
 - 7. Review monitoring of pipe jack and bore activities.
 - 8. Review removal of pipe jack and bore equipment and excavation support and protection system.



1.4 DEFINITIONS

- A. Admixtures: Materials other than water, aggregate, or cement added to grout mix to modify mix properties.
- B. Annular Grouting: Injection of cement grout into annulus between jacked pipe and [soil] [weathered rock] [and] [rock].
- C. Casing Pipe: The outer sleeve that is installed by jacking method.
- D. Carrier Pipe: The pipe inserted within the casing pipe and which acts as the conveyor for wastewater.
- E. [Cutoff Grouting: Pressure grouting in [soil] [weathered rock] [and] [rock] to eliminate or retard water into underground structures or excavations].
- F. Launch Shaft: The pit in which the jacking equipment is installed and from which both the casing pipe and carrier pipe are launched.
- G. In rare cases, the pipe may be direct jacked, and there is no casing used. This specification does not address this scenario, and the Geotechnical Division should be consulted to modify the specification accordingly.
- H. Permeation Grouting: Grout used to control water infiltration into pits or tunnels.
- I. Pipe Jacking: The use of thrust shield with hydraulic jacks pushing against the casing pipe with hydraulic jacks located in the jacking pit.
- J. Auger Boring: A trenchless installation system that involves the use of jacking forces (thrust) and auger motion to install casing pipe. The system typically includes a boring machine, mechanical steering head, cutting header and augers.
- K. Receiving Shaft: The pit at the point where the carrier pipe exits the casing pipe.
- L. Tunnel: An underground opening supported using the casing pipe.

1.5 ACTION SUBMITTALS

- A. Submit complete shop drawings, material certificates, and product data for encasement pipe, carrier pipe, fittings, and related appurtenances.
- B. Auger boring system designs shall be prepared by a licensed professional engineer, registered in the State of South Carolina, having a minimum of 5 years of professional experience in the design and construction of auger boring (jacking and boring) systems. Submit a copy of the licensed professional engineer's certification included herein.
- C. Design Calculations: Submit design calculations detailing equipment and construction methods to be used for auger bore operations as specified herein and as shown on the plans. The submittal shall include the following and shall be signed and sealed by the Contractor's Design Engineer.



1. Control of groundwater and surface drainage.
2. Method of soil stabilization and/or groundwater control at the face.
3. Method of face excavation.
4. Method of excavation removal.
5. Maintenance of alignment and grade.
6. Materials and installation of casing pipe.
7. Annular filling between encasement pipe and carrier pipe.
8. Bulkhead.
9. Auger boring schedule, including a detailed work plan.
10. Lubricant for decreased jacking friction and pumping system, as required.
11. Arrangement, layout, details and design of jacks, thrust ring, jacking controls, thrust block and pressure gauges.
12. Methods, equipment, and materials used to monitor, prevent, and control lost ground at the face and to control ground water at the face.
13. Calculations of encasement pipe friction, comparison of the required thrust with the thrust and pressure of the jacking system, reaction for the jacking frame, and transfer of thrust to the ground.
14. Encasement pipe: Submit product data for the encasement pipe including manufacturer, type, class size, thickness and strength.
15. The design calculations are to be submitted for Informational review only.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Contractor and Contractor's Design Engineer.
- B. Quality control plan, including procedures for producing, sampling and testing of grout, methods for controlling critical mix parameters and injection pressures, qualification of sampling and testing personnel, calibration certificates for gauges, scales, meters, and jacks.
- C. Daily surveyor reports of casing pipe position and control point monitoring [, per [Insert Jurisdiction such as DOT or Railroad] requirements,] conducted by Contractor's surveyor.
- D. For crossings within [Insert Jurisdiction such as DOT or Railroad], Contractor's Professional Engineer licensed in the State of South Carolina shall certify the shoring of all excavations as adequate to prevent damage to [roadway], [rail] [or] [utility].

1.7 QUALITY ASSURANCE

- A. Contractor Qualifications: Experienced in auger boring installation with at least 5 years of successful pipe installations, employing labor and supervisory personnel who are similarly experienced in this type of work. Include auger boring work of at least <Insert>-inch-diameter casing pipe at least <Insert>-foot-long below [roadways][rails] or [utilities].
- B. Superintendent: Minimum five years of experience in auger boring construction methods.
- C. Contractor's Design Engineer: Professional Engineer licensed in the State of South Carolina with minimum 5 years of professional experience in design of auger boring, excavation support, dewatering, grouting, and soil stabilization.



1.8 REFERENCE SUBMITTALS

- A. American Society for Testing and Materials (ASTM)
 - 1. ASTM A36 – Standard Specification for Carbon Structural Steel.
 - 2. ASTM A53 – Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
 - 3. ASTM A134 – Standard Specification for Pipe, Steel, Electric-Fusion (Arc)-Welded (Sizes NPS 16 and over)
 - 4. ASTM A139 – Standard Specification for Electric Fusion (arc) Welded Steel Pipe (NPS 4 and over)
 - 5. ASTM A1011 – Standard Specification of Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved formability, and Ultra-High Strength.
- B. American Welding Society (AWS)
- C. American Water Works Association (AWWA)
 - 1. AWWA C203 – Standard for Coal-Tar Protective Coatings and Linings for Steel Water Pipelines – Enamel and Tape – Hot Applied
- D. The Society for Protective Coatings Paint Application (SSPC)
 - 1. SSPC SP 6 – Commercial Blast Cleaning

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.
- B. Store excavated materials to prevent erosion of soil type materials and contamination of adjacent water sources:
 - 1. According to manufacturer instructions.
 - 2. Stack piping lengths no more than three layers high.
 - 3. Store field joint materials in original shipping containers in dry area indoors.
- C. Handling: Support pipes with nylon slings during handling.
- D. Protection:
 - 1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
 - 2. Protect pipe from entry of foreign materials and water by installing end caps and closures completing sections of Work, and isolating parts of completed system.
 - 3. Provide additional protection according to manufacturer instructions.



1.10 FIELD CONDITIONS

- A. Project-Site Information: [A geotechnical data report] [Geotechnical data] has been prepared for this Project and is available for information only. Owner is not responsible for interpretations or conclusions drawn from this [geotechnical data report] [geotechnical data].
1. Make additional test borings and conduct other exploratory operations necessary for pipe jacking installation according to the performance requirements.
 2. Groundwater levels may vary during the work and should not be assumed to be accurately represented by groundwater level readings reported in the [geotechnical data report] [geotechnical data].
 3. [Geotechnical data report] [Geotechnical data] is [included] elsewhere in Project Manual.

PART 2 - PRODUCTS

2.1 ENCASEMENT PIPE

- A. Encasement pipe shall be high strength seamless or welded steel conforming to the requirements of ASTM A53 (ASTM A139 Grade "B"). Length and Diameter shall be as shown on the Plans. 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. Encasement pipe shall be designed to meet the permitting authority's requirements should it be more stringent compared to these requirements.
- 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"

- C. Encasement pipe shall be furnished in lengths of the Contractor's choice. The casing shall have beveled ends with a single v-groove and shall be field joined by full-penetration butt welding all around prior to jacking.
- D. The shield for pipe jacking operations shall have a hood extending a minimum of 18-inches beyond the flat face of the shield. The hood shall extend 120 degrees on both sides of the crown. The shield shall produce an opening not exceeding the outside diameter of the casing pipe by more than 2-inches. The shield shall have the capability of supporting breast boards used to



laterally support soil at the tunnel face. Breast boards shall only be removed in sequential order to allow for excavation in a benched manner.

2.2 CASING SPACERS

- A. Casing spacers shall be made of carbon steel, runners shall be minimum 2 inches wide. Casing spacers shall be as manufactured by Advanced Products and Systems, Inc., or equal.
- B. Casing spacers shall be placed as recommend by the manufacturer.

2.3 END SEALS

- A. Provide end seals to seal space between carrier pipe and casing pipe at each end of casing pipe for grout containment.
- B. The ends shall then be sealed with a rubber boot.

2.4 ANNULAR GROUTING

- A. Fill space between casing and carrier pipes with cement grout which consists of a mixture of cement and sand to provide good flowing characteristics.

PART 3 - EXECUTION

3.1 GENERAL

- A. 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.
- B. 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.
- C. Provide barricades, fencing, or other safety measures to prevent public access into Work and staging areas.
- D. Control groundwater at all times. If groundwater is expected to be above or within casing level, install a groundwater control system consisting of vertical or horizontal wells or well points and operate such that groundwater level is lowered to at least casing invert level at face.

3.2 LAUNCHING AND RECEIVING SHAFTS

- A. Include design and details of thrust block, base support and tunnel opening in excavation support submittals.



- B. Furnish and install a level, lean concrete mat at least 6 inches thick at bottom of launch and receiving shafts to protect subgrade and provide a working surface.
- C. Furnish, install and remove, to extent required, thrust blocks or such other provisions as may be required in driving casing pipe forward.
- D. Do not use trench boxes as support of excavation for any launch and receiving shafts unless approved by Engineer.
- E. Keep launch and receiving shaft subgrades continuously free from groundwater and surface waters during pipe jacking operations

3.3 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.

3.4 INSTALLATION

- A. Remove material from the casing face by augering. Utilize an auger and cutting head for soil removal. Do not extend the auger and cutting head assembly past the leading edge of casing and arrange to provide reasonable obstruction to the free flow of soft or poor subsurface materials. Provide an auger and cutting head assembly that is removable from the casing pipe in the event an obstruction is encountered.
- B. Installation of casing pipe shall be continuous and shall avoid interruptions which could cause the pipe to "freeze" in place. Consistently maintain proper alignment and elevation of casing throughout jacking operation. Tolerances for installation of casing pipes:
 - 1. Vertical: Plus or minus 0.50 feet.
 - 2. Horizontal: Plus or minus 0.50 feet.
- C. Consistently maintain proper alignment and elevation of casing throughout jacking operation. Tolerances for installation of casing pipes:
 - 1. Vertical: Plus or minus 0.50 feet.
 - 2. Horizontal: Plus or minus 0.50 feet.
- D. Dewatering through the casing pipe during construction will not be permitted.
- E. Establish survey station marks over entire length of jacked casing pipe during jacking operations at intervals of not more than 20 feet and to an accuracy of 0.01 feet. Commence auger boring only after Contractor's surveyor has verified in writing to Engineer that first pipe casing segment is at



correct location and elevation and is oriented at correct horizontal and vertical direction. After first segment has been jacked forward, Contractor's surveyor shall again verify in writing to Engineer that alignment is correct. Should alignment not be correct at this or any point, stop jacking operation and do not resume until Contractor has modified jacking operation as required to maintain proper alignment. Check alignment of casing pipe daily by Contractor's surveyor as casing progresses and provide daily written reports to Engineer. Make adjustments immediately if any misalignment occurs.

3.5 CARRIER PIPELINE INSTALLATION IN ENCASEMENT PIPE AND ANNULAR GROUTING

- A. Design casing spacers to withstand grouting pressures, forces to pull pipe sections into casing, and to support full weight of pipe using methods certified by Manufacturer. Prevent any movement or displacement of casing spacers or carrier pipe during grouting.
- B. Air test each gasketed air-testable pipe joint immediately after installation per appropriate pipe specification. Block pipe as necessary to prevent joint separation during testing and reduce pressure to 2.0 pounds per square inch (psi). Permit no exceptions to this requirement.
- C. After carrier pipe has been installed in casing, shimmed, blocked, and tested, seal ends of casing around pipeline with bulkheads and completely fill space between casing and pipeline with cement grout. Pump cement grout through 2-inch-minimum unjointed HDPE pipes extending through one bulkhead into top of casing. Perform operation in at least two stages to help prevent flotation. To ensure that casing is completely full, install two 2-inch-minimum unjointed HDPE pipes near crown of casing from midpoint of casing to each end, and provide 2-inch openings in each bulkhead at tunnel crown location. Pump grout or concrete into casing until it flows from top of casing in HDPE pipe and bulkhead openings at both ends. Leave HDPE pipe in place and cut off at end of casing.

END OF SECTION 02300



P.E. CERTIFICATION FORM

The undersigned hereby certifies that he/she is a professional Engineer registered in the State of South Carolina and that he/she has been employed by

_____ to design
(Company Name)

(Insert P.E. Responsibilities)

In accordance with Specification Section _____ for the

_____.
(Name of Project)

The undersigned further certifies that he/she has performed the said design in conformance with all applicable local, state and federal codes, rules and regulations; and, that his/her signature and P.E. stamp have been affixed to all calculations and drawings used in, and resulting from, the design.

The undersigned hereby agrees to make all original design drawings and calculations available to the Metropolitan Sewer Subdistrict or Owner's representative within seven days following written request therefor by the Owner.

P.E. Name

Company Name

Signature

Signature

P.E. Registration Number

Title

Address

Address



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SECTION 02301 - HORIZONTAL DIRECTIONAL DRILLING (HDD)

The following specifications have been created as go-by specifications for Developers working inside the Metropolitan Sewer Subdistrict jurisdiction. They should be considered tentatively final with the potential for additional product requirements to be added in the future. Developers are instructed to modify the specifications to meet specific project needs and take full responsibility for the final products applicability, entire contents of the specification section, and for concordance with the other project documents. Areas shaded in gray have been identified as areas in need of further review or editing.

PART 1 - GENERAL

1.1 SUMMARY

- A. The Work specified in this section includes installation of force mains utilizing conventional Horizontal Directional Drilling (HDD) equipment and techniques. The requirements are based on HDD employed for pipe segments with depths up to 15 feet, and nominal pipe diameters up to 24 inches.
- B. Horizontal directional drilling scope shall include, but not be limited to, controlled and guided horizontal directional drilling of a pilot bore, reaming, and installation of the specified pipe in a straight line at the location and grade as shown on the Drawings.
- C. Contractor shall examine the site, taking into consideration conditions that may affect the Work. Owner will not assume responsibility for variations of subsurface conditions at locations other than places shown and at the time the investigation was made.
- D. All work shall be conducted from off the highway. Location control, recovery, installation, bypassing obstructions and drilling must all be conducted without access to the roadway.
- E. Drilling shall either be conducted from a pit or as a sacrificial tangent curve to intersect the alignment outside of the highway embankment. Should a pit be used, all work to construct and maintain the pit will be part of this work.

1.2 DEFINITIONS

- A. Annular Space: Space between the final reamed bore diameter and the largest outside diameter of the force main.
- B. Bent Sub: A section of drill pipe behind the cutting tools that is inclined at an angle of one to three degrees from the axis of the bore in the desired direction of steering. The bent sub allows steering while rotating the cutting tools.
- C. Break-Away Connection: A connection to the product pipe that will fail at a pull force less than the rated stresses that is acceptable for the product pipe.



- D. Critical Structure: Any pipeline, utility building, structure, bridge, pier, or similar construction partially or entirely located within a zone of active excavation.
- E. Drilling Fluid/Mud: A mixture of water, bentonite, and/or environmentally approved polymers, lubricants, and viscosifiers continuously pumped to the drill head to facilitate the removal of soil cuttings, to stabilize the bore, lubricate the drill string and product pipe, and to cool the drill head and transmitter electronics.
- F. Drill Head: A tool or system of tools, such as a slanted drill face or mud motor, which enables steering and path corrections and creates the pilot bore.
- G. Drill String: Total length of the drill pipe in the borehole.
- H. Entry Point: Location where the pilot bore initially penetrates the ground surface and where the HDD rig is positioned. The drill head may be launched from the surface or from within an excavation.
- I. Exit pit: Excavation where the pilot bore emerges.
- J. Pilot Bore: The initial bore hole of several inches in diameter in a shallow arc from the entry point to the force main alignment, and a straight path along the alignment of the force main.
- K. Obstruction: An object lying completely or partially within the design pathway of the pilot bore and product pipe that prevents further advancement of the drill string, reamer, and/or product pipe, after reasonable attempts to advance past the object or re-drill around the object have failed.
- L. Pullback: Part of a drilling process in which the drill pipe, swivel, and gravity sewer pipe are pulled back along the path of the pilot bore to the entry point, which pulls the gravity sewer pipe into place.
- M. Reamer: A cutting tool pulled in order to enlarge the pilot bore hole to a diameter sufficient for the installation of the force main.
- N. Tracking System: System that locates the actual position of the drill head referenced to the design line and grade.

1.3 SUBMITTALS

- A. The following is the summary of information to be included in submittals required for the Work. Combine submittals at discretion but at a minimum the following information shall be assembled and furnished for review to allow the Engineer to judge whether the proposed equipment, materials, and procedures will result in pipeline installation that meets the Contract requirements.
 - 1. Qualifications.
 - 2. Description of methods, materials and equipment
 - 3. Work plan



- B. **Contractor Qualifications and Experience:** The Contractor or the subcontractor who will perform the drilling work shall submit documentation showing the following minimum qualifications:
1. Demonstrate at least 3 years of successful experience installing pipelines by the means of HDD with at least 50,000 linear feet of 6-inch to 24-inch diameter pipelines. Documentation shall include date and duration of work, location, project owner, pipe information (diameter, length, material, depth of installation, contents).
 2. Field supervisory personnel employed by the HDD Contractor shall have at least five years of direct experience in HDD operations particularly including pilot hole steering and position monitoring, reaming and pullback. The field supervisory personnel shall be on-site at all times while HDD operations are being conducted.
- C. **Submit written procedures and information that demonstrates the proposed method of operation.** The submittal shall include the following information.
1. Size, capacity and setup requirements of all equipment including drill rig weight, thrust/pullback capacity, and rotary torque capacity.
 2. HDD guidance system type and information including the accuracy, range and repeatability values for inclination, roll and azimuth of the system.
 3. Type of drill head.
 4. Tracking system and method of monitoring and controlling line and grade.
 5. Drilling pipe, swivels and reaming equipment including the diameter of the reamer and the annular space for each force main installation.
- D. **Submit a work plan including the following information:**
1. Equipment arrangement, entry point and exit pit
 2. Method of dewatering
 3. Method of removing and disposing of spoils
 4. Location of product pipe joining areas and staging areas
 5. Contingency plan for encountering obstructions, deviations from planned bore path alignment, and exceeding allowable tolerances for product pipe installation.
- E. **Provide an informational submittal of drilling fluid information including product data, material specifications, Safety Data Sheets (SDS), handling procedures, and method of mixing and installation.**
- F. **Equipment Layout Plan:** Submit a plan which provides sketches depicting the layout and locations of equipment within the rig side work area and pipe side work area, including storage location of carrier pipe and proposed drilling fluid containment and recirculation pits. Confirm that operations shall be completely contained within the right-of-way and/or easements as shown on the Drawings.

1.4 PERFORMANCE REQUIREMENTS

- A. **Provide equipment, materials, and personnel necessary for completing the installation as shown on the Drawings and specified herein.**



- B. The pilot bore shall not deviate from the planned alignment more than 1 inch vertical and 2 inches horizontal when measured at 10-foot intervals.
- C. The force main shall be installed at the slope and alignment shown on the Drawings. Invert elevations at each end of pipe installed by HDD shall not deviate more than 1 inch from the calculated invert elevations. A hump or sag which does not exceed 2 inches over a length of 10 feet will be acceptable. The force main shall not deviate more than 6 inches from the horizontal alignment in a continuous bow. A “corkscrew” or “roller coaster” installation of the force main will not be accepted.

1.5 QUALITY ASSURANCE

- A. Logs and Records: Maintain logs and records including the following information.
 - 1. Actual drill head position referenced to planned alignment.
 - 2. Instances of retraction and re-drilling of the drill head or segments thereof.
 - 3. Drilling fluid pressures and flow rates.
 - 4. Other relevant observations, including observed settlement, heave, or surface spills.
- B. The equipment used for tracking the drill head shall be inspected and calibrated by the equipment manufacturer prior to use. Proof of this inspection and calibration shall be provided to the Engineer prior to commencement of drilling operations as specified herein.
- C. Allow access by the Engineer and furnish necessary assistance and cooperation to aid the Engineer in observations, measurements, data and sample collection.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Care shall be taken in loading, transporting and unloading to prevent injury to the pipe or coatings. Pipe shall not be dropped. Any damage to the pipe or coatings shall be repaired to the Owner’s satisfaction.

1.7 PROJECT/SITE REQUIREMENTS

- A. Boring logs and geotechnical memorandum are included in the Appendix and boring locations are as indicated.
- B. Provide all maintenance of traffic and establish and maintain all safety procedures on adjacent highways during the HDD operation.
- C. Inspect the locations where HDD operations will be conducted and force main is to be installed, verify the conditions under which the work will be performed, and provide all necessary details, whether shown or specified in the Contract Documents or not, for the orderly prosecution of the work.



- D. Be prepared to work at night and on weekends, if required, to complete the work. Request and obtain written authorization in accordance with the General Conditions prior to working nights and weekends.
- E. HDD operations shall not result in settlement greater than [Design Engineer to specify]. If any movement or settlement occurs that causes or might cause damage to roadways, roadbeds, or structures over, along, or adjacent to the work, operations shall stop immediately except for those activities which will assist in making the work secure and prevent further movement, settlement, or damage. Operations may resume only after all necessary precautions have been taken to prevent further movement, settlement, or damage.
- F. Roadways, roadbeds, and structures damaged by HDD operations shall be repaired or replaced as necessary to restore them to their condition prior to beginning HDD operations.

PART 2 - PRODUCTS

2.1 DRILLING FLUID

- A. Select drilling fluid mixture proportions to ensure continuous circulation, bore stability, reduce drag on the pipe, and completely fill the annular space to control settlement.
- B. Drilling fluids shall consist of a mixture of potable water and gel-forming colloidal material, such as bentonite or a polymer surfactant mixture producing a slurry of custard-like consistency.

2.2 DRILLING SYSTEM

- A. The directional drilling machine shall consist of a hydraulically powered system to rotate, push, and pull hollow drill pipe into the ground at a variable angle while delivering a pressurized fluid mixture to a steerable drill head. The machine shall be anchored to the ground to withstand the pulling, pushing, and rotating pressure required to complete the line segment. The hydraulic power system shall be self-contained with sufficient pressure and volume to power drilling operations. The hydraulic system shall be free of leaks. The rig shall have a system to monitor and record maximum pullback pressure during pullback operations. The rig shall be grounded during drilling and pullback operations. There shall be a system to detect electrical current from the drilling string and an audible alarm that automatically sounds when an electrical current is detected.
- B. Provide drill pipes that have been inspected and determined to be adequate for the Project requirements. Bent, racked, or fatigued drill pipes shall not be used. Threads shall be in good condition.
- C. Provide reamer to minimize annular space and accomplish reaming and pullback in a single operation without prereaming. Reamer diameter shall not exceed the maximum product pipe diameter by more than 2 inches.



- D. Provide a drilling fluid mixing, delivery and recovery system of sufficient capacity to successfully complete the force main installation. Pipe lubricants shall be injected as necessary to maintain acceptable thrust loads and mitigate ground movement. Pumps shall be adequate to supply the necessary flow rates and pressures at the anticipated drilling fluid viscosity at all times.

2.3 GUIDANCE SYSTEM AND TRACKING SYSTEM

- A. The guidance system must have the capability of measuring inclination, roll and azimuth. The locating and tracking system shall include a sonde transmitter in the drill head and a manually operated walkover receiver capable of detecting position, depth and orientation of the drill head.

2.4 WATER

- A. Contractor shall be responsible for transporting, storing, and disposing of water as necessary.

2.5 FORCE MAIN

- A. Provide pipe material as called out in the plans. Pipe thickness shall conform to the most conservative design with respect to design calculations for the critical combination of internal and external pressure and pullback.

PART 3 - EXECUTION

3.1 GENERAL

- A. HDD shall not begin until all required submittals have been reviewed and approved by the Engineer.
- B. Properly manage and dispose of groundwater inflows.
- C. Conduct all operations such that trucks and other vehicles do not interfere with traffic or create a mud, dust, or noise nuisance in the streets and to adjacent properties. Promptly clean up, remove, and dispose of spoils.
- D. All Work shall be done so as not to disturb roadways, adjacent structures, landscaped areas, waterways, or existing utilities. Any damage shall be immediately repaired to original condition.
- E. Provide adequate control of surface water drainage and runoff, and provide silt fences, hay bales, and wattles to prevent surface water from being transported off-site.



3.2 ACCESS PITS/PREPARATION

- A. Excavation, trenching, dewatering, sheeting, shoring and bracing shall comply with all applicable OSHA and specifications.
- B. Locate and protect existing utilities as required. Coordinate utility protection with the respective utility companies.
- C. No rescue shafts will be allowed within the limits of the roadway or drainage way.

3.3 HORIZONTAL DIRECTIONAL DRILLING

- A. HDD shall be completed in accordance with approved submittals and all applicable permit conditions.
- B. Though the installation process may be licensed or proprietary in nature, the Contractor shall not change any material, thickness, design, values or procedural matters stated in the submittals, without the prior knowledge and approval of the Engineer. The Contractor shall submit, in writing, full details about component materials, their properties and installation procedures and abide by them fully during the entire course of the work.
- C. The pumps used shall be adequate to supply the required flow rate and pressures at the anticipated drilling fluid viscosity at all times. Drilling speeds shall not exceed pump capacity, and shall be monitored continuously during HDD operations.
- D. Control lubrication pressures and avoid excessive pumping pressures to prevent the discharge of lubricant at the ground surface or into any water body. Contain and clean up any lubricant discharges immediately. Wash any paved areas with water to avoid the tracking of lubricant away from the construction area.
- E. Spoils and slurry shall be contained in trucks, tanks, acceptable recirculation pits, or other containers at all times. Dumping of spoil or slurry on the ground, discharge into sewers, or discharge into the water bodies will not be permitted. Transport and dispose of spoils off-site at a disposal facility that meets Federal, State, and local requirements.
- F. Drill Head Tracking and Monitoring: At all times during the drilling, provide and maintain a drill head tracking system that is capable of accurately locating the position of the drill head in the x, y, and z axes. Check the position of the drill head at intervals of not less than 10 feet. Deviations between the recorded and designed bore path shall be calculated and reported. If the deviations exceed specified tolerances specified, undertake necessary measures to correct deviations and return to design line and grade.

3.4 REAMING AND PULLBACK OPERATIONS

- A. Reaming and pullback shall be performed in a single operation without prereaming. Once reaming and pullback operations have commenced, operations must continue without interruption until the product pipe is completely pulled into the borehole.



- B. Leading end of the pipe shall be closed during the pullback operation, in accordance with the pipe supplier's recommendations. A pulling head shall be used that is rated at the allowable pull force capability of the pipe section being installed, in accordance with the pipe supplier's recommendations. Pipe shall be isolated from excessive torsional and axial stresses by a swivel device.
- C. During pullback operations, the Contractor shall not apply more than the manufacturer's recommended maximum safe pipe pull pressure at any time. A break away head rated at the maximum safe pull pressure shall be utilized.
- D. Fusion-welded pipelines shall be adequately supported during installation so as to prevent overstressing or buckling. The pipe layout area shall be cleared of large stones, construction debris, or other foreign objects that could damage the pipe during pullback. Monitor and inspect pipe rollers and methods for suspending fusion-welded pipe at entry during the pullback operation to avoid damage to the pipe. Equipment used to make thermal butt fusion joints shall be approved by the pipe and fitting manufacturer. Personnel that make thermal butt fusion joints shall be certified by the pipe and fitting manufacturer.
- E. Inspect and clean each length of mechanically joined pipe as necessary to be free of debris immediately before joining.
- F. Handle product pipe in a manner that does not overstress or otherwise damage the pipe. If the pipe is buckled or otherwise damaged, the damaged section shall be removed and replaced at the Contractor's expense. Take appropriate steps during pullback to ensure that the product pipe will be installed without damage. Cease pullback operations if the product pipe is damaged, remove the pipe from the bore, and repair the pipe using the manufacturer's recommended procedure or replace the damaged pipe before resuming installation.
- G. All reamed boreholes that are not used for pipe installation shall be grouted with a mixture of one part cement to six parts sand. The quantity of cement may be increased or decreased as necessary and as permitted by the Engineer to provide good flowing characteristics. This applies to boreholes that are created by pulling the pipe from the ground surface, but may apply elsewhere. The displaced volume for pilot bore stems alone is not of sufficient volume to require grouting.

3.5 CONTROL OF LINE AND GRADE

- A. Monitor line and grade at points throughout the drilling operations. Verification may be by visible or electronic tracking. Record deviation with respect to design line and grade and submit records as requested. Control line and grade of the pipe to within the specified tolerances.
- B. If the pipe installation does not meet the specified tolerances, the Contractor shall correct the installation including any necessary redesign of the pipeline or structures and acquisition of necessary easements. All corrective work shall be performed by the Contractor at no additional cost to the Owner and without schedule extension, and is subject to the written approval of the Engineer.



3.6 WORK STAGING AREA

- A. Provide barricades, barriers, lights, signals, pavement markings, signs, and flaggers as specified.
- B. Combustible materials (e.g., fuel, oil, lubricants, etc.) shall be stored off-site or in a well-ventilated storage facility removed from the immediate vicinity of the drilling area by at least 20 feet.

NOTE: Designer should plan sufficient space for staging and assembling fusion-welded pipe, or design for use of restrained joint pipe.

- C. Limit the pipe layout, assembly and staging areas to rights-of-way and easements. Maintain access to adjacent properties.
- D. Provide appropriate measures for containing cuttings at the exit pit. Use appropriate methods to minimize erosion and runoff. Containment and cleanup equipment shall be available to contain and clean up surface spills and inadvertent returns.

3.7 CLEANING AND TESTING

- A. Installed force main shall be cleaned and tested per Section 04531.

END OF SECTION 02301



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SECTION 02575 - PAVEMENT, MARKINGS, AND APPURTENANCES

The following specifications have been created as go-by specifications for Developers working inside the Metropolitan Sewer Subdistrict jurisdiction. They should be considered tentatively final with the potential for additional product requirements to be added in the future. Developers are instructed to modify the specifications to meet specific project needs and take full responsibility for the final products applicability, entire contents of the specification section, and for concordance with the other project documents. Areas shaded in gray have been identified as areas in need of further review or editing.

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. Furnish all labor, materials, equipment, and incidentals required to install paved roadway, parking areas, and guard, rails as shown on the Drawings and as specified herein.
- B. The work includes removal of existing pavement, preparation of existing paved surfaces and repaving of those surfaces as specified herein.
- C. All pavement markers and markings shown on the Drawings or that existed prior to construction shall be replaced with new markers and new markings.
- D. All work on South Carolina State Highways shall conform to South Carolina Department of Transportation (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.

1.2 RELATED WORK

- A. Trench Excavation, Bedding and Backfill is included in Section 02221.

1.3 SUBMITTALS

- A. Submit to the Owner/Engineer shop drawings showing dimensions, layouts, and details of construction, and accessories required.



- B. Copies of load tickets shall be submitted to the Engineer on a daily basis when paving work is performed.

1.4 REFERENCE STANDARDS

- A. Except as otherwise specified herein, the material and construction shall be in accordance with the current Standard Specifications for Highway Construction and relevant supplemental specifications as issued by the SCDOT.
- B. American Society for Testing and Materials (ASTM)
 - 1. ASTM A307 – Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 Psi Tensile Strength.
- C. American Association of State Highway and Transportation Officials (AASHTO)
 - 1. AASHTO M144 – Standard Specification for Calcium Chloride.
 - 2. AASHTO M180 – Standard Specification for Corrugated Sheet Steel Beams for Highway Guardrail.
- D. American Wood Preservers Association (AWPA)
 - 1. AWPA C1 – All Timber Products, Preservative Treatment by Pressure Process.
 - 2. AWPA C14 – Wood for Highway Construction, Preservative Treatment by Pressure Process.
 - 3. AWPA M4 – Standard for the Care of Preservative-Treated Wood Products.
 - 4. AWPA P5 – Standards for Waterborne Preservatives.
- E. Where reference is made to one of the above standards, the revision in effect at the time of Bid opening shall apply.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. **SURFACE COURSE:** The surface course shall be Type C, 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. Bituminous concrete binder course shall meet Section 402 of SCDOT standards.
- D. Calcium chloride shall meet AASHTO M-144 and shall be spread wherever directed to allay dust conditions. The Owner/Engineer may direct the Contractor to employ sprinkling of water in lieu of calcium chloride for dust control.
- E. Asphalt – Tack coat shall consist of either emulsified asphalt or cutback asphalt conforming to the above referenced SCDOT standards.
- F. Pavement marking paint shall be fast-drying type conforming to the above referenced SCDOT standards and Federal Specifications TT-P 1952B.
- G. 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

3.1 GENERAL

- A. Asphalt pavement materials specified shall be installed in accordance with the requirements of Section 401 of SCDOT Specifications.
- B. Concrete materials shall be installed in accordance with the SCDOT Specification Section 720.
- C. 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.
- D. 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.
- E. When required, remove existing pavement by saw, pneumatic hammer, or wheel, cutting edges of trenches to be repaved as directed by the Owner/Engineer. After pipe laying, backfilling, and compaction operations are completed satisfactorily, and after the gravel subbase is shaped and compacted, place the type of pavement as shown on the Drawings.
- F. Furnish and spread calcium chloride on or wet down disturbed surfaces to allay dust conditions as directed by the Owner/Engineer.
- G. All new and existing manhole frames, utility boxes, and drain inlets shall be set to the grade of the wearing course. At no time shall the manhole frames be allowed to protrude above the surface of the wearing course.
- H. The contact surfaces of castings, previously constructed asphalt or Portland cement concrete pavements shall be painted with a tack coat in accordance with SCDOT standards. Surfaces shall be thoroughly cleaned of all loose material and debris prior to application of the tack coat.



- I. Pavement replacement and other surfacing as specified herein will be a condition of progress payment applications.
- J. No vehicular traffic or loads shall be permitted on the newly completed pavement, until adequate stability has been attained and/or the material has cooled sufficiently to prevent distortion or loss of fines. If climatic or other conditions warrant it, the period of time before opening to traffic may be extended at the discretion of the Owner/Engineer.
- K. Contractor shall properly maintain the pavement cut until the patch is made and shall promptly fill ruts and depressions.
- L. Contractor shall maintain pavement under this Contract during the guarantee period of two year and shall promptly (within three days of notice given by Owner/Engineer) refill and repave areas which have settled or are otherwise unsatisfactory for traffic.

3.2 BITUMINOUS PAVING

- A. All pavement thicknesses referred to herein are compacted thicknesses. The Contractor shall place sufficient mix to ensure that the specified thickness of pavement occurs where called for.
- B. Where the trench patch crosses a SCDOT roadway, the roadway shall be resurfaced per SCDOT requirement. The limit of surface course shall be feathered into the existing pavement.
- C. 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.
- D. The binder course shall be placed as soon as possible after the aggregate base course has been prepared, shaped, and compacted.
- E. The binder course shall be placed and compacted by steel-wheeled rollers of sufficient weight to thoroughly compact the bituminous concrete. Where necessary, the new pavement shall be rolled smooth and even with the existing pavement.
- F. Hose clean all road surfaces after backfilling and before any surfacing but, in no case, shall pavement be placed until the gravel base is dry and compacted to at least 98-percent maximum density at optimum moisture content in accordance with the requirements of Section 02221.
- G. After the paving mixture has been properly spread, initial compaction shall be obtained by the use of power rollers weighing not less than 240 pounds per inch width of tread.
- H. 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.
- I. Final compaction of the surface shall be accomplished by rollers weighing not less than 285 pounds per inch width of tread. Along curbs, structures, and all places not accessible with a roller, the mixture shall be thoroughly compacted with tampers. Such tampers shall not weigh less than 25 pounds and shall have a tamping face of not more than 50 square inches. The



surface of the mixture after compaction shall be smooth and true to the established line and grade.

- J. When the air temperature falls below 50°F, extra precautions shall be taken in drying the aggregates, controlling the temperatures of the materials, and placing and compacting the mixtures.
- K. No mixtures shall be placed when the air temperature is below 40°F nor when the material on which the mixtures are to be placed contains frost or has a surface temperature the Owner/Engineer considers too low.

3.3 CONCRETE PAVING, CURB AND GUTTER

- A. The replacement of concrete pavements, and concrete curb and gutters shall meet all requirements of Section 720 of the SCDOT specifications.

3.4 CUTTING AND REPLACING SIDEWALK

- A. 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.
- B. Trench Backfill under sidewalk shall be as describe in Subgrade Preparation (3.01C) above.
- C. Base for sidewalk shall be minimum 4-inches compacted crusher run granite stone material.
- D. 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.

3.5 TRENCH PAVEMENT RESTORATION

- A. Restore trench pavement in County and State roads as shown on the Drawings.
- B. If points of settlement or holes appear in the pavement, the Contractor shall repair the same within three days of notification by the Owner/Engineer. If, after due notice, the Contractor fails to make the repairs, the work will be done by the Owner and the total cost of such repairs will be charged to the Contractor.

VERIFY THE NEED FOR THE FOLLOWING PARAGRAPH

3.6 GUARDRAILS

- A. Guardrails shall be installed at locations as shown on the Drawings and as detailed.



- B. Posts shall be set plumb in augered holes and backfilled with the specified material thoroughly tamped. Install uniform 4-inch layer of crushed stone at finish grade in areas shown on the Drawings.
- C. Guardrails shall be joined together as shown on the Drawings and securely bolted to all posts. Nut end of bolts shall be placed on the backside of the guardrail post and peened to prevent removal.
- D. Each post shall have a minimum of two carriage bolts installed as shown on the Drawings.
- E. Where guardrails meet and change direction, angle and provide two end posts—one post for each direction of rail. End posts shall not be further than three feet apart and rails shall not be further than four inches apart. Rails and post tops shall be constructed parallel with finish grade and generally appear as one continuous line without abrupt change in alignment.
- F. Where temporarily removing existing guardrails to perform the work, replace the guardrails to match existing.

VERIFY THE NEED FOR THE FOLLOWING PARAGRAPH

3.7 ROAD REFLECTIVE MARKERS

- A. Road markers shall be installed in accordance with the manufacturer's instructions.
- B. Road marker locations shall be spotted in the field and approved by the Owner/Engineer before installation.

3.8 ROADWAY MARKINGS

- A. Markings shall be located as shown on the Drawings or as existed prior to construction.
- B. All surface dirt within the areas to be painted shall be removed. Large areas of tar, grease, or foreign materials may require sand blasting, steam cleaning, or power brooming to accomplish complete removal. Application of stripes shall not proceed until final authorization is received from the Owner/Engineer.
- C. No thinners shall be used for the pavement marking applications, except in accordance with the manufacturer's specifications and at the direction of the Owner/ Engineer.
- D. No paint or pavement marking material shall be heated above the temperature marked on the container.
- E. Bituminous concrete pavements shall have been in place for 48 hours prior to the application of pavement markings.
- F. If for any reason, material is spilled or tracked on the pavement; or if any markings applied, in the Owner/Engineer's judgement, fail to conform because of a deviation from the desired pattern, the Contractor shall remove such material by a method that is not injurious to the roadway surface



and is acceptable to the Owner/ Engineer. Contractor shall clean the roadway surface and prepare the surface for a reapplication of markings, and reapply the markings as directed without additional compensation.

END OF SECTION 02575



SECTION 02730 - SANITARY SEWER SYSTEMS

The following specifications have been created as go-by specifications for Developers working inside the Metropolitan Sewer Subdistrict jurisdiction. They should be considered tentatively final with the potential for additional product requirements to be added in the future. Developers are instructed to modify the specifications to meet specific project needs and take full responsibility for the final products applicability, entire contents of the specification section, and for concordance with the other project documents. Areas shaded in gray have been identified as areas in need of further review or editing.

PART 1 - GENERAL

1.1 SCOPE:

- A. 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.

1.2 RELATED WORK

- A. Section 02221 Trench Excavation, Bedding and Backfill
- B. Section 02300 Auger Boring
- C. Section 02731 Ductile Iron Sewer Pipe (DIP)
- D. Section 02732 Polyvinyl Chloride (PVC) Sewer Pipe

1.3 OTHER REQUIREMENTS

- A. All pipe elevations shown on the Drawings are invert elevations (i.e., the bottom inside of pipe), unless otherwise shown.

1.4 SUBMITTALS

- A. Submit material certifications and product data for all pipe, couplings and fittings demonstrating conformance to specifications.

1.5 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 regulations.
2. All requirements of the sewer service agency that will own, operate and maintain this sewer.

1.6 REFERENCE STANDARDS:

- A. ASTM A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
- B. ASTM A126 – Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
- C. ASTM A139 - Standard Specification for Electric-Fusion (Arc)-Welded Steel Pipe (NPS 4 and Over).
- D. ASTM C425 – Standard Specification for Compression Joints for Vitrified Clay Pipe and Fittings.
- E. ASTM C923 – Standard Specification for Resilient Connectors between Reinforced Concrete Manhole Structures, Pipes and Laterals.
- F. ASTM D3034 – Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
- G. AWWA C200 – Standard for Steel Water Pipe 6 Inch (150 mm) & Larger.
- H. AWWA C900 – Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 in. through 60 in.

PART 2 - PRODUCTS

2.1 COUPLINGS:

- A. 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.
- B. Provide couplings per approved materials list.
- C. Coupling to connect steel pipe shall be steel per approved materials list to suit the piping to be connected.

2.2 PIERS AND PROTECTION WORK:

- A. 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.



- B. Concrete Piers: Foundation for piers shall be adequate to support intended load and will be subject to Engineer's approval prior to pouring concrete.
- C. Protection Concrete shall be provided in locations as shown on plans or directed by Engineer.
- D. 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.

2.3 PRECAST CONCRETE MANHOLES

- A. 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".
- B. 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.

2.4 FOUNDATION MATERIAL

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

2.5 FLEXIBLE PIPE CONNECTORS

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

2.6 CAST-IN-PLACE-CONCRETE

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

2.7 MANHOLE STEPS

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

2.8 MANHOLE RINGS AND COVERS

- A. 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 in the Standard Detail.

- B. 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 in the Standard Detail.

2.9 MORTAR

- A. 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.
- B. 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.
- C. Water used in mixing mortar shall be clean and free of deleterious amounts of acid, oil, alkalies or organic materials. Mortar shall not be allowed to stand for longer than one hour after water is added.

2.10 TRACER WIRE

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

PART 3 - EXECUTION

3.1 GENERAL

- A. 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.
- B. Any pipe, in the Owner/Engineer's opinion, which is not in true alignment or shows settlement after laying, or is damaged, shall be removed and re-laid at no additional cost to the Owner.



- C. 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.
- D. 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.
- E. 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.

3.2 PIPE INSTALLATION

- A. 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.
- B. 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.
- C. Pipe shall be laid with beginning at the bottom of the slope and proceed upward with the bell ends of the new pipe upslope. The spigot end shall be installed into the bell end until the reference point on the pipe.
- D. Pipe joints shall be made up in strict accordance with the manufacturer's directions.

3.3 INSTALLATION OF PIPE REPAIR COUPLINGS

- A. 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.
- B. All repair couplings shall be examined before installation and none shall be installed which are found to be defective.
- C. Installation of flexible couplings shall be in accordance with manufacturer's instructions and as specified herein.



- D. 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 Owner/Engineer to repair all damages, in which case the repair work shall be performed at his own expense.
- E. Flexible sleeve type couplings shall be installed for connecting new replacement pipe and fittings to existing sewer pipe made of any pipe material.
- F. 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.
- G. 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.

3.4 MANHOLE INSTALLATION

- A. 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.
- B. 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.
- C. Rings and covers shall be installed per the Standard Details. 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. Metal grade rings are not acceptable. Use only Owner approved grade rings.
- D. Steps shall be vertically aligned at the spacing indicated, but in no case more than 16 inches on center.
- E. Pipe shall be placed in openings provided in the base section and properly aligned and set to grade.
- F. 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.



- G. 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 two-tenths of a drop per manhole. 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.
- H. Fill in all chips or holes greater than 1/2" in depth with mortar to provide a final finish.
- I. Where visible leakage occurs through the structure walls, the Contractor shall immediately notify the Owner and the Engineer. The Contractor shall provide all requisite information to the Owner and Engineer to help determine the cause of the leak, location of the leak fix (internal or external) and shall address the leak as directed by the Owner.

3.5 CLEANING

- A. 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.

3.6 INSPECTION AND TESTING

- A. 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.
- B. 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 in accordance with ASTM F1417 Time-Pressure drop method and as outlined below.
 - 1. 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.
 - 2. 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.
 - 3. 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 if directed by the Owner/Engineer.



4. Plug all openings in test section.
 5. Pressurize the section gradually to a minimum of 4.0 psi (maximum of 9.0 psi) and allow pressure to stabilize (maintain the minimum pressure for a minimum of 5 minutes). Do not over-pressurize the section. No one will be allowed in the manhole during testing.
 6. Once the pressure has stabilized, 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).
 7. If the pressure drops more than 1.0 psi within this time, then the section has failed.
- C. 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.
- D. 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:

1. 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.
2. Install the vacuum tester head assembly at the top access of manhole.
3. Evacuate the manhole to 10" Hg. (approximately negative 5 psig, 0.3 bar).
4. 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 for manhole depth of 24 ft and less* (sec.)
48	60
60	75
72	90
84	105
96	120
120	150

*- for manhole depths above 24 feet, test times as recommended by ASTM C1244 shall be used.

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



3.7 CLEAN UP

- A. 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.
- B. 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



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SECTION 02731 - DUCTILE IRON SEWER PIPE

The following specifications have been created as go-by specifications for Developers working inside the Metropolitan Sewer Subdistrict jurisdiction. They should be considered tentatively final with the potential for additional product requirements to be added in the future. Developers are instructed to modify the specifications to meet specific project needs and take full responsibility for the final products applicability, entire contents of the specification section, and for concordance with the other project documents. Areas shaded in gray have been identified as areas in need of further review or editing.

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

1.2 REFERENCE STANDARDS

- A. American National Standard Institute (ANSI) and American Water Works Association (AWWA):
 - 1. ANSI B18.2.2 Nuts for General Applications Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts
 - 2. AWWA C105/A21.5 American National Standard for Polyethylene Encasement for Ductile-Iron Pipe.
 - 3. AWWA C110/A21.10 Ductile Iron and Gray Iron Fittings.
 - 4. ANSI/AWWA C111/A21.11 Rubber Gasket Joints for Ductile Iron and Gray Iron Pressure Pipe and Fittings.
 - 5. ANSI/AWWA C151/A21.51 Ductile Iron Pipe, Centrifugally Cast.
 - 6. AWWA C600 Installation of Ductile Iron Water Mains and Their Appurtenances.
 - 7. AWWA C210 Liquid-Epoxy Coatings and Linings For Steel Water Pipe and Fittings.
- B. American Society for Testing and Materials (ASTM):
 - 1. ASTM A307 – Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 psi Tensile Strength
 - 2. ASTM A746 – Standard Specification for Ductile Iron Gravity Sewer Pipe
 - 3. ASTM D1330 – Standard Specification for Rubber Sheet Gaskets
- C. The Society for Protective Coatings Paint Application
 - 1. SSPC-PA-2 Procedure for Determining Conformance to Dry Coating Thickness Requirements



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 shall be 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 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 trademark.
 - 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 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 tees or 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. Fittings for piping 6-inches and above shall be mechanical joint (MJ), domestic manufacture with interior lining as specified in paragraph 2.1.F. 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 Section 02732.
- 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.
 1. 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.
 2. 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.

NOTE: Verify if polyethylene encasement is required in corrosive soils and if so include the following, if not delete paragraphs I through K. In most cases, use paragraph H.

- I. If required and noted per plans, polyethylene encasement for use with ductile iron pipe shall be V-Bio and meet all the requirements for ANSI/AWWA C105/A21.5, Polyethylene Encasement for Ductile Iron Pipe Systems. Polyethylene encasement for use with ductile iron pipe systems



shall consist of three layers of co-extruded linear low-density polyethylene (LLDPE), fused into a single thickness of not less than eight mils.

- J. The inside surface of the polyethylene wrap to be in contact with the pipe exterior shall be infused with a blend of anti-microbial biocide to mitigate microbiologically influenced corrosion and a volatile corrosion inhibitor to control galvanic corrosion. Ductile iron pipe and the polyethylene encasement used to protect it shall be installed in accordance with AWWA C600 and ANSI/AWWA C105/A21.5 and also in accordance with all recommendations and practices of the AWWA M41, Manual of Water Supply Practices.
- K. Where required, buried pipe shall be installed with polyethylene encasement. V-Bio polyethylene encasement shall have a minimum thickness of 8 mils and meet or exceed the minimum standards established by AWWA C105, current edition.
 - 1. Polyethylene encasement shall meet minimum size requirements per TABLE 3 of section 2.15 of DIPRA's Installation Guide for Ductile Iron Pipe.
 - 2. Test results from an independent testing agency certifying that the V-Bio polyethylene encasement meets all criteria established by AWWA C105, current edition, shall be submitted to the Owner/Engineer prior to approval of the polyethylene encasement for use. In general, samples shall be submitted and include test results in accordance with the AWWA standard associated with tensile strength, elongation, dielectric strength, impact resistance, and propagation tear resistance.
 - 3. A 2-inch wide plastic adhesive tape, such as Calpico Vinyl, Polyken, U.P.C. Tape, or approved equal, shall be used for sealing seams, cuts, or tears in polyethylene encasement. Duct tape shall not be allowed.
- L. 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

- A. 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. If there is conflict, the manufacturer's instructions shall take precedence.



- B. Pipe shall be laid with beginning at the bottom of the slope and proceed upward with the bell ends of the new pipe upslope. The plain end shall be installed into the bell end until the reference point on the pipe.
- C. The joint surfaces shall be cleaned and lubricated and the plain end of the pipe shall be aligned with the bell of the pipe to which it is to be joined and pushed home. After joining the pipe, a metal feeler shall be used to make certain that the rubber gasket is properly seated.

NOTE: Delete Paragraph D in its entirety where polyethylene encasement is not required.

- D. Install V-Bio polyethylene encasement around ductile iron pipe in accordance with pipe manufacturer's recommendations.
 - 1. Polyethylene encasement shall be installed per ANSI/ AWWA C105/A21.5, Method 'A' in accordance with section 2.15 of DIPRA's Installation Guide for Ductile Iron Pipe.
 - 2. A fabric type or padded sling shall be used when handling polyethylene encased pipe to prevent damage to the polyethylene encasement.
 - 3. All seams in the polyethylene encasement shall be sealed completely with approved 2-inch wide plastic adhesive tape.
 - 4. Extreme care shall be taken to ensure that all rips or tears in the polyethylene encasement are properly repaired with additional tape and film as described in ANSI/AWWA C105/A21.5
 - 5. Extreme care shall be taken when backfilling to avoid damaging the polyethylene encasement
- E. Bedding shall be as shown on the detail drawings for gravity sewer.

END OF SECTION 02731



SECTION 02732 - POLYVINYL CHLORIDE SEWER PIPE

The following specifications have been created as go-by specifications for Developers working inside the Metropolitan Sewer Subdistrict jurisdiction. They should be considered tentatively final with the potential for additional product requirements to be added in the future. Developers are instructed to modify the specifications to meet specific project needs and take full responsibility for the final products applicability, entire contents of the specification section, and for concordance with the other project documents. Areas shaded in gray have been identified as areas in need of further review or editing.

NOTE: Schedule 80 pressure PVC pipe is not included in this section. Also perforated PVC pipe is not included.

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 11, 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 – Standard Classification System and Basis for Specification for 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 D2321 – Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
 - 5. ASTM D3034 – Standard Specification for Type PSM PVC Sewer Pipe and Fittings.



6. ASTM D3139 – Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
7. ASTM D3212 – Standard Specifications for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
8. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
9. ASTM F679 - Standard Specification for Polyvinyl Chloride (PVC) Large Diameter Plastic Gravity Sewer Pipe and Fittings.
10. 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 60 In. (100 mm Through 1,500 mm).

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:

Pipe Size	ASTM (latest edition)
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.

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", 12", 14" and 16" 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:
1. 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

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

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 the Standard Details.

3.3 WYE BRANCES, CLEANOUTS AND STUBS

- A. New service lateral wye branches shall be furnished and installed and capped as shown on the Drawings or in locations directed by the Owner/Engineer. Each wye branch shall be provided with a PVC end cap and a marker post installed in the vicinity to locate the buried service lateral end.
- B. PVC cleanouts shall be installed according to the detail on the Drawings at locations to be determined by the Owner/Engineer.
- C. Ample time shall be given to the Owner/Engineer to obtain the exact location of each wye branch and chimney before it is covered. Wye branches and chimneys, which are covered before the Owner/Engineer has had time to obtain their location, shall be exposed at no additional cost so that location measurements can be taken.
- D. PVC manhole drops shall be installed as shown on the Drawings.

END OF SECTION 02732



SECTION 02733 - SANITARY SEWER SERVICE CONNECTIONS

The following specifications have been created as go-by specifications for Developers working inside the Metropolitan Sewer Subdistrict jurisdiction. They should be considered tentatively final with the potential for additional product requirements to be added in the future. Developers are instructed to modify the specifications to meet specific project needs and take full responsibility for the final products applicability, entire contents of the specification section, and for concordance with the other project documents. Areas shaded in gray have been identified as areas in need of further review or editing.

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 Systems
 - 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

- A. 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.

3.2 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



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SECTION 02768 - MANHOLE LINING

The following specifications have been created as go-by specifications for Developers working inside the Metropolitan Sewer Subdistrict jurisdiction. They should be considered tentatively final with the potential for additional product requirements to be added in the future. Developers are instructed to modify the specifications to meet specific project needs and take full responsibility for the final products applicability, entire contents of the specification section, and for concordance with the other project documents. Areas shaded in gray have been identified as areas in need of further review or editing.

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.
- B. Where indicated in the drawings or as directed by the Owner/Engineer, work may require patching and filling cracks and spalls in manhole walls, benches, chimneys and inverts; stopping infiltration with chemical or cementitious grout; rebuilding brickwork in inverts, walls, and benching; resetting or replacing manhole frame and cover assemblies; installing chimney seals; installing new drop assemblies; coating manhole inverts; installing a cementitious or epoxy monolithic coating to the entire manhole; and adjusting elevation of manhole frames and covers.
- C. 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.
- D. The manhole lining shall not be installed until all main sewer, service lateral, and manhole work is complete.
- E. 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. [ENGINEER TO SPECIFY REHABILITATION REQUIREMENTS.]

1.2 SUBMITTALS

- A. Identify the staging area for deployment of manhole repair equipment for each work area.
- B. Submit to the Owner/Engineer, in accordance with the contract documents, shop drawings and product data for all manhole rehabilitation materials specified in this Section for each manhole to be rehabilitated. [ENGINEER TO SPECIFY SUBMITTAL REQUIREMENTS AND TIMEFRAME.]



- C. Submit a traffic control plan which includes the following items: [ENGINEER TO ADD SPECIFIC SUBMITTAL REQUIREMENTS, BASED ON PROJECT NEEDS AND PERMIT REQUIREMENTS.]
- D. Contractor to complete an Owner monthly work-summary sheet by Asset ID electronically in Excel format documenting what was completed that month for each asset. This shall be submitted on a monthly basis along with the pay application. A copy of the template will be provided upon request.
- E. Material type and manufacturer to be used including: catalog data sheets, ASTM references, material composition, manufacturers recommended specifications, component physical properties and chemical resistance.
- F. 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.
- G. 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.
- H. 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.
- I. Manufacturer's detailed description of all required field testing processes and procedures.
- J. 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.
- K. 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.
- L. 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.
- M. All shipping, storage and safety requirements including Safety Data Sheet documents.
- N. 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.
- O. Submittal of all quality assurance documentation and test reports for materials installed.
- P. Written statement indicating compliance with the 2-year guarantee for all manhole work as required herein.



1.3 REFERENCE STANDARDS

- A. American Society for Testing and Materials (ASTM)
- B. ASTM C39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
- C. ASTM C109 - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars
- D. ASTM C293 - Standard Test Method for Flexural Strength of Concrete (Using Simple Beam With Center-Point Loading)
- E. ASTM C321 - Standard Test Method for Bond Strength of Chemical-Resistant Mortars
- F. ASTM C496 - Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens
- G. ASTM C596 - Standard Test Method for Drying Shrinkage of Mortar Containing Portland Cement
- H. ASTM C666 - Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing
- I. ASTM C1244 - Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test
- J. ASTM D638 – Standard Test Method for Tensile Properties of Plastics
- K. ASTM D695 – Standard Test Method for Compressive Strength of Rigid Plastics
- L. ASTM D790 – Standard Test Method for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
- M. ASTM D2240 – Standard Test Method for Rubber Property – Durometer Hardness
- N. ASTM D4414 – Standard Practice for Measurement of Wet Film Thickness by Notch Gages
- O. ASTM D4541 – Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
- P. ASTM F2551 – Standard Practice for Installing a Protective Cementitious Liner System in Sanitary Sewer Manholes
- Q. NACE - The published standards of National Association of Corrosion Engineers (NACE International), Houston, TX.
- R. NACE RPO 188-99 Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates



- S. Where reference is made to one of the above standards, the revision in effect at the time of the pre-construction meeting shall apply.

1.4 QUALIFICATIONS

- A. The installer 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 installer 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.
- B. The Contractor shall have 5 years of experience in performing this type of specialized work and in installing the specified lining system.
- C. The Contractor shall also be capable of providing crews as needed to complete this work without delay.
- D. The Contractor shall submit the name of the manufacturer and supplier for this work and previous work listed below.
- E. The Contractor shall submit a list of municipal clients that the installer has performed this type of work including contact names, phone numbers, and number of manholes.
- F. The Contractor shall submit a certified statement from the manufacturer that he/she is a certified and/or licensed installer of the liner.
- G. The Owner reserves the right to approve or disapprove the Contractor/Installer, based on the submitted qualifications.

1.5 NOTIFICATIONS

- A. Notify the Owner and Engineer:
 - 1. On a weekly basis of scheduled work for the upcoming week, including a map showing the area of work and a list of streets being affected. Submittal shall be provided by electronic mail and a map and list of fire hydrants that will be utilized for a water source, in PDF format. Provide 24-hour notice for deviations from the plan that are not caused by weather or natural causes.
 - 2. Immediately, when a collapsed pipe or other pipe failure is identified.
 - 3. Immediately, if the conditions for the work described are found to be unsafe or impractical.
 - 4. Immediately, if a manhole is buried, cannot be found or cannot be accessed. Along with the manhole identification number, provide a map (in PDF format) showing the location of the manhole and what procedures were used to attempt to locate the manhole.



5. Immediately of any defects posing imminent danger to the public (missing lids, covers broken during inspection, sink holes, etc.) and any observed pipe blockages, surcharging, or potential overflow conditions.
6. If the pipe configuration in the field is different than shown or if a new asset found, the notification shall include a diagram clearly indicating the location of structures in relation to immediately adjacent structures in PDF format via electronic mail.
7. If any obstructions are found within the easement, even if not impacting work.

B. Notify the public and coordinate with homeowners:

1. Contractor shall prepare and install yard signs to notify customers in the area of work being conducted and who to contact for information. The Owner-approved Water yard sign file will be provided by the Owner. This file is the standard sign layout to be filled in with project specific information. (Sign specs: digital print full color two-sided coroplast 4mm 18"x24" & metal step stakes 30"x10").
 - a. **# of signs anticipated**
 - b. Signs shall be placed in key intersections and at the project site, incoming/outgoing roads to the area/neighborhood, and intersections near the site at start of project.
 - c. Signs shall be placed in yards a minimum of 7 days prior to work but no more than 14 days ahead of scheduled work.
 - d. Signs shall be displayed throughout scheduled work and will be replaced if removed or damaged.
 - e. Signs shall be removed at the conclusion of the project.
2. A minimum of 72 hours prior to the inspection or work on any manhole, cleanout, service lateral, or line segment, distribute door-to-door an Owner approved Homeowner Notification door hanger describing the work to be performed, if work is performed or accessed through private property or easement adjacent to property, or if the property is potentially tied to the section of line being inspected or worked on. On the day of work and prior to beginning the work, knock on the doors of all properties that will require entering their private property to access the manholes, cleanouts, or pipes which will potentially be impacted by the work and notify occupants of the work to be performed.
3. Contractor shall use approved magnetic car signs affixed to vehicles at all times during the project to identify affiliation with the Owner.
4. Contractor responsible for determining route of access for the proposed work, unless specified otherwise, and is responsible for coordinating with the Property Owner to obtain any temporary access to perform the work. Contractor shall provide copies of temporary access/easement agreements made with Property Owners. Clearing and other costs related to gaining access (including restoration) should be included in Contractor's pricing.
5. Contractor to notify Property Owner of any trees or other obstructions within easements that need to be moved to access or perform the work. The Property Owner shall be given a minimum of 7 days to relocate the obstruction off of the easement at their own cost to their own chosen location. After this time period, the Contractor shall be responsible for removing and disposing of the obstruction, and all costs associated with this. Contractor to coordinate with the Engineer on each obstruction found before proceeding.



1.6 GUARANTEE

- A. All monolithic cementitious lining installed shall be guaranteed by the Contractor for a period of two years from the date of final payment. During this period, all defects discovered in the monolithic lining, as determined by the Owner, 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 minimum period of five years from the date of final payment. During this period, all defects discovered in the monolithic lining, as determined by the Owner, 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. Installer shall utilize equipment for the spray application of the coating product(s) which has been approved by the coating product manufacturer; and, shall have received training on the operation and maintenance of said equipment from the coating product manufacturer.
- D. Installer 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.
- F. Inspections of the lining products and materials may also be made by any representative of the Owner. 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. Installer 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. Installer shall provide appropriate guidance on inspecting coating application prior to construction.



- H. Installer 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 Owner.
- 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 safety data sheets (SDS).
- 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 to perform the specified work.

PART 2 - PRODUCTS

2.1 MATERIALS TO STOP ACTIVE LEAKS

- A. All active leaks in manholes to be rehabilitated shall be stopped prior to performing the rehabilitation. Elimination of active leaks shall be paid for in related other bid items, no separate payment shall be made.
- B. To stop active leaks in the manhole, the Contractor must use one or more of the following materials and procedures to stop the active leaks prior to completing the rehabilitation.
 - 1. Premixed Fast-Setting, Volume-Stable Waterproof Cement Plug - This material shall consist of hydraulic cement, graded silica aggregates, special plasticizing and accelerating agents. It shall not contain chlorides, gypsums, plasters, iron particles, aluminum powder or gas-forming agents, or promote the corrosion of steel it may come in contact with. The cement plug should have the following minimum requirements:

Minimum Requirements



Compressive Strength	ASTM C109	>1000 psi, 1hr. >2500 psi, 24 hrs.
Sulfate Resistance	ASTM C267	No weight loss after 15 cycles @ 2000 ppm
Freeze/Thaw	ASTM C666 "Method A"	100 cycles
Pull Out Strength	ASTM C234	14,000 lbs.
Set Time		<5.0 minutes

2. Chemical Grout - Repair work shall be in accordance with ASTM F 2414, and manufacturers recommended installation methods. Use in accordance with the manufacturer's recommendations for the specific application. The grout shall be of a formula that is suitable for application in a manhole that is susceptible to frost, if applicable for the regional climate.
 - a. Drilling and injection method shall use a hydrophilic polyurethane chemical grout manufactured by Avanti or equal unless otherwise approved by the Owner/Engineer.
 - b. Exterior chemical curtain grouting method shall use a hydrophobic polyurethane chemical grout manufactured by Avanti or equal unless otherwise approved by the Owner/Engineer.
 - c. Expanded Gasket Procedure shall use Oil Free Oakum with hydrophilic polyurethane chemical grout manufactured by Avanti or equal used for sealing larger cracks and manhole joints, unless otherwise approved by the Owner/Engineer.
3. Obtain approval from Owner/Engineer for materials to stop active leaks before starting the Field Work.
4. Obtain approval from Owner/Engineer for application equipment prior to starting the Field Work.

2.2 PATCHING, FILLING AND REPAIRING CRACKS AND SPALLS IN CONCRETE AND MASONRY MANHOLES

- A. A quick-setting cementitious material shall be used as a patching material and is to be mixed and applied according to manufacturer's recommendations and shall have the following minimum requirements:

Physical Properties		
Compressive Strength	ASTM C109	>1800 psi, 1 hr. >2600 psi, 24hr. >3000 psi, 28 days
Bond	ASTM C882	>1600 psi, 28 days
Applied Density		105 lbs. pcf \pm 5 lbs.
Shrinkage	ASTM C596	0% at 90% R.H.
Placement Time		5 to 10 minutes



Set Time		15 to 30 minutes
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- B. The material used to mix product shall be clean and potable. No material (other than water) shall be used with or added to the patching product without prior approval or recommendation from manufacturer.

2.3 COATINGS FOR INVERTS

- A. A quick-setting material shall be used to coat the inverts of manholes as indicated on the Drawings. The coating shall be mixed and applied according to manufacturer's recommendations and shall have the following minimum requirements:

Physical Properties		
Compressive Strength	ASTM C109	>1800 psi, 1 hr. >2600 psi, 24hr. >3000 psi, 28 days
Bond	ASTM C882	>1600 psi, 28 days
Applied Density		105 lbs. pcf \pm 5 lbs.
Shrinkage	ASTM C596	0% at 90% R.H.
Placement Time		5 to 10 minutes
Set Time		15 to 30 minutes

- B. Water used to mix product shall be clean and potable. Potable water need not be tested. No material (other than water) shall be used with or added to the patching product without prior approval or recommendation from manufacturer.

2.4 INTERIOR FLEXIBLE CHIMNEY SEALS

- A. Interior flexible chimney seals shall prevent leakage of water into the manhole through the frame joint area and the area above the manhole cone including all extensions to the chimney area. The seal shall remain flexible allowing for repeated vertical or horizontal movements of the frame due to frost lift, ground movement, or the thermal movement of pavement.

1. Urethane Liner **DELETE IF ONLY RUBBER SLEEVES ARE TO BE USED**

- a. The final liner material shall be made no less than 170 mils of corrosion resistant flexible urethane resin coating to be applied to the inside wall of the entire chimney area.



- b. The product shall have a minimum elongation of 800% and a Durometer hardness of 75. Final liner shall have a minimum tensile and adhesion strengths of 1150 psi and 175 lb. l/in. respectively.
 - c. The manhole sealant shall conform to the physical requirements of ASTM D412 Standard Test Methods for Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers-Tension.
 - d. Sealant shall equal or exceed Sherwin Williams Envirolastic AR 530 or “Flex-Seal” as manufactured by Sealing Systems, Inc., Loretto, MN.
- 2. Flexible Internal Rubber Sleeve **DELETE IF ONLY URETHANE LINERS ARE TO BE USED**
 - a. The flexible rubber sleeve shall be extruded or molded from a high-grade rubber conforming to the applicable material requirements of ASTM C923, with a minimum 1500 psi tensile strength, a maximum 18% compression set and a hardness (durometer) of 48±5.
 - b. The sleeve shall have a minimum thickness of 0.130 inches and a range of coverage which allows a span of up to 24 vertical inches of chimney without the use of an extension. The area of the seal that compresses against the manhole frame casting and the chimney/cone shall have a series of sealing fins to facilitate a watertight seal.
 - c. Any splice used to fabricate the sleeve shall be hot vulcanized and have a strength such that the sleeve shall withstand a 180-degree bend with no visible separation.
 - d. The expansion bands used to compress the sleeve against the manhole shall be integrally formed from 16-gauge stainless steel conforming to the applicable material requirements of ASTM C923, Type 304, with no welded attachments and shall have a minimum width of 1-3/4 inches.
 - e. The bands shall have a minimum adjustment range of 2-1/2 diameter inches and the mechanism used to expand the band shall have the capacity to develop the pressures necessary to make a watertight seal. The band shall be permanently held in place with a positive locking mechanism which secures the band in its expanded position after tightening.
 - f. Rubber sleeve shall be manufactured by Cretex Specialty Products or approved equal.

2.5 BRICKWORK AND MASONRY FOR REPAIRING AND REBUILDING INVERTS, BENCHES, WALLS, AND CHIMNEYS IN EXISTING MANHOLES

- A. Bricks shall be sound, hard, uniformly burned, regular and uniform in shape and size. Underburned or salmon brick shall not be acceptable. Only whole brick shall be used.
- B. Bricks for channels and shelves shall conform to ASTM C32, Grade SS except that the mean of five tests for absorption shall not exceed 8 percent and no individual brick exceed 11 percent.
- C. Mortar shall be composed of 1 part Portland cement, 2 parts sand, and hydrated lime not to exceed 10-lbs to each bag of cement. Portland cement shall be ASTM C150, Type II; hydrated lime shall conform to ASTM C207.



- D. Sand shall be washed, cleaned, screened, well graded with all particles passing a No. 4 sieve and conform to ASTM C33.

2.6 RAISING MANHOLE FRAMES TO FINISHED GRADE

- A. Grade adjustment rings shall be manufactured using a high compression molding process to produce a finished density of 120 g/l ((7.5 pcf).
- B. Grade adjustment rings may contain either an upper and lower keyway (tongue and groove) for vertical alignment and/or an adhesive trench on the underside with a flat top.
- C. “Finish” or “Flat” rings may either have a keyway (groove) on the underside for vertical alignment and/or an adhesive trench with a flat upper surface. These rings shall be available in heights (thicknesses) which will allow final adjustment of the frame and cover or grate to within ¼” (one quarter inch) to ½” (one half inch) of the specified final elevation.
- D. “Finish” rings may also have a keyway on the upper surface of the inner diameter to facilitate installation of an “Angle” ring.
- E. “Angle” rings may either have an upper and lower keyway (tongue and groove) for vertical alignment and/or an adhesive trench on the underside. When required, the “Angle” ring or rings shall allow final adjustment of the frame and cover or grate to within ¼” (one quarter inch) to ½” (one half inch) of the specified final elevation.
- F. Grade adjustment rings shall be manufactured by Cretex Specialty Products or approval equal.

2.7 MANHOLE FRAME AND COVERS

- A. Manhole frames and covers shall be of good quality, strong, tough, even grained cast iron smooth, free from scale, lumps, blisters, sand holes and defects of any kind that render them unfit for the service for which they are intended. Manhole frame and cover seats shall be machined to a true surface. Castings shall be thoroughly cleaned and subject to hammer inspection. Manhole frames and covers shall be Owner approved standard as specified in Section 02730.

NOTE Design Engineer to identify appropriate Manhole Lining for each Manhole in the project.

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

2.8 MANHOLE MONOLITHIC LINING SYSTEMS

- A. The monolithic manhole lining system shall be designed and installed to protect concrete, brick, mortar, and other manhole surfaces from corrosion. The products shall be designed to stop infiltration, root intrusion, and further deterioration in the manhole. The interior surfaces to be



protected shall include the walls, benches, inverts, pipe junctions and the chimney (corbel). The table below outlines the different monolithic manhole lining systems and the respective product specification paragraph(s) for each lining system. The pH limits listed below are typical and the type of manhole lining used shall be as shown on the drawings or as directed by the Owner/Engineer.

B. CONDITION A: CEMENTITIOUS MANHOLE LINING - WALLS AND BENCHES

1. 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. Strong Seal MS-2A, MS-2C, or High Performance by Strong Seal Systems
 - b. QM-1s Restore or Aluminaliner by Quadex
 - c. Cemtec Silatec MSM or CAM by A.W. Cook Cement
 - d. Sewpercoat PG by Kerneos, Inc.
 - e. Permacast MS-10,000 or CR-9000 by Action Products Marketing Corp.
 - f. PerpetuCrete MSC or CA by Protective Liner Systems
 - g. Mainstay ML-72, ML-CA or ML-PF by Madewell
 - h. Reliner MSP or Maximum CA Cement by Standard Cement Materials
 - i. High Performance by Strong Seal Systems
 - j. Aluminaliner PF by Quadex
 - k. Sewpercoat PG by Kerneos, Inc.
 - l. Mainstay ML-PF by Madewell
 - m. Cemtec HITECH 100 by A.W. Cook Cement
 - n. Maximum CA Plus Cement by Standard Cement Materials
2. The cementitious lining shall be self-forming and shall be applied to cover all interior 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 inch. The cured surfacing thickness shall be smooth and continuous with proper sealing connections to all unsurfaced areas.
3. 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.
4. 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
Freeze/Thaw Resistance	ASTM C666	100 cycles with no visible damage.

5. The cementitious lining shall provide a minimum service life of 25 years.



6. 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.
7. 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.
8. 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.
9. 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.
10. The lining shall be compatible with the thermal condition of the existing sewer manhole surfaces. Surface temperatures will range from 20oF to 100oF. Provide test data on shrinkage of the cementitious lining based on ASTM C596.

C. CONDITION A: CEMENTITIOUS MANHOLE LINING - INVERT CHANNEL COATING

1. All invert channels shall be coated with cementitious mortar.
2. 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.

D. CONDITION B: EPOXY MANHOLE LINING

1. 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 proven experience in the production of the lining products utilized and shall have satisfactory installation record.
2. The materials shall be applied by an approved certified applicator and must meet the manufacturer's recommendations.
3. Equipment for installation of lining materials shall be high quality grade as deemed by the Owner and be as recommended by the manufacturer.
4. 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

E. External Coating:

1. Whenever the outside of exposed manholes walls are specified to be coated with a special exterior cementitious mortar product, the exterior mortar shall be HB2 Repair Mortar by ThoRoc, SikaTop 123 by Sika Corporation, or approved equal. The existing surface shall be completely cleaned and all loose material removed prior to applying the cementitious material. Installation shall be in strict accordance with the manufacturer's recommendations including utilizing any required bonding agents and providing proper curing conditions. The installed thickness shall be at least 2 inches, troweled smooth after application.

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 Owner 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 Owner 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 Installer shall furnish and place cementitious lining in each manhole as shown on the Drawings and where directed by the Owner. 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. Epoxy liners shall be installed on newly installed cementitious liner. Epoxy lining shall be applied only after the cementitious liner has fully set.
- B. The corrosion resistant barrier shall be spray applied as per the manufacturer's recommendation and shall have an average minimum finished thickness of 100 mils when applied in conjunction with cementitious liner.
- C. The Contractor shall 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 Owner's evaluation of the proper surfacing of the manhole per field inspections. Acceptance shall also be based on the Owner'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. If the thickness of the cementitious lining is not uniform or is less than specified, it shall be repaired or replaced.
 - 2. Epoxy Liner Thickness Measurement: During application of corrosion resistant liner, a wet film thickness gauge, meeting ASTM D4414, shall be provided by the Contractor. Measurements shall be taken, documented and attested by the Contractor for submission to the Owner. Additional measurements may be made by the Owner.



- C. The Owner 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 Owner 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 upon approval by the Owner.
- 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, selected by the Contractor for compression strength testing as described in ASTM C-109.
 - 1. Cementitious Liner: There shall be no cracks, voids, pinholes, uncured spots, dry spots, lifts, de-laminations or other type defects in the cementitious lining.
 - 2. Holiday Testing of Epoxy Liner: 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.
 - a. 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.
 - b. 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.
 - c. 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.
 - d. 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:
 - 1. Owner Name
 - 2. Project Location
 - 3. Cleaning Date
 - 4. Rehabilitation Date
 - 5. Superintendent's Name
 - 6. Rehabilitation Weather Conditions



7. Manhole Number
8. Manhole Location
9. Manhole Diameter
10. Manhole Height
11. Manhole Substrate Material (i.e., brick, block, pre-cast concrete, etc.)
12. Liner Thickness Applied
13. Type and Amount of Patching Material Used
14. Type of Liner Used
15. Number of Bags/Tubs of Cementitious Liner Used
16. Gallons of Epoxy Applied
17. Steps Removed?
18. Description of any problems during installation
19. Duration of Vacuum Test
20. Holiday Test Voltage
21. Number of Holidays Found
22. Signature of Tester

END OF SECTION 02768



SECTION 03300 - CONCRETE AND REINFORCING STEEL

The following specifications have been created as go-by specifications for Developers working inside the Metropolitan Sewer Subdistrict jurisdiction. They should be considered tentatively final with the potential for additional product requirements to be added in the future. Developers are instructed to modify the specifications to meet specific project needs and take full responsibility for the final products applicability, entire contents of the specification section, and for concordance with the other project documents. Areas shaded in gray have been identified as areas in need of further review or editing.

NOTE: This specification is not to be used for buildings or large concrete structures. Its intent is to be used for water, sewer, and stormwater utility projects that require small applications of miscellaneous concrete work.

PART 1 GENERAL

1.1 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required and install all concrete work complete as shown on the Drawings and as specified herein.

1.2 SUBMITTALS

- A. Submit shop drawings and product data for:
 - 1. Placing drawings and bar bending details in conformity with the recommendations of ACI 315.
 - 2. Technical data on all materials and components.
 - 3. Safety Data Sheets (SDS) for all concrete admixtures and curing agents.
- B. Test Reports
 - 1. Sieve analysis, mechanical properties and deleterious substance content for fine and coarse aggregates.
 - 2. Concrete mixes: For each formulation of concrete proposed for use, submit constituent quantities per cubic yard, water cementitious ratio, concrete slump, type, and manufacturer of cement. Provide either a. or b., below, for each mix proposed.
 - a. Standard deviation data for concrete mixes based on statistical records.
 - b. Water cementitious ratio curve for concrete mixes based on laboratory tests. Provide average cylinder strength test results at 7 and 28 days for laboratory concrete mix designs. Provide results of 14 day tests if available.
- C. Certifications
 - 1. Certify that admixtures used in the same concrete mix are compatible with each other and the aggregates.



2. Certify admixtures are made for use in concrete in contact with potable water after 30 days of concrete curing.

1.3 REFERENCE STANDARDS

A. ASTM International

1. ASTM A185 - Standard Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement.
2. ASTM A615 - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
3. ASTM A1064 – Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
4. ASTM C31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field.
5. ASTM C33 - Standard Specification for Concrete Aggregates.
6. ASTM C39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
7. ASTM C94 - Standard Specification for Ready-Mixed Concrete.
8. ASTM C143 - Standard Test Method for Slump of Hydraulic-Cement Concrete
9. ASTM C150 - Standard Specification for Portland Cement
10. ASTM C173 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
11. ASTM C231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
12. ASTM C260 - Standard Specification for Air-Entraining Admixtures for Concrete.
13. ASTM C311 - Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use in Portland-Cement Concrete.
14. ASTM C494 - Standard Specification for Chemical Admixtures for Concrete.
15. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.

B. American Concrete Institute (ACI).

1. ACI 211.1 - Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete.
2. ACI 232.2R – Report on the Use of Fly Ash in Concrete.
3. ACI 301 - Specification for Concrete Construction.
4. ACI 304R - Guide for Measuring, Mixing, Transporting, and Placing Concrete.
5. ACI 305R – Guide to Hot Weather Concreting.
6. ACI 306R – Guide to Cold Weather Concreting.
7. ACI 318 - Building Code Requirements for Structural Concrete.
8. ACI 350 - Code Requirement for Environmental Engineering Concrete Structures.
9. ACI SP-66 – ACI Detailing Manual.

C. Concrete Reinforcing Steel Institute (CRSI)

1. MSP - Manual of Standard Practice



- D. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.4 QUALITY ASSURANCE

- A. Comply with ACI 318, ACI 350 and other stated specifications, codes and standards. Apply the most stringent requirements of stated specifications, codes, standards, and this Section if conflicts exist.
- B. If, during the progress of the work, it is impossible to secure concrete of the specified workability and strength with the materials being furnished, the Owner/Engineer may order such changes in proportions or materials, or both, as may be necessary to secure the specified properties. Make all changes so ordered at the no additional cost to the Owner.
- C. All field testing services and related laboratory tests required will be provided by the Contractor at no additional cost to the Owner. The laboratory shall be certified by the SCDOT and approved in advance by the Owner/Engineer.
- D. Methods of testing will comply with the latest applicable ASTM methods.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Ship and store reinforcing steel with bars of the same size and shape fastened in bundles with durable tags, marked in a legible manner with waterproof markings showing the same designations as those shown on the submitted placement drawings. Provide reinforcing steel free from mill scale, loose rust, mud, dirt, grease, oil, ice or other foreign matter. Store off the ground, protect from moisture and keep free from rust, mud, dirt, grease, oil, ice or other injurious contaminants.
- B. Store products in conformity with the manufacturer's recommendations.
- C. Store or stockpile sand, aggregates, cement and fly ash in conformity with ACI 301.

PART 2 PRODUCTS

2.1 GENERAL

- A. The use of manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired.
- B. Like items of materials shall be the end products of one manufacturer in order to provide standardization for appearance, maintenance and manufacturer's service.
- C. Materials shall comply with this Section and any applicable State or local requirements.



2.2 MATERIALS

- A. Cement: Domestic Portland cement conforming to ASTM C150. Do not use air entraining cements. The allowable types of cement for each class of concrete are shown in Table 1.
- B. Fine Aggregate: Washed inert natural sand conforming to ASTM C33.
- C. Coarse Aggregate: Well-graded crushed stone or washed gravel conforming to ASTM C33, size 57. Limits of deleterious substances and physical property requirements as listed in ASTM C33, Table 3 for severe weathering regions.
- D. Water: Potable water free of oil, acid, alkali, salts, chlorides, (except those attributable to drinking water) organic matter, or other deleterious substances.
- E. Admixtures: Use admixtures free of chlorides and alkalis (except for those attributable to drinking water). The admixtures shall be from the same manufacturer when it is required to use more than one admixture in the same concrete mix. Use admixtures compatible with the concrete mix including other admixtures and made for use in contact with potable water after 30 days of concrete curing.
 - 1. Air Entraining Admixture: Conforming to ASTM C260. Proportion and mix in accordance with manufacturer's recommendations.
 - 2. Water Reducing Admixture: Conforming to ASTM C494, Type A. Proportion and mix in accordance with manufacturer's recommendations.
 - 3. Do not use admixtures causing retarded or accelerated setting of concrete without written approval from the Owner/Engineer. Use retarding or accelerating water reducing admixtures when so approved.
- F. Fly Ash: Class F fly ash complying with ASTM C618, including the requirements of Table 1 but with the Loss of Ignition (LOI) limited to 3 percent maximum and the optional physical requirements of Table 3.
- G. Deformed Concrete Reinforcing Bars: ASTM A615, Grade 60 deformed bars.
- H. Welded Steel Wire Fabric: Conforming to ASTM A185.
- I. Reinforcing Steel Accessories
 - 1. Plastic Protected Wire Bar Supports: CRSI Bar Supports, Class 1 - Maximum Protection.
 - 2. Stainless Steel Protected Wire Bar Supports: CRSI Bar Supports, Class 2 - Moderate Protection with legs made wholly from stainless steel wire.
 - 3. Precast Concrete Bar Supports: CRSI Bar Supports, Precast Concrete Bar Supports. Precast concrete blocks that have equal or greater strength than the surrounding concrete.
- J. Tie Wires for reinforcement: 16 gauge or heavier black annealed wire.
- K. Sheet Curing Materials: Waterproof paper, polyethylene film or white burlap-polyethylene sheeting, all conforming to ASTM C171.
- L. Fiber Reinforcement



1. Synthetic reinforcing fibers for concrete grout shall be 100 percent polypropylene collated, fibrillated fibers, Fibermesh 300 as manufactured by Propex Concrete Systems Corp, Chattanooga, TN, or equal. Fiber length and quantity for the concrete grout mix shall be in strict compliance with the manufacturer's recommendations as approved by the Owner/Engineer.

2.3 MIXES

- A. Select proportions of ingredients to meet the design strength and materials limits specified in Table 1 and to produce placeable, durable concrete conforming to these Specifications. Proportion ingredients to produce a homogenous mixture which will readily work into corners and angles of forms and around reinforcement without permitting materials to segregate or allowing free water to collect on the surface.
- B. Base concrete mixes on standard deviation data of prior mixes with essentially the same proportions of the same constituents or, if not available, develop concrete mixes by laboratory tests using the materials proposed for the work.
- C. Entrained air, as measured by ASTM C231, shall be as shown in Table 1.
- D. Slump of the concrete as measured by ASTM C143, shall be as shown in Table 1.
- E. Proportion admixtures according to the manufacturer's recommendations. Two or more admixtures specified may be used in the same mix provided that the admixtures in combination retain full efficiency and have no deleterious effect on the concrete or on the properties of the other admixture(s).

TABLE 1

Class	Design Strength (1)	Cement ASTM C150	Cementitious Content (2)	W/C (3)	WR (4)	Slump Range Inches
A	2500	Type II	440	0.62 max	Yes	1-4
B	4000	Type II	560	0.44 max	Yes	3-5

TABLE 1 NOTES:

- (1) Minimum compressive strength in psi at 28 days
- (2) Minimum cementitious content in lbs per cubic yard [(where fly ash is used, cementitious content is defined as cement content plus fly ash content)]
- (3) W/C is Maximum Water Cementitious ratio by weight
- (4) WR is water reducing admixture
- (5) [Fly ash content in the range of 20-25 percent of the total cement content plus fly ash content, by weight]
- (6) All concrete classes shall have 3.5 to 5 percent air entrainment.



2.4 MEASURING, BATCHING, MIXING AND TRANSPORTING CONCRETE

- A. Measure, batch, mix and transport concrete in conformance with ASTM C94 and the requirements herein or as otherwise approved in writing by the Owner/Engineer.
- B. Ready-mixed concrete, whether produced by a concrete supplier or the Contractor shall conform to the requirements above. Do not hand mix.
- C. Dispense admixtures into the batch in conformity with the recommendations of the admixture manufacturer.
- D. Mix concrete until there is uniform distribution of the materials and discharge completely before the mixer is recharged. The mixer shall be rotated at a speed recommended by the mixer manufacturer and mixing shall be continued for at least 1-1/2 minutes after all the materials are in the mixer. Place concrete within 1-1/2 hours of the time at which water was first added, otherwise it will be rejected. Concrete which has been remixed or retempered, or to which an excess amount of water has been added, will also be rejected.

2.5 FORMS

- A. Provide forms free from roughness and imperfections, watertight and braced and tied to prevent motion when concrete is placed. Wooden spreaders will not be allowed in the concrete.
- B. Wire ties will not be allowed. Metal ties or anchorages which are necessary within the forms shall be so constructed that the metal work can be removed for a depth of at least 1-1/2-in from the concrete surface without damage by spalling. Clean forms before using and treat with form release agent, or other approved material.
- C. All exposed edges of the finished concrete shall be chamfered 3/4-in.

PART 3 - EXECUTION

3.1 CONSTRUCTION JOINTS

- A. Locate construction joints where indicated or where approved by the Owner/Engineer.
- B. Continue all reinforcing steel through the joint.
- C. At construction joints and at concrete joints indicated to be "roughened", uniformly roughen the surface of the concrete to a full amplitude (distance between high and low points and side to side) of 1/4-in with chipping tools to expose a fresh face. Thoroughly clean joint surfaces of loose or weakened materials by waterblasting or sandblasting and prepare for bonding. At least two hours before and again shortly before the new concrete is deposited, saturate the joints with water. After glistening water disappears, coat joints with neat cement slurry mixed to the consistency of very heavy paste. The surfaces shall receive a coating at least 1/8-in thick, scrubbed-in by means of stiff bristle brushes. Deposit new concrete before the neat cement dries.



3.2 REINFORCING STEEL

- A. Fabricate reinforcing steel accurately to the dimensions shown. Bend bars around a revolving collar having a diameter of not less than that recommended in ACI 318. All bars shall be bent cold.
- B. Provide tension lap splices in compliance with ACI 318. Stagger splices in adjacent bars where possible. Provide Class B tension lap splices at all locations unless otherwise indicated.
- C. Lap splices in welded wire fabric in accordance with the requirements of ACI 318 but not less than 12-in. Tie the spliced fabrics together with wire ties spaced not more than 24-in on center and lace with wire of the same diameter as the welded wire fabric. Offset splices in adjacent widths to prevent continuous splices.
- D. Use precast concrete blocks where the reinforcing steel is to be supported over soil. Use plastic protected bar supports or steel supports with plastic tips where the reinforcing steel is to be supported on forms for a concrete surface that will be exposed to weather, high humidity, or liquid. Use stainless steel supports or plastic tipped metal supports in all other locations unless otherwise noted on the Drawings or specified herein.
- E. Before placing in position, clean reinforcement of loose mill scale and rust, mud, dirt, grease, oil and other coatings, including ice that reduce or destroy bond. When there is a delay in depositing concrete after the reinforcement is in place, bars shall be reinspected and cleaned again when necessary.
- F. Coat reinforcement which is to be exposed for a considerable length of time after being placed with a heavy coat of cement grout.
- G. Do not cover any reinforcing steel with concrete until the amount and position of the reinforcement has been checked and the Owner/Engineer has given permission to proceed.

3.3 INSPECTION AND COORDINATION

- A. Batching, mixing, transporting, placing and curing of concrete shall be subject to the inspection of the Owner/Engineer at all times. Advise the Owner/Engineer of readiness to proceed at least six working hours prior to each concrete placement. The Owner/Engineer will inspect the preparations for concreting including the preparation of previously placed concrete, the reinforcing and the alignment, cleanliness and tightness of formwork. Do not place concrete without the inspection and acceptance of the Owner/Engineer.

3.4 CONCRETE APPEARANCE

- A. Remix concrete showing either poor cohesion or poor coating of the coarse aggregate with paste. If this does not correct the condition, the concrete shall be rejected.
- B. Provide concrete having a homogeneous structure which, when hardened, will have the specified strength, durability and appearance. Provide mixtures and workmanship such that concrete surfaces, when exposed, will require no finishing except as specified herein.



3.5 PLACING AND COMPACTING

- A. Do not place concrete until forms, condition of subgrade and method of placement have been approved by the Owner/Engineer. Remove all debris, foreign matter, dirt, ice and standing water from the forms before depositing concrete. Do not place concrete on frozen subgrade, snow or ice. The contact surface between concrete previously placed and new concrete shall be cleaned and brushed with cement paste. Concrete, except as indicated on the Drawings, shall not be placed in water or submerged within 24 hours after placing, nor shall running water be permitted to flow over the surface of fresh concrete within 4 days after its placing.
- B. Deposit concrete as near its final position as possible to prevent segregation due to rehandling or flowing. Pumping of concrete will be permitted when an approved design mix and aggregate sizes suitable for pumping are used. Do not deposit concrete which has partially hardened or which has been contaminated by foreign materials. If the section cannot be placed continuously, place construction joints as specified or as approved. Place concrete for walls using tremie tubes in 12-in to 24-in lifts, keeping the surface horizontal. Do not drop concrete more than 4-ft.
- C. Use high frequency mechanical vibrators to obtain proper consolidation of the concrete. Do not use vibrators to move or transport concrete in the forms. Do not over-vibrate so as to segregate. Continue vibration until the frequency returns to normal, trapped air ceases to rise and the surface appears liquefied, flattened and glistening. Use spades, rods or forks so that concrete is completely worked around reinforcement, embedded items, pipe stubs, and openings and into corners of forms.

3.6 FINISHING CONCRETE

- A. Clean all exposed concrete surfaces and adjoining work stained by leakage of concrete, to the satisfaction of the Owner/Engineer.
- B. Steel Trowel Finish. Finish by screeding and floating with straightedges to bring the surfaces to the elevations indicated and to a true plane with a tolerance of 1/8-in when checked with a 10-ft straightedge. Pitch surface to drain unless otherwise noted on the Drawings. While the concrete is still green, but sufficiently hardened to bear a person's weight without deep imprint, the surface shall be wood floated to a true, even plane with no coarse aggregate visible. Apply sufficient pressure on the wood floats to bring moisture to the surface. After surface moisture has disappeared, hand steel trowel to produce a smooth, impervious surface, free from trowel marks. Trowel the surface again for the purpose of burnishing. The final troweling shall produce a ringing sound from the trowel. Do not use dry cement or additional water in troweling.

3.7 CURING AND PROTECTION

- A. Protect all concrete work against injury from the elements and defacements of any nature during construction operations.
- B. Cure all concrete in conformance with ACI 301. Concrete that is to be used for the containment of water shall be water cured. Water curing shall be by ponding, by continuous sprinkling or by covering with continuously saturated burlap. Other concrete shall be cured by either water curing, sheet material curing or liquid membrane curing compound except that liquid membrane curing



compound shall not be used on any concrete surface where additional concrete is to be placed or where the concrete surface is to be coated or painted.

- C. Protect finished surfaces and slabs from the direct rays of the sun to prevent checking and crazing.
- D. During cold weather concrete shall be batched, delivered, placed, cured and protected in compliance with the recommendations of ACI 306R. Do not use salt, manure or other chemicals for cold weather protection.
- E. During hot weather concrete shall be batched, delivered, placed, cured and protected in compliance with the recommendations of ACI 305R. The temperature of the concrete shall be such that it will cause no difficulties from loss of slump, flash set or cold joints. Immediately cover plastic concrete with sheet curing material during hot weather.

3.8 FIELD TESTS

- A. Sets of field control cylinder specimens shall be taken by the Contractor during the progress of the work, in compliance with ASTM C31. The number of sets of concrete test cylinders taken of each class of concrete placed each day will not be less than one set per day, nor less than one set for each 150 cu yds of concrete nor less than one set for each 5,000 sq ft of surface area for slabs or walls. Specimens will be formed in 6-in diameter by 12-in long non-absorbent cylindrical molds.
 - 1. A "set" of test cylinders shall consist of four cylinders: one to be tested at seven days and two to be tested and their strengths averaged at 28 days. The fourth may be used for a special test at 3 days or to verify strength after 28 days if 28-day test results are low.
 - 2. When the average 28-day compressive strength of the cylinders in any set falls below the required compressive strength or below proportional minimum seven-day strengths (where proper relation between seven and 28-day strengths have been established by tests), change proportions, cementitious content, or temperature conditions to achieve the required strengths at no additional cost to the Owner.
- B. Cooperate in the making of tests by allowing free access to the work for the selection of samples. Provide an insulated closed curing box for the specimens and protect the specimens against injury or loss through construction operations. Furnish material and labor required for the purpose of taking concrete cylinder samples.
- C. Slump tests will be made in the field by the Contractor in conformity with ASTM C143.
- D. Tests for air content will be made in the field by the Contractor in compliance with either the pressure method (ASTM C231) or by the volumetric method (ASTM C173).

3.9 STRIPPING AND FINISHING CONCRETE

- A. Do not remove forms before the concrete has attained a strength of at least 30 percent of the specified design strength nor before reaching approximately "100 day-degrees" of moist curing (whichever is the longer). Degree-days are defined as the total number of 24-hour periods



multiplied by the weighted average daily air temperature at the surface of the concrete (e.g., 7 days at an average 50 degrees F = 350 degree-days).

- B. Exercise care to prevent damaging edges or obliterating the lines of chamfers, rustications or corners when removing the forms or doing any other work adjacent thereto.
- C. Clean all exposed concrete surfaces and adjoining work stained by leakage of concrete, to the satisfaction of the Owner/Engineer.
- D. Immediately after removal of forms remove tie cones and metal portions of ties. Fill holes promptly upon stripping as follows: Moisten the hole with water, followed by a 1/16-in brush coat of neat cement slurry mixed to the consistency of a heavy paste. Immediately plug the hole with a 1 to 1.5 mixture of cement and concrete sand mixed slightly damp to the touch (just short of "balling"). Hammer the grout into the hole until dense, and an excess of paste appears on the surface in the form of a spider web. Trowel smooth with heavy pressure. Avoid burnishing.
- E. Defective concrete and honeycombed areas: Chip down square and at least 1-in deep to sound concrete with hand chisels or pneumatic chipping hammers. Irregular voids or surface stones need not be removed if they are sound, free of laitance, and firmly embedded in the parent concrete. If honeycomb exists around reinforcement, chip to provide a clear space at least 3/8-in wide all around the steel. For areas less than 1-1/2-in deep, the patch may be made in the same manner as described above for filling form tie holes, care being exercised to use adequately dry (non-trowelable) mixtures and to avoid sagging. Thicker repairs will require build-up in successive 1-1/2-in layers on successive days, each layer being applied (with slurry, etc.) as described above.
- F. Concrete to receive damp proofing and concrete not exposed in the finished work shall have off-form finish with fins and other projections removed and tie cones and defects filled as specified above.
- G. Screed top surface of slabs to the established grades and to a true plane with a tolerance of 1/8-in when checked with a 10-ft straightedge. Pitch surface to drain unless otherwise noted on the Drawings. Finish the surface to give a smooth, hard, even surface free from high or low spots or other defects. Concrete subject to pedestrian traffic shall be given a broom finish. Failure to meet these conditions shall be cause for removal, grinding, or other correction as directed by the Owner/Engineer.

3.10 SCHEDULE

- A. The following (Table 2) are the general applications for the various concrete design strengths to be used:

TABLE 2

Class	Design Strength (psi)	Description
A	2,500	Concrete fill, thrust blocks, and pipe encasement
B	4,000	Slabs on grade, sidewalks, gutters, driveway aprons, and all other structural concrete



END OF SECTION 03300



SECTION 03310 – GROUTING

The following specifications have been created as go-by specifications for Developers working inside the Metropolitan Sewer Subdistrict jurisdiction. They should be considered tentatively final with the potential for additional product requirements to be added in the future. Developers are instructed to modify the specifications to meet specific project needs and take full responsibility for the final products applicability, entire contents of the specification section, and for concordance with the other project documents. Areas shaded in gray have been identified as areas in need of further review or editing.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

[ENGINEER TO ADD/ MODIFY REQUIREMENTS BASED ON PROJECT REQUIREMENTS.]

- 1. Portland cement grout.
- 2. Cement grout.
- 3. Nonshrink cementitious grout.

- B. Related Requirements:

- 1. Section 03300 “Concrete and Reinforcing Steel.”

1.3 ACTION SUBMITTALS

- A. Product Data: Submit manufacturer information regarding grout and surface preparation, mixing and installation.
 - 1. Commercially manufactured nonshrink cementitious grout. Include catalog cuts, technical data, storage requirements, product life, working time after mixing, temperature considerations, and conformity to the specified ASTM standards.
 - 2. Cement grout. Include the type and brand of cement, the gradation of fine aggregate, product data on any proposed admixtures and the proposed grout mix.
 - 3. Concrete grout. Include data as required for concrete and for fiber reinforcement as delineated in Section 03300.



1.4 INFORMATIONAL SUBMITTALS

- A. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- B. Manufacturer Instructions: Submit instructions for mixing, handling, surface preparation, and placing nonshrink grouts.
- C. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.
- D. Qualifications Statement:
 - 1. Submit qualifications for manufacturer.

1.5 QUALITY ASSURANCE

- A. Perform Work according to the standards referenced herein.
- B. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum ten years' experience in production and use of provided grouts.
- C. Independent testing laboratory shall meet the requirements of ASTM E329 and ASTM C1077 and be acceptable to the Engineer. Laboratories affiliated with the Contractor or in which the Contractor or officers of the Contractor's organization have beneficial interest are not acceptable.
- D. Field Testing:
 - 1. Assist in the sampling of materials and cooperate by allowing free access to the work and permitting the use of ladders, scaffolding, and such incidental equipment as may be required. Methods of testing will comply with the applicable ASTM Standards.

1.6 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. Limit total storage time from date of manufacture to date of installation to six months or the manufacturer's recommended storage time, whichever is less.
- C. Remove immediately from the site material which becomes damp, contains lumps, or is hardened and replace with acceptable material.
- D. Protection:
 - 1. Protect materials from moisture and dust by storing in clean, dry location.
 - 2. Provide additional protection according to manufacturer instructions.



1.7 AMBIENT CONDITIONS

- A. Maximum Conditions: Do not perform grouting if temperatures exceed 90 degrees F.
- B. Minimum Conditions: Do not perform grouting if the minimum temperature of base plates, supporting concrete and grout are less than 40 degrees F. Maintain minimum temperature of 40 degrees F before, during, and after grouting, until grout has set.

PART 2 - PRODUCTS

2.1 PORTLAND CEMENT GROUT

[ENGINEER TO ADD/ MODIFY REQUIREMENTS BASED ON PROJECT REQUIREMENTS.]

- A. Portland Cement: Comply with ASTM C150/C150M, Type I and II.
- B. Water:
 - 1. Potable.
 - 2. No impurities, suspended particles, algae, or dissolved natural salts in quantities capable of causing:
 - a. Corrosion of steel.
 - b. Volume change increasing shrinkage cracking.
 - c. Efflorescence.
 - d. Excess air entraining.
- C. Fine Aggregate:
 - 1. Washed natural sand.
 - 2. Gradation:
 - a. Comply with ASTM C33/C33M.
 - b. Represented by smooth granulometric curve within required limits.
 - 3. Free from injurious amounts of organic impurities according to ASTM C40/C40M.
- D. Mix:
 - 1. Portland cement, sand, and water.
 - 2. Do not use ferrous aggregate or staining ingredients in grout mixes.

2.2 NONSHRINK CEMENTITIOUS GROUT

- A. Description:
 - 1. Pre-mixed and ready-for-use formulation requiring only addition of water.



2. Nonshrink, non-corrosive, nonmetallic, non-gas forming, not containing expansive cement and no chlorides.
3. No shrinkage when tested in conformity with ASTM C827/C827M.

B. Performance and Design Criteria:

1. Certified to maintain initial placement volume or expand after set, and to meet following minimum properties when tested according to ASTM C1107/C1107M for Grades B, C, D and CRD-C621 nonshrink grout:
 - a. Setting Time:
 - 1) Initial: Approximately two hours.
 - 2) Final: Approximately three hours.
 - 3) Comply with ASTM C191.
 - b. Maximum Expansion: 0.10 to 0.40 percent.
 - c. Minimum Compressive Strength:
 - 1) One-Day: 4,000 psi (27.6 MPa).
 - 2) Seven-Day: 7,000 psi (48.3 MPa).
 - 3) 28-Day: 10,000 to 10,800 psi (69.0 to 74.5 MPa).
 - 4) Comply with CRD-C621.

The following flowable nonshrink cementitious grouts, often called "precision grouts", are for general purpose applications. Variations of these grout formulations may be available with special qualities for unusual conditions of high early strength, salt water resistance, long working time, architectural color, fluid consistency, low heat of hydration, sulfate resistance, pumpability, radiation shielding, high temperature resistance, cable or rod grouting, hot weather grouting, or deep grout pour requirements. When such qualities are required, contact grout manufactures for specific products.

Typically specified products:

1. Flowable (Precision) nonshrink cementitious grout products: Provide one of the following or equal:
 - a. Masterflow 928 by BASF Building Systems
 - b. Hi-Flow Grout by The Euclid Chemical Co.
 - c. SikaGrout 212 by Sika Corp.
 - d. Five Star Grout by Five Star Products, Inc.

Concrete grout is used as an overlay course for concrete slabs to control the surface geometry. It is usually placed beneath scraper mechanisms of water containment structures. The use of pozzolan in the concrete grout mix is desirable to reduce shrinkage but pozzolan may not be generally available in all locations. 3/8 (9.5 mm) in aggregate should be used for overlays which are less than 2 in (51 mm) in thickness and 1/2 in (12.7 mm) aggregate should be used for overlays 2 in (51 mm) or greater in thickness.



2.3 CONCRETE GROUT

- A. Description: Conform to the requirements of Section 03300, except as follows. Proportion with Type II cement, coarse and fine aggregates, water, water reducing admixture, and air entraining agent to produce specified mix performance:
1. Average Strength (ASTM C579): [3500 psi (24.1 MPa) at 28 days] [(2500 psi (17.2 MPa)] nominal strength].
 2. Maximum Coarse Aggregate Size: [3/8-inch (9.5 mm)] [1/2-inch (12.7 mm)].
 3. Minimum Cement Content: 540 lbs per cubic yard (245 Kg per cubic meter).
 4. Maximum Water to Cement Ratio: 0.45.
 5. Maximum Slump: 5 inches (127 mm).
- B. Add synthetic reinforcing fibers to the concrete grout mix at the rate of 1.5 lbs (0.68 Kg) of fibers per cubic yard (meter) of grout. Add fibers from manufacturer's pre-measured bags and according to manufacturer's recommendations to ensure complete dispersion of fiber bundles as single monofilaments within the concrete grout.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify areas to receive grout.

3.2 PREPARATION

- A. Place grout where indicated or specified over [existing concrete and] cured concrete which has attained its specified design strength unless otherwise approved by Engineer.
- B. Remove defective concrete, ice, laitance, dirt, oil, grease, form release agents, paints, and other foreign material from concrete surfaces, which may affect the bond or performance of the grout by brushing, hammering, chipping, sand blasting or other similar dry mechanical means until sound and clean concrete surface is achieved. Irregular voids or projecting coarse aggregate need not be removed if they are sound, free of laitance and firmly embedded into the parent concrete.
1. Air compressors used to clean surfaces in contact with grout shall be the oil-less type or equipped with an oil trap in the airline to prevent oil from being blown onto the surface.
- C. Roughen concrete lightly, but not to interfere with placement of grout.
- D. Remove foreign materials from metal surfaces in contact with grout.
- E. Align, level, and maintain final positioning of components to be grouted.
- F. Wash concrete surfaces clean and then keep moist for at least 24 hours prior to the placement of nonshrink cementitious or cement grout. Saturation may be achieved by covering the concrete



with saturated burlap bags, use of a soaker hose, [or] flooding the surface [or other method acceptable to Engineer]. Upon completion of the 24 hour period, remove visible water from the surface prior to grouting.

- G. Support equipment during alignment and installation of grout by shims, wedges, blocks, or other approved means. Prevent bond of shims, wedges and blocking devices by bond breaking coatings and remove after grouting unless otherwise approved by Engineer. Grout voids created by the removal of shims, wedges, and blocks.

3.3 INSTALLATION - GENERAL

A. Formwork:

1. Construct leakproof forms anchored and shored to withstand grout pressures.
2. Install formwork with clearances to permit proper placement of grout.

B. Mixing - Portland Cement Grout:

1. Use proportions of two parts sand and one part cement, measured by volume.
2. Prepare grout with water to obtain consistency to permit placing and packing.
3. Mix water and grout in two steps:
 - a. Premix using approximately 2/3 of water.
 - b. After partial mixing, add remaining water to bring mix to desired placement consistency and continue mixing two to three minutes.
4. Mix only quantities of grout capable of being placed within 30 minutes after mixing.
5. Do not add additional water after grout has been mixed.
6. Minimum Compressive Strength (ASTM C 579):
 - a. In 48 hours: [2,400] <Insert number> psi ([17] <Insert number> MPa).
 - b. In 28 days [7,000] <Insert number> psi ([48] <Insert number> MPa).

C. Placing of Grout:

1. Place grout material quickly and continuously.
2. Do not use pneumatic-pressure or dry-packing methods.
3. Apply grout from one side only to avoid entrapping air.
4. Do not vibrate placed grout mixture or permit placement if area is being vibrated by nearby equipment.
5. Thoroughly compact final installation and eliminate air pockets.
6. Do not remove leveling shims for at least 48 hours after grout has been placed.

D. Curing:

1. Prevent rapid loss of water from grout during first 48 hours [by use of approved membrane curing compound or] by using wet burlap bags, soaker hoses or ponding.
2. Immediately after placement, protect grout from premature drying, excessively hot or cold temperatures, and mechanical injury.



3. After grout has attained its initial set, keep damp for minimum three days.
- E. Reflect existing underlying expansion joints, partial contraction joints, and construction joints through the grout.

3.4 INSTALLATION - CONCRETE GROUT

- A. Inspect finished slabs and scheduled to receive concrete grout. [ICRI CSP 6 (medium scarification).] Protect and keep the surface clean until placement of concrete grout.
- B. Remove debris and clean the surface by sweeping and vacuuming of all dirt and other foreign materials. Pressure wash the surface. Do not flush debris into tank drain lines.
- C. Saturate the concrete surface for at least 24 hours prior to placement of the concrete grout by use of saturated burlap bags, soaker hoses or ponding. Remove excess water just prior to placement of the concrete grout. Place a cement slurry immediately ahead of the concrete grout so that the slurry is moist when the grout is placed. Work the slurry over the surface with a broom until it is coated with approximately 1/16 to 1/8-in (1.58 to 3.18 mm) thick cement paste.
- D. Place concrete grout to final grade using the scrapers of the installed mechanical equipment as a guide for surface elevation and to eliminate high and low spots. Unless specifically approved by the equipment manufacturer, do not use mechanical scraper mechanisms powered by their motors as a finishing machine or screed to push grout.
- E. [Provide grout control joints as indicated on Drawings.]
- F. Steel trowel finish. Cure the concrete grout as specified for cast-in-place concrete in Section 03300.

Modify as necessary for the particular project. Note that the location of nonshrink epoxy grout applications must be specifically noted on the Drawings. Additional information may be required if special grouts are to be used due to sulfate or chemical attack, areas subject to vibration from pumps or motors, and areas designated on the Drawings for other types of grout

Verify the following are required for project and modify for the specific project requirements.

3.5 SCHEDULE

- A. Use particular types of grout as follows:
 1. General Purpose Nonshrink Cementitious Grout (CRD-C621 Grade D): Use at locations where nonshrink grout is indicated, except for base plates greater in area than 3-feet wide by 3-feet long (0.91 meters wide by 0.91 meters long).
 2. Flowable (precision) Nonshrink Cementitious Grout (CRD-C621 Grade B or C): Use under base plates greater in area than 3-feet wide by 3-feet long (0.91 meters wide by 0.91 meters long). Use at locations indicated to receive flowable (precision) nonshrink



grout. Flowable (precision), nonshrink, cementitious grout may be substituted for general purpose nonshrink cementitious grout.

3. Cement Grout: Use where indicated.

END OF SECTION 03310



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SECTION 04005 - COMBINATION AIR VALVES FOR WASTEWATER SERVICE

The following specifications have been created as go-by specifications for Developers working inside the Metropolitan Sewer Subdistrict jurisdiction. They should be considered tentatively final with the potential for additional product requirements to be added in the future. Developers are instructed to modify the specifications to meet specific project needs and take full responsibility for the final products applicability, entire contents of the specification section, and for concordance with the other project documents. Areas shaded in gray have been identified as areas in need of further review or editing.

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Combination air valves for wastewater treatment facilities.
- B. Related Requirements:
 - 1. Section 02730 – Sanitary Sewer Systems
 - 2. Section 04332 – Submersible Sewage Pumping Station

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. The publications listed herein form a part of this specification. Publications are referred to within the text by basic designation only. Most recent versions of these publications shall be applicable.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Coordination
 - 1. Coordinate Work of this Section with other Contractors, Owner, utilities, and other entities as applicable.

1.4 ACTION SUBMITTALS

- A. Shop Drawings: Indicate materials, dimensions, weights, and end connections on assembly drawings.

1.5 INFORMATIONAL SUBMITTALS

- A. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.



- B. Product Data: Submit manufacturer catalog information.
- C. Manufacturer Instructions: Submit special procedures and setting dimensions.
- D. Source Quality-Control Submittals: Indicate results of factory tests and inspections.
- E. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections and provide required certifications.
- F. Manufacturer Reports: Certify that equipment has been installed according to manufacturer instructions.
- G. Qualifications Statements:
 - 1. Submit qualifications for manufacturer and installer.
 - 2. Submit manufacturer's approval of installer.

1.6 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of combination air valves.

1.7 QUALITY ASSURANCE

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

1.8 QUALIFICATIONS

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

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Section 01660 – Material Storage and Handling: Requirements for transporting, handling, storing, and protecting products.
- B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.
- C. Store materials according to manufacturer instructions.
- D. Protection:
 - 1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.



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.

1.10 FIELD CONDITIONS

A. Field Measurements:

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

1.11 WARRANTY

- ##### A. Furnish five-year manufacturer's warranty for combination air valves.

PART 2 - PRODUCTS

2.1 COMBINATION AIR 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. DeZURIK
5. Val-Matic Valve & Manufacturing Corp.
6. Or Approved Equal

[ENGINEER TO SPECIFY APPROPRIATE SELECTIONS TO SUIT THE PROJECT NEEDS, AND THE MANUFACTURER SELECTED]

B. Description:

1. Type:

- a. Fully automatic, float operated.
- b. Body: [Single] [Double].

2. Comply with AWWA C512.

3. Size: As indicated on Drawings.

4. Suitable for sewage service.

5. Provide with flushing capabilities.

6. Pressure Rating: [<20] [150] [300] [740] <_____> psig.

7. Combination air valves:

- a. perform the functions of an air/vacuum valve (exhaust large quantities of air on start-up, admits air on shut-down) and air release valves (release air continuously during operation) to maintain system efficiency and prevent pipeline surges.



C. Materials:

1. Body and Cover: [Cast iron, ASTM A126] [Ductile iron, ASTM A536] [Stainless steel, ASTM A351].
2. Float: [Type < > stainless steel] < >.
3. Seats: [Buna-N] < >.
4. Seals: [Buna-N] < >.
5. Trim:
6. Hardware: [Stainless steel]

[ENGINEER TO SPECIFY END CONNECTIONS BASED ON VALVE SIZE AND BODY STYLE, AND TO SUIT THE VARIOUS OFFERINGS OF THE MANUFACTURERS.]

D. End Connections - Single Body:

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

E. End Connections - Double Body:

1. Size 4 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.

F. Valve Body Connections:

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

G. 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 FINISHES

- A. Prepare piping appurtenances for field finishes as required by the Manufacturer.

2.4 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. 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



SECTION 04212 - LIFT STATION ASPHALT PAVING

The following specifications have been created as go-by specifications for Developers working inside the Metropolitan Sewer Subdistrict jurisdiction. They should be considered tentatively final with the potential for additional product requirements to be added in the future. Developers are instructed to modify the specifications to meet specific project needs and take full responsibility for the final products applicability, entire contents of the specification section, and for concordance with the other project documents. Areas shaded in gray have been identified as areas in need of further review or editing.

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish all labor, materials, equipment, and incidentals required to install paved roadway inside Lift Stations as shown on the Drawings and as specified herein.
- B. The work includes removal of existing pavement, preparation of existing paved surfaces and repaving of those surfaces as specified herein.
- C. 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 RELATED WORK

- A. Trench Excavation, Bedding and Backfill is included in Section 02221.

1.3 SUBMITTALS

- A. Submit to the Owner/Engineer shop drawings showing dimensions, layouts, and details of construction, and accessories required.
- B. Copies of load tickets shall be submitted to the Engineer on a daily basis when paving work is performed.
- C. Product Data:
 - 1. Submit product information for asphalt and aggregate materials.
 - 2. Submit mix design with laboratory test results supporting design.
- D. Manufacturer's Certificate: Certify Products are produced at a plant approved by SCDOT and that meet or exceed specified requirements.



1.4 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

1.5 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. 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.

1.6 QUALIFICATIONS

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

1.7 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

[ENGINEER TO SELECT BEST PIPE MATERIAL FOR EACH LOCATION, PROJECT]

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 & 401.
2. Tack Coat
 - a. The work covered under this section of this specification shall be performed in strict conformance with SCDOT Section 401.
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.
6. Bituminous Concrete Binder
 - a. Bituminous concrete binder course shall meet Section 402 of SCDOT standards.
7. Calcium chloride shall meet AASHTO M 144 and shall be spread wherever directed to allay dust conditions. The Owner/Engineer may direct the Contractor to employ sprinkling of water in lieu of calcium chloride for dust control.

2.2 ACCESSORIES

- A. Geotextile Fabric: AASHTO M288; non-woven, polypropylene.
- B. Pavement marking paint shall be fast-drying type conforming to the above referenced SCDOT standards and Federal Specifications TT-P 1952B.

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 SCDOT Standards.
- B. Asphalt pavement materials specified shall be installed in accordance with the requirements of Section 401 of SCDOT Specifications.
- C. 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.
- D. When required, remove existing pavement by saw, pneumatic hammer, or wheel, cutting edges of trenches to be repaved as directed by the Owner/Engineer. After pipe laying, backfilling, and compaction operations are completed satisfactorily, and after the gravel subbase is shaped and compacted, place the type of pavement as shown on the Drawings.
- E. Furnish and spread calcium chloride on or wet down disturbed surfaces to allay dust conditions as directed by the Owner/Engineer.
- F. All new and existing manhole frames, utility boxes, and drain inlets shall be set to the grade of the wearing course. At no time shall the manhole frames be allowed to protrude above the surface of the wearing course.
- G. The contact surfaces of castings, previously constructed asphalt or Portland cement concrete pavements shall be painted with a tack coat in accordance with SCDOT standards. Surfaces shall be thoroughly cleaned of all loose material and debris prior to application of the tack coat.
- H. Pavement replacement and other surfacing as specified herein will be a condition of progress payment applications.
- I. No vehicular traffic or loads shall be permitted on the newly completed pavement, until adequate stability has been attained and/or the material has cooled sufficiently to prevent distortion or loss



of fines. If climatic or other conditions warrant it, the period of time before opening to traffic may be extended at the discretion of the Owner/Engineer.

- J. Contractor shall properly maintain the pavement cut until the patch is made and shall promptly fill ruts and depressions.
- K. Contractor shall maintain pavement under this Contract during the guarantee period of two years from final payment and shall promptly (within three days of notice given by Owner/Engineer) refill and repave areas which have settled or are otherwise unsatisfactory for traffic.

3.3 DEMOLITION

- A. Saw cut and notch existing paving as indicated 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. All pavement thicknesses referred to herein are compacted thicknesses. The Contractor shall place sufficient mix to ensure that the specified thickness of pavement occurs where called for.
- B. 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.
- C. The binder course shall be placed as soon as possible after the aggregate base course has been prepared, shaped, and compacted.
- D. The binder course shall be placed and compacted by steel wheeled rollers of sufficient weight to thoroughly compact the bituminous concrete. Where necessary, the new pavement shall be rolled smooth and even with the existing pavement.
- E. Hose clean all road surfaces after backfilling and before any surfacing but, in no case, shall pavement be placed until the gravel base is dry and compacted to at least 98-percent maximum density at optimum moisture content in accordance with the requirements of Section 02221.
- F. When the air temperature falls below 50°F, extra precautions shall be taken in drying the aggregates, controlling the temperatures of the materials, and placing and compacting the mixtures.
- G. No mixtures shall be placed when the air temperature is below 40°F nor when the material on which the mixtures are to be placed contains frost or has a surface temperature the Owner/Engineer considers too low.
- H. Subbase:
 - 1. Prepare subbase in accordance with SCDOT Standard Specifications.



I. 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.

J. 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.

K. 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.

L. 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.

M. 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



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SECTION 04231 - CHAIN LINK FENCES AND GATES

The following specifications have been created as go-by specifications for Developers working inside the Metropolitan Sewer Subdistrict jurisdiction. They should be considered tentatively final with the potential for additional product requirements to be added in the future. Developers are instructed to modify the specifications to meet specific project needs and take full responsibility for the final products applicability, entire contents of the specification section, and for concordance with the other project documents. Areas shaded in gray have been identified as areas in need of further review or editing.

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 Steel Industrial 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.

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.

1.9 FIELD CONDITIONS

- A. Field Measurements: Verify layout information for chain-link fences and gates shown on Drawings in relation to property survey and existing structures. Verify dimensions by field measurements.

1.10 WARRANTY

- A. Special Warranty: Installer agrees to repair or replace components of chain-link fences and gates that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Failure to comply with performance requirements.
 - b. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - c. Faulty operation of gate operators and controls.
 - d. [ENGINEER TO SELECT OTHER FAILURE MODES].
 - 2. Warranty Period: Minimum Two (2) years from date of Final Payment.

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 inches.
- 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 ¾ inch wide steel.
- H. Tie Wire: Aluminum alloy steel wire, 9-gage or 11-gage as indicated.

2.3 ACCESSORIES

- A. Caps: Cast steel galvanize, 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 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with survey of property lines and legal boundaries, site clearing, earthwork, pavement work, and other conditions affecting performance of the Work.
 - 1. Do not begin installation before final grading is completed unless otherwise permitted by Architect.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

3.3 FENCE 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.

3.4 GATE INSTALLATION

- A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation.

3.5 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



SECTION 04301 - CORROSION PROTECTION FOR CONCRETE WASTEWATER STRUCTURES

The following specifications have been created as go-by specifications for Developers working inside the Metropolitan Sewer Subdistrict jurisdiction. They should be considered tentatively final with the potential for additional product requirements to be added in the future. Developers are instructed to modify the specifications to meet specific project needs and take full responsibility for the final products applicability, entire contents of the specification section, and for concordance with the other project documents. Areas shaded in gray have been identified as areas in need of further review or editing.

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. Surface preparation, priming, and finish coats specified in this Section are in addition to shop priming and surface treatment specified in other Sections.
 - 7. 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, immediately contact the Engineer. 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 concealed 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.
 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).
- B. 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.
- C. Qualification Data: For firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects, to establish a minimum of [five (5)] years' experience, with project names and addresses, names and addresses of engineers and owners, and other information specified.

1.4 QUALITY ASSURANCE

- A. 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.
- C. 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.
- B. 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 waterbased 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 solventthinned 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.



- C. 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.
- F. 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.
- C. Or Owner approved equal.

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 bestgrade product will not be acceptable.
- C. Color Pigments: Pure, nonfading, applicable types to suit substrates and service indicated.



D. Colors:

1. Selected and approved by Owner and Engineer.
2. Prior to beginning Work, Engineer will provide color-coordinating schedule.
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 specified herein, 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 cementasbestos 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. Steel Structure Painting Council (SSPC) SP-13: Concrete preparation.
 - b. International Concrete Repair Institute (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 shopcoated, of oil, grease, dirt, loose mill scale and other foreign substances by solvent or mechanical cleaning methods that comply with the 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. Touchup shopapplied prime coats wherever damaged or bare, where required by other sections of these Specifications. Clean and touchup with same type of shop primer.
- D. Galvanized Surfaces: Clean free of oil and surface contaminants with nonpetroleum-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.

3.3 APPLICATION

- 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 ensure 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, convactor 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, nonspecular 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 shopprimed and touchup 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 firstcoat material to surfaces that have been cleaned, pretreated or otherwise prepared for painting as soon as practical 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 burnthrough 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 noncomplying 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 noncompatible.
- 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 CLEANUP AND PROTECTION

- A. CleanUp: 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, touchup and restore all damaged or defaced painted surfaces.
- C. Stopping Leaks - Infiltration leakage of all concrete and brick structures shall be stopped by 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

NOTE: Design Engineer to verify the need for DI pipe coating. Refer to Specification Section 02731 for typical exterior coatings for DI piping.

- 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

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

System B: Tnemec

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Corrosion Protection for Concrete Wastewater Structures
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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)

	DFT - Mils
One Coat: Sherwin-Williams Duraplate 6100/6000 Epoxy	50- 60

B. Below Grade Concrete and Precast Concrete Waste Water Service:

1. Interior: Wet Well or Manhole
2. Leak Stop/I&I Prevention : Avanti 275 or 202
3. 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.
4. 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
DETERIORATED CONCRETE: AW Cook Micro Silica Mortar	1/2 – 2 inches
5. 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



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SECTION 04305 - CONCRETE VAULTS AND CHAMBERS

The following specifications have been created as go-by specifications for Developers working inside the Metropolitan Sewer Subdistrict jurisdiction. They should be considered tentatively final with the potential for additional product requirements to be added in the future. Developers are instructed to modify the specifications to meet specific project needs and take full responsibility for the final products applicability, entire contents of the specification section, and for concordance with the other project documents. Areas shaded in gray have been identified as areas in need of further review or editing.

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 211.1 – Standard Practice for Selecting Proportions for Normal Heavyweight, and Mass Concrete
2. ACI 311 – Manual of Concrete Inspection
3. ACI 301 – Specifications for Structural Concrete for Buildings
4. ACI 318 – Building Code Requirements for Structural Concrete
5. ACI 347 – Guide to Formwork for Concrete
- ACI 350.1 – Specification for Tightness Testing of Environmental Engineering Concrete Containment Structures

B. ASTM International:

1. ASTM A615 – Specification for Deformed and Plain Carbon-Steel Bards for Concrete Reinforcement
2. ASTM A767 – Standard Specifications for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement
3. ASTM A1064 – Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete



4. ASTM C443 – Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
 5. ASTM C857 – Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures
 6. ASTM C877 – Standard Specification for External Sealing Bands for Concrete Pipe, Manholes and Precast Box Sections
 7. ASTM C891 – Standard Practice for Installation of Underground Precast Concrete Utility Structures
 8. ASTM C913 – Standard Specification for Precast Concrete Water and Wastewater Structures
 9. ASTM C923 - Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals.
 10. ASTM C1107 – Standard Specification for Packaged Dry, Hydraulic – Cement Grout (Nonshrink)
- 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.

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum five years' documented experience.
- B. Concrete manufacturing 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
- 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 Approved Equal.

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

ENGINEER TO DESIGN THE FOUNDATION SLAB TO RESIST FLOATATION. INCLUDE BUOYANCY CALCULATIONS IN DESIGN SUBMITTAL TO OWNER

C. Foundation Slab:

1. Precast concrete of type as shown on drawings.

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 A1064(Wire) and A615 (Bar).

2.7 MIXES

A. Concrete:

1. Normal Weight: Select proportions according to ACI 211.1 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. 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



SECTION 04306 - IDENTIFICATION AND SIGNAGE FOR UTILITIES

The following specifications have been created as go-by specifications for Developers working inside the Metropolitan Sewer Subdistrict jurisdiction. They should be considered tentatively final with the potential for additional product requirements to be added in the future. Developers are instructed to modify the specifications to meet specific project needs and take full responsibility for the final products applicability, entire contents of the specification section, and for concordance with the other project documents. Areas shaded in gray have been identified as areas in need of further review or editing.

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 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 "green" 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.

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



SECTION 04332 - SUBMERSIBLE SEWAGE PUMPING STATION

The following specifications have been created as go-by specifications for Developers working inside the Metropolitan Sewer Subdistrict jurisdiction. They should be considered tentatively final with the potential for additional product requirements to be added in the future. Developers are instructed to modify the specifications to meet specific project needs and take full responsibility for the final products applicability, entire contents of the specification section, and for concordance with the other project documents. Areas shaded in gray have been identified as areas in need of further review or editing.

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 RELATED DOCUMENTS

- A. Refer to Specification Section 04600 "Electrical" for electrical requirements.

1.3 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).
2. NFPA 820 - Standard for Fire Protection in Wastewater Treatment and Collection Facilities

E. UL, Inc.

1. UL 83 – Standard for Thermoplastic-Insulated Wires and Cables.

1.4 QUALITY ASSURANCE

1. The pumps and other equipment covered by this Specification shall be in accordance with the Hydraulic Institute (HI) standards and shall operate to the satisfaction of the Owner when installed.

1.5 SUBMITTALS

[ENGINEER TO SELECT SUBMITTALS BASED ON PROJECT REQUIREMENTS]

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.
2. Pump submittals shall include information on the performance characteristics of each pump, along with guaranteed, actual performance curves from factory tests, clearly demonstrating compliance with requirements of head, flow rate, efficiency, submergence, horsepower and net positive suction head. Pump curves shall be specific to the pumps required for the project and not generic curves.
3. Structural calculations signed and sealed by a Professional Engineer licensed to practice in the state of South Carolina.
4. Shipping weight of equipment.
5. Certified agreement to the terms and conditions of the warranty.
6. Description of factory tests and procedures
7. Factory certified test reports
8. Schematics and wiring diagrams for power and control systems.
9. Motor information and data, including, but not limited to:



- a. RPM
 - b. Input KW, nameplate rating
 - c. Speed, torque curves
 - d. Trip and alarm settings for temperature protective devices
 - e. Enclosure design
 - f. Starting current
 - g. Locked rotor kilo volt Amps (LR KVA)
 - h. Locked Rotor Amps (LRA)
 - i. Full Load Amps (FLA)
 - j. NEMA starting code letter and insulation code letter
 - k. Starting calculations
 - l. Starting current
 - m. Rated horsepower
 - n. Cable size
 - o. Efficiency and power factors at 50%, 75%, and 100% load.
10. Total bill of materials of all equipment.
 11. Recommended spare parts, with current price listing for each item
 12. Complete set of record drawings upon completion
 13. Provide [three (3)] copies of operations and maintenance manuals (O&M) specific to the project. The O&M manuals shall include, but shall not be limited to, equipment cut sheets, associate drawings, list of equipment, programming and controls descriptions, maintenance schedules, maintenance equipment, operation limits.
 14. O&M 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. Three copies of manual shall be submitted for review. After review of manual, three final copies shall be furnished.

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, 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 impeller 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 or 120/208V, 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, NEMA Design B, equipped 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 operating on VFD shall be inverter duty, with a 1.0 service factor. 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 and Class I, Division 1, Group C&D hazardous locations. 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) embedded 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 Protection Relay: The pump supplier shall furnish all relays required for monitoring all motor sensors. The relays shall be installed by others in the pump 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 pump 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 PUMP CONTROL PANELS:

- A. Pump controls panels shall be provided with the pumps and shall be coordinated with the pump manufacturer to meet the requirements herein:
1. Pump control panels shall be suitable for power supply as shown on the drawings.
 2. The complete control panel assembly shall be UL certified or carry a UL listing for "Industrial Control Panels"
 3. The control panel shall meet all applicable requirements of the National Electrical Code.
 4. The pump control panel shall include circuit breakers for auxiliary equipment, an ultrasonic liquid level monitoring/control system, backup floats, a pump station management system, an emergency backup full voltage starter, shipped separately (for one pump motor) and all items required for a complete system. The system shall be complete, requiring only connection of power, motor and control wiring.
- B. Normal Operation: Liquid levels will be monitored 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 motor moisture detection or high motor temperature shut down.
 3. Two amber LED push-to-test indicator lights for each pump (4 required) shall be provided on the face of the pump control panel to indicate 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 next pump selection when the "pump start" liquid level is reached. These alarm circuits shall signal the telemetry unit so operations personnel will be notified of the alarm condition.
 5. Liquid Level Monitoring/Control System – One system shall be installed at the pump station wet well and control panel to monitor wet well level. The system shall be an ultrasonic sensor Zenith pump controller by Pulsar Measurement, no approved equal.
 6. If a high-water condition is detected by the liquid level monitoring/control system, it shall activate the telemetry unit. The telemetry unit shall also be activated during a total power failure.
 7. Backup Float Switches (see paragraph C) - Four mercury-free float switches shall be provided and be mounted on stainless steel chain with 15 lbs weight:
 - a. Level High-High 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 telemetry unit. 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).



- b. Level High Switch (lag pump on) – Shall be installed in the pump station wet well to turn on the lag pump. Lead pump will remain in operation.
- c. Level Low Switch – Shall be installed in the pump station wet well to turn on the lead pump.
- d. Level Low-Low Switch (pumps off) - Shall be provided in the pump station wet well to turn off the lead and lag pumps.

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.

- 8. The pump control panel shall have circuitry to lock out a pump due to high temperature. The telemetry unit 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 telemetry unit 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 event of utility 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 via backup float switches to control the emergency full-voltage non-reversing starter (see below).
- 3. One full-voltage non-reversing bypass motor 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 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 telemetry unit. 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 telemetry unit. The telemetry unit shall also monitor for power failure.

- E. Components of the control panel shall include the starters for both pumps and strip of 120/208 volt branch circuit breakers for distribution of 120/208 volt power.

- 1. Main circuit breaker shall be a thermal-magnetic molded case breaker. Provide a flange mounted main power disconnect operating handle with mechanical interlock having a bypass that will allow the panel door to open only when the switch is in the OFF position.



2. A mechanical disconnect mechanism, with bypass, shall be installed on each motor circuit protector, capable of being locked in the "OFF" position to provide a means of disconnecting power to the motor.
3. An open frame, [full voltage non-reversing, reduced voltage soft start, or VFD] as shown on the Drawings. NEMA rated magnetic motor starter shall be furnished for each motor. Motor starters shall be provided with motor circuit protectors and equipped to provide under-voltage release and overload protection on all three phases. Overload reset push-buttons shall be located on the exterior of the control panel door.
4. Auxiliary contacts shall be provided for remote run indication and indication of each status and alarm condition. Additional controls shall be provided as specified herein and as required by the detailed mechanical equipment requirements, the Control Descriptions, and as shown on the Drawings.
5. All operating control devices and instruments shall be securely mounted on the exterior door. All controls shall be clearly labeled to indicate function and shall be rated as indicated in the detailed mechanical equipment requirements in accordance with the electrical area classification indicated on the Electrical Contract Drawings.
 - a. Indicator lamps shall be heavy duty, industrial type, high-visibility LED, full voltage type. Units shall have screw on plastic lenses and shall have factory engraved legend plates as required. Lens color shall be green for OFF, red for ON and amber for FAIL or ALARM. For all control applications indicator lamps shall incorporate a push-to-test feature.
 - b. Mode selector switches (HAND-OFF-AUTO, LOCAL-OFF-REMOTE, PUMP SELECTOR, LEAD-LAG, etc.) shall be heavy-duty, industrial type with contacts rated for 120 VAC at 10 Amps continuous. Units shall have standard size, black field, and legend plates with white markings, as indicated. Operators shall be black knob type. Units shall have the number of positions and contact arrangements, as required. Units shall be single-hole mounting, accommodating panel thicknesses from 1/16-in minimum to 1/4-in maximum.
 - c. Push-button, shall be heavy-duty, industrial type with momentary or maintained contacts as required, rated for 120 VAC at 10 Amps continuous. Units shall have standard size, black field, and legend plates with white markings, as indicated. Button color shall be red for EMERGENCY STOP or START and green for STOP. Contact arrangement shall be as required.
6. Intrinsically safe relays shall be solid state type with 5 Amp output contacts, suitable for use on a 120 Volt, 60 Hz power supply and shall be Factory Mutual approved for pilot devices in Class I, Division I, Group D hazardous atmospheres.
7. Control relays and timers shall be 300 Volt, industrial rated, plug-in socket type, housed in a transparent polycarbonate dust cover, designed in accordance with UL Standard 508 for motor controller duty. Continuous contact rating shall be 10 Amps resistive, 1/4 Hp, at 120 VAC, with an operating temperature of minus 10 to plus 55 degrees C.
8. Specific control devices, control descriptions and other data are specified under the detailed specification for the mechanical equipment with which the control panel is supplied.
9. Control panel shall include necessary components to allow functions described above in backup operation.
10. Suitable 480-120/208V 3-phase transformers shall be provided in the pump control panel to provide 120V 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.
 11. 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.
 12. Pump controls shall include continuous power phase monitoring that will stop the pumps and signal the telemetry in the case of losing one phase of power.
 13. Pump control panel shall include condensation heaters with control thermostat mounted inside the panel.
- 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 316 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. Telemetry unit: The telemetry shall be SCADA - High Tide Technologies (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 protective device (SPD) on a dedicated circuit breaker.
- 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 Owner 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 Oring, and shall be replaceable. The valve body shall be cast iron incorporating a cleanout 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 Orings 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 2way, full port plug valve to permit isolation of the pumps from the common discharge header. The plug valve shall be nonlubricated type. Valve body shall be cast iron with flanged end connections drilled to 125 pound standard. Valve shall be furnished with a driptight 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 minimum pressure class 250.
 - 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 ensure 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. 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.
- C. 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:

- A. The authorized pump / package shall warrant the pumps to be supplied to the owner for a period of five (5) years from date of final payment. 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



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SECTION 04531 - SANITARY SEWER FORCE MAINS

The following specifications have been created as go-by specifications for Developers working inside the Metropolitan Sewer Subdistrict jurisdiction. They should be considered tentatively final with the potential for additional product requirements to be added in the future. Developers are instructed to modify the specifications to meet specific project needs and take full responsibility for the final products applicability, entire contents of the specification section, and for concordance with the other project documents. Areas shaded in gray have been identified as areas in need of further review or editing.

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
 - 2. Section 02730 – Sanitary Sewer Systems
 - 3. Section 02731 – Ductile Iron Sewer Pipe
 - 4. Section 02732 – Polyvinyl Chloride Sewer Pipe

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.

1.3 REFERENCE STANDARDS

- A. American National Standard Institute (ANSI) and American Water Works Association (AWWA):
 - 1. ASME/ANSI B16.1 – Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125 and 250
 - 2. AWWA C110 – Ductile-Iron and Gray-Iron Fittings
 - 3. AWWA C111 – Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
 - 4. AWWA C151 – Ductile-Iron Pipe, Centrifugally Cast, for Water
 - 5. AWWA C210 – Liquid-Epoxy Coatings and Linings for Steel Water Pipe and Fittings
 - 6. AWWA C213 – Fusion-Bonded Epoxy Coatings and Linings for Steel Water Pipe and Fittings
 - 7. AWWA C600 – Installation of Ductile-Iron Water Mains and Their Appurtenances
 - 8. AWWA C900 – Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. Through 60 In (100 mm Through 1,500 mm)



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

1. ASTM A285 – Standard Specification for Pressure Vessel Plates, Carbon Steel, Low-and Intermediate-Tensile Strength
2. ASTM A377 – Standard Index of Specifications for Ductile Iron Pressure Pipe

PART 2 - PRODUCTS

2.1 DUCTILE IRON PIPE (DIP)

- A. Pipe shall be pressure class 350 in compliance with ASTM A377, AWWA C150, and AWWA C151. 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. Metro may require, in certain circumstances, for the exterior to be coated with Tnemec 431.
- E. Gaskets for flanged pipe shall be suitable for AWWA C110 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 AWWA C111.
- 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 at maximum of 1,000 LF intervals.

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":
 1. Comply with AWWA C900.



2. Minimum Class 200 (DR 18) or as designed by engineer.
3. Joints: elastomeric-gasket bell-end pipe.
4. Joint Restraint:
5. Provide restraint for C900 PVC pipe by mechanical means separate from the mechanical joint gasket sealing gland.
6. Restraint device to be a two-piece configuration with a serrated inside surface to provide contact around full pipe circumference.
7. Restraint device body to be manufactured from steel (ASTM A285 Grade C) with fusion epoxy coated surfaces except the serrations.
8. Comply with AWWA C111.
9. Pressure rating to match PVC pipe on which it is used with capability to withstand test pressure of 2 times rated pressure.
10. Finish fusion applied epoxy coating per AWWA C213.

2.4 JOINT RESTRAINT

- A. Provide joint restraints per approved materials list.

2.5 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 unless otherwise approved by MetroConnects.**
- D. Pipe shall be laid by beginning at the bottom of the slope and proceeding upward with the bell ends of the new pipe upslope. The spigot end shall be installed into the bell end until the reference point on the pipe.
- E. Force mains in relation to water lines must conform to subsection 67.300.A.14.d 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. 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



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SECTION 04600 - ELECTRICAL

The following specifications have been created as go-by specifications for Developers working inside the Metropolitan Sewer Subdistrict jurisdiction. They should be considered tentatively final with the potential for additional product requirements to be added in the future. Developers are instructed to modify the specifications to meet specific project needs and take full responsibility for the final products applicability, entire contents of the specification section, and for concordance with the other project documents. Areas shaded in gray have been identified as areas in need of further review or editing.

PART 1 - GENERAL

1.1 SUMMARY

- A. The Contractor shall provide all labor, 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 latest adopted edition of the National Electric Code, national and local codes and standards, 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, coordinate Division of Responsibility between work to be completed by the Contractor and work to be completed by the Utility, and arrange for temporary power as required.

1.2 SUBMITTALS

- A. Shop Drawings shall be submitted for review and shall include the following:

ENGINEER TO SPECIFY ANY ADDITIONAL, SPECIFIC SUBMITTAL REQUIREMENTS
ARC FLASH STUDY REQUIREMENTS AND TIMEFRAME BASED ON PROJECT
NEEDS.

- 1. Materials list of items proposed to be provided under this Section.
- 2. Manufacturer's specifications, schematic diagrams, elevation diagrams with dimensions, project-specific catalog cut sheets, other data and shop drawings needed to prove compliance with the specified requirements. Provide the following Shop Drawings for review:
 - a. Raceways and Fittings
 - b. Conductors
 - c. Grounding and Bonding



- d. Surge Protective Device
 - e. Wiring Devices and Cover Plates
 - f. Lighting Systems
 - g. Disconnect Switches
 - h. Main Circuit Breakers
 - i. Mini-Power Centers
 - j. Manual Transfer Switch
 - k. Automatic Transfer Switch
 - l. Power Quality Meter
 - m. 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. Shop Drawing information shall be project specific. Where several options or model numbers are provided, highlight the selection that will be provided as a part of this project and cross out irrelevant information. Generic catalog cut sheets will not be acceptable.
 - C. Material and equipment of the same type shall be the product of one manufacturer and be UL listed and labeled.
 - D. Operation and Maintenance (O&M) 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. All warranties shall start at final payment.
 - B. Provide standard two (2) year warranty on all labor and materials.
 - C. Provide a five (5) year warranty on all LED fixtures.
 - D. Provide minimum five (5) year warranty on Surge Protection Devices, incorporating unlimited replacements of suppressor parts if destroyed by transients during the warranty period.
 - E. Provide standard five (5) year parts and labor warranty on automatic transfer switch.
 - F. Provide a minimum two (2) year warranty for all elements, work, equipment not detailed above.
- 1.4 POWER SUPPLY



- A. Voltage power supply to the pump station shall be as indicated on the Drawings.

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 6A: Electrical Rigid Metal Conduit – Aluminum, Red Brass, and Stainless Steel
4. UL 651-2011: Schedule 40 PVC and schedule 80 Rigid PVC Conduit.
5. UL 514B: Flexible conduit fittings.
6. NEMA FB 1: Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing and Cable.
7. ASTM F512: Polyvinyl Chloride (PVC) Conduit.
8. FS-WW-C-540C: Federal Specification for Rigid Aluminum Conduit.
9. 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 in 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" copper clad 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.
 5. All exposed conduits and installations in concrete-encased duct bank for analog signal wiring: Galvanized rigid steel conduit.

2.3 CONDUCTORS

A. Applicable standards:

1. UL 44: Thermoset-Insulated Wires and Cables.
2. UL 83: Thermoplastic-Insulated Wires and Cables.
3. UL 854: Service Entrance Cables.

B. Conductors Acceptable Manufacturers:

1. Okonite.
2. Pirelli.
3. Southwire.



4. Superior Essex.
5. Belden.
6. Or approved equal.

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, XLPE insulated, twisted pair or triplet, 100-percent aluminum-polyester, overall shield with 20-gauge drain. Pairs individually shielded.
 - g. Provide analog signal conductors sized as shown on drawings with minimum size of 16-gauge.
 - h. For all discrete signal conductors, provide copper stranded, 600V, Type THWN with a minimum size of #14, unless otherwise noted.
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: 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 AC Substation Grounding.



5. IEEE 81: Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System.
 6. NETA ATS: Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems (InterNational Electrical Testing Association).
- 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. Acceptable Manufacturers:
 - a. Harger GAW series
 - b. 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 WIRING DEVICES AND COVER PLATES

A. Applicable standards:

1. ANSI/NEMA OS 1: Sheet-steel Outlet Boxes, Device Boxes, Covers and Box Supports.
2. ANSI/NEMA FB 1: Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable.
3. NEMA 250: Enclosures for Electrical Equipment (1000 Volts Maximum).
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 SYSTEMS

A. Lighting fixtures shall be LED type and full cutoff to be dark-sky compliant.

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.

D. Light Poles:

1. Light Poles shall be square cross-section, anodized aluminum, dark bronze color, and shall be furnished with stainless steel anchor bolts, washers, and nuts for installation in concrete pole bases.
2. Poles and anchors shall be rated for 110-mph (minimum) wind loading with the installed lighting fixtures.

E. Wall Packs

1. Outdoor wall-packs required to illuminate emergency egress pathways shall be battery-backed.



2.8 DISCONNECT SWITCHES

A. Applicable standards:

1. FS W-S-865: Switch, box (enclosed), surface-mounted.
2. NEMA KS 1: Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum).

B. Acceptable manufacturers – disconnect/safety switches:

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

C. Disconnect Switches:

1. 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. Fusible disconnect switches shall be provided with Class R Fuse Kit.
 - d. Service-rated switches shall be labeled for use as service equipment.
 - e. Provide auxiliary contact kit with two NO/NC (Form “C”) auxiliary contacts arranged to active before switch blades open.

D. Provide NEMA 4X, Type 316 stainless steel enclosures or as indicated on the Drawings.

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: Enclosures for Electrical Equipment, Non-Environmental 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.



2. Provide frame size, trip rating, interrupting rating, and auxiliary devices as required for application.
3. Provide NEMA 4X, 316 stainless steel enclosures or as indicated on the Drawings.

2.10 MINI-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 316 stainless steel.

2.11 MANUAL TRANSFER SWITCH

A. Applicable standards:

1. UL 50: Enclosures for Electrical equipment, Non-Environmental Considerations.

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, Type 316 stainless steel rain-tight, 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 316 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.
- L. Product features:
1. Indicating Lights: Mount in cover of enclosure to indicate switch position.
 2. Transfer Switch Auxiliary Contacts: 1 normally open; 1 normally closed
- 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 110: Emergency and Standby Power Systems.
 4. IEEE 446: IEEE Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications.
 5. 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, 316 stainless steel as a minimum.
- E. Provide switch as open transition, 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 or 4-pole with switched 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. Two (2) NO and two (2) NC Contacts Rated 10 amps 250VAC.
 13. 60 Hz.
 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. Splices for power wiring shall be compression type connectors insulated with a heat shrink boot or outer covering and epoxy filling. Splice kits shall be as manufactured by Raychem; Ideal Industries; 3M Co., or equal.
- B. Splices for control wiring shall be insulated compression type connectors of the expanded vinyl insulated parallel or pigtail type as manufactured by Ideal Industries; 3M Co.; Panduit Corp., or equal.
- C. Splice only in accessible junction boxes.
- D. Thoroughly clean wires before installing lugs and connectors.
- E. Terminate spare conductors with 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, including installation of explosion-proof seal-offs.
- 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 the Owner's representative. Identify and properly record all readings. Submit test results to Owner 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

ENGINEER TO SPECIFY ANY ADDITIONAL, SPECIFIC SUBMITTAL REQUIREMENTS AND TIMEFRAME BASED ON PROJECT NEEDS.

- A. Wiring and equipment in hazardous locations, as defined by the NEC Article 500, 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



SECTION 04632 - STANDBY ELECTRICAL POWER SYSTEM

The following specifications have been created as go-by specifications for Developers working inside the Metropolitan Sewer Subdistrict jurisdiction. They should be considered tentatively final with the potential for additional product requirements to be added in the future. Developers are instructed to modify the specifications to meet specific project needs and take full responsibility for the final products applicability, entire contents of the specification section, and for concordance with the other project documents. Areas shaded in gray have been identified as areas in need of further review or editing.

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-resistant, 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)
 - 10. Aluminum access platform with stairs and handrail if sub-base fuel tank is taller than 30-inches.
- 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, schematics, project specific catalog cut sheets, dimensioned drawings of the generator, enclosure and fuel tank, fuel consumption, weight, 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 Owner, 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) plus auxiliary loads such as lighting and HVAC. 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. All warranties shall start at the time of Final Payment. There shall be one source responsible for warranty; parts and service through a local representative, located within a 100-mile radius of the Owner, 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 and labor costs for failures due to defects in materials and workmanship to the "as shipped consist" from the factory, excluding filters, fluids, v-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. Cummins/Onan

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 DIESEL ENGINE

A. Provide fuel filter and fuel transfer pump at engine.

B. Provide intake and exhaust valves made of heat resisting alloy steel with exhaust valve seat inserts.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Fuel: ASTM D 975 diesel fuel oil, Grade 2-D S15.

E. Rated Engine Speed: 1800 rpm.

F. Lubrication System: Engine or skid mounted.

1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.

G. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine generator mounting frame and integral engine-driven coolant pump.

1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.



2. Size of Radiator: Adequate to contain expansion of total system coolant, from cold start to 110 percent load condition.
 3. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
 4. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, UV-, and abrasion-resistant fabric.
 - a. Rating: 50-psig maximum working pressure with coolant at 180 deg F, and non-collapsible under vacuum.
 - b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.
- H. Supply full pressure lubrication by lube oil pumps.
- I. Provide air cleaner, fuel and oil filters with replaceable elements, and lube oil cooler.
- J. Govern engine speed by electronic governor to maintain the alternator frequency within one (1) hertz from no load to full load alternator output.
- K. Provide remote, 2-wire starting by a solenoid shift, electric starter.
- L. 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. Comply with UL 508A.
- C. Automatic-Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of engine generator. When mode-selector switch is switched to the ON position, engine generator starts. The OFF position of same switch initiates engine generator shutdown. When engine generator is running, specified system or equipment failures or derangements automatically shut down engine generator and initiate alarms.
- D. Provide the following functionality integral to the control panel:

ENGINEER TO UPDATE REQUIREMENTS BASED ON PROJECT NEEDS.

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
- E. Provide the panel with the following Digital indications:

ENGINEER TO UPDATE REQUIREMENTS BASED ON PROJECT NEEDS.

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

- F. 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):

ENGINEER TO UPDATE REQUIREMENTS BASED ON PROJECT NEEDS.

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
- G. Provide the ability to accept six (6) programmable digital input signals.
- H. 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
- I. 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
- J. Equip unit with factory mounted terminal blocks and strips for all power, signal and control wiring connections.
- K. Provide the following dry contacts to interface with Owner's RTU:
 - 1. Generator Running
 - 2. Generator Alarm
 - 3. Generator Fail
 - 4. Low Fuel
 - 5. Fuel Leak
- L. Provide the following analog signals with Owner's RTU:
 - 1. Fuel Level

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.

ENGINEER TO UPDATE REQUIREMENTS BASED ON PROJECT NEEDS.

- 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) Complying with UL 142 fuel-oil tank.

C. Access Platform:

1. If required, engage a licensed structural professional engineer for the design of the access platform and concrete landings or pad.

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.
3. Generator Circuit Breaker: Molded-case, electronic-trip type; complying with UL 489.



- a. Tripping Characteristics: Adjustable long-time and short-time delay and instantaneous.
- b. Trip Settings: Selected to coordinate with generator thermal damage curve.
- c. Shunt Trip: Connected to trip breaker when engine generator is shut down by other protective devices.
- d. Mounting: Adjacent to or integrated with control and monitoring panel.

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 the Owner's representative. It shall be demonstrated during these tests that the voltage sensitive and time delay devices perform at their specified settings.
- D. Perform tests recommended by manufacturer and each visual and mechanical inspection and electrical and mechanical test listed in first two subparagraphs below, as specified in NETA ATS. Certify compliance with test parameters.
 - 1. Visual and Mechanical Inspection:
 - a. Compare equipment nameplate data with Drawings and the Specifications.
 - b. Inspect physical and mechanical condition.
 - c. Inspect anchorage, alignment, and grounding.
 - d. Verify that the unit is clean.
- E. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here, including, but not limited to, single-step full-load pickup test.
- F. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.



1. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
 2. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
 3. Verify acceptance of charge for each element of the battery after discharge.
 4. Verify that measurements are within manufacturer's specifications.
- G. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
- H. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine generator system before and during system operation. Check for air, exhaust, and fluid leaks.
- I. Retain "Exhaust-System Back-Pressure Test" Subparagraph below for long, restricted exhaust systems.
- J. Verify local requirements and delete "Exhaust Emissions Test" Subparagraph below for most projects. See the Evaluations for discussion of Tier requirements.
- K. Exhaust Emissions Test: Comply with applicable government test criteria.
- L. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.
- M. Noise Level Tests: Measure A-weighted level of noise emanating from engine generator installation, including engine exhaust and cooling-air intake and discharge, at four locations 25 feet from edge of the generator enclosure, and compare measured levels with required values. Coordinate tests with tests for transfer switches and run them concurrently.
- N. Test instruments shall have been calibrated within the past 12 months, traceable to NIST Calibration Services, and adequate for making positive observation of test results. Make calibration records available for examination on request.
- O. Leak Test: After installation, charge exhaust, coolant, and fuel systems and test for leaks. Repair leaks and retest until no leaks exist.
- P. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation for generator and associated equipment.
- Q. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- R. Remove and replace malfunctioning units and retest as specified above.
- S. Retest: Correct deficiencies identified by tests and observations, and retest until specified requirements are met.



- T. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

3.3 TRAINING

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

END OF SECTION 04632



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