

SANITARY SEWER STANDARDS AND PROCEDURES

STANDARD TECHNICAL SPECIFICATIONS

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DIVISION 1 – GENERAL

01410 REGULATORY REQUIREMENTS AND REFERENCES

PART 1 GENERAL

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

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

1.2 SILTATION AND EROSION CONTROL

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

1.3 SAFETY AND HEALTH REGULATIONS

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

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

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

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

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION 01410

01550 VEHICULAR ACCESS AND TRAFFIC CONTROL

PART 1 GENERAL

1.1 RELATED SECTIONS

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

1.2 PROJECT ACCESS

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

1.2 TRAFFIC CONTROL

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

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION 01550

01570 ENVIRONMENTAL PROTECTION

PART 1 GENERAL

1.1 SUMMARY

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

1.2 WATER AND AIR POLLUTION

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

1.3 WASTEWATER FLOW

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

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION 01570

01660 MATERIAL STORAGE AND HANDLING

PART 1 GENERAL

1.1 DELIVERY AND HANDLING

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

1.2 STORAGE

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

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION 01660

DIVISION 2 - SITE CONSTRUCTION

02100 CLEARING AND GRUBBING

PART 1 - GENERAL

1.1 SCOPE OF WORK

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

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.1 GENERAL

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

END OF SECTION 02100

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

PART 1 GENERAL

1.1 SCOPE

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

1.2 RELATED SECTIONS

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

PART 2 PRODUCTS

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

PART 3 EXECUTION

3.1 SAFETY

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

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

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

- A. No pipeline, including service connections, shall be installed in open trench unless actually shown on plans as open cut. All service connections shall be bored, driven, or punched under roadways maintained by the DOT. If open cutting is allowed, backfilling of trenches is to be accomplished immediately after placement of the pipe. Trenches will not be left open during hours of darkness.
- B. The top of the pipeline or casing shall be installed at a minimum depth of thirty-six (36) inches from grade for longitudinal installations located between the ditch line and the right-of-way line. Otherwise, the top of the pipeline or casing shall be installed at a minimum depth of forty-two (42) inches from the top of asphalt.
- C. Excavation for the roadways, drives, and parking areas shall conform to the lines, grades, cross sections, and dimensions indicated on the drawings and shall include the excavation of all unsuitable material from the subgrade. After shaping to line, grade, and cross section, the subgrade shall be placed and compacted in six (6) inch layers or less with each layer being thoroughly compacted to a density of 95% standard proctor as determined by AASHTO T-99. This operation shall include any reshaping and wetting or drying required to obtain proper compaction. All soft or otherwise unsuitable material shall be removed and replaced with suitable material. Compaction tests shall be taken per associated SCDOT permit.

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

3.3 INSPECTIONS

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

3.4 MAINTENANCE

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

END OF SECTION 02210

02221 TRENCH EXCAVATION, BEDDING AND BACKFILL

PART 1 GENERAL

1.1 SCOPE

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

1.2 RELATED WORK

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

1.3 MANHOLE EXCAVATION

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

1.4 PIPE LINES

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

1.5 REFERENCE STANDARDS

- A. ASTM D 698 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort
- B. ASTM D 2321-11 – Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity Flow Applications.
- C. ASTM D 2487-93 – Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).

PART 2 PRODUCTS

2.1 BEDDING MATERIALS

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

2.2 BACKFILL MATERIAL

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

2.3 STABILIZATION STONE

Materials used for stabilization shall be equal to bedding materials.

2.4 SELECT BACKFILL

Select backfill material shall be well graded soil obtained from on site or off-site locations. Material shall be free from roots and vegetative matter, debris, stones larger than 1-1/2", and organic matter including soils OL, OH and PT as defined in the Unified Soil Classification System and referenced in ASTM D 2487-93.

PART 3 EXECUTION

3.1 TRENCH EXCAVATION

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

3.2 ROCK EXCAVATION

- A. The Contractor shall notify the Engineer immediately if "rock excavation" is encountered. "Rock excavation" shall be material which, in the opinion of the Engineer, cannot be removed by a John Deere 230, Caterpillar 230, Komatsu 220 or other similar trackhoe, or by means other than blasting or with air hammer. Materials which can be removed by ripping shall not be considered "rock excavation". Removal of "hard material" will not be considered rock excavation because of intermittent drilling and blasting that is performed merely to increase production.

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

3.3 BLASTING

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

3.4 BEDDING

- A. General. The bedding surface for the pipe shall provide a firm foundation of uniform density throughout the entire length of the pipe. If soft, mucky, or otherwise unstable or unsuitable materials are encountered in the trench bottom, it shall be removed and replaced with stabilization stone as directed by the Engineer.
- B. Joints. Bell holes and depressions for joints shall be shaped in order that the pipe or conduit rest on the prepared bottom for its full length, bell holes and depressions shall be only of such length, depth and width as required for making the particular type of joint. Blocking under pipe or conduit will not be allowed.

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

3.5 BRACING AND SHEETING

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

3.6 PUMPING

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

3.7 TRENCH EARTH DAMS

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

3.8 BACKFILLING

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

the original adjacent material. However, the minimum compaction density shall be 95% of maximum density as specified by ASTM-D-698 or AASHTO T99 (Standard Proctor) Method A, at optimum moisture content. Wet or dry backfill as necessary.

- E. In all paved areas the Contractor shall provide crushed stone for the top 4" of the trench backfill as a temporary patch. The crushed stone shall be maintained flush with existing pavement until the temporary patch is removed and replaced with the required base course. The Contractor shall be responsible for maintaining the pavement cut in a safe condition for pedestrian and vehicular traffic.
- F. Backfill adjacent to manholes shall be placed and compacted uniformly in such a manner as to prevent wedging action or eccentric loading upon or against the structure. Slopes bounding or within the areas to be backfilled shall be stepped or serrated to prevent sliding of the fill. During backfilling operations, equipment that will overload the structure in passing over and compacting these fills shall not be used.
- H. Any deficiency in the quantity or quality of material for backfilling the trenches, or for filling depressions caused by settlement, shall be supplied by the Contractor at his expense from an approved borrow site or the Contractor may use crusher run stone at his option without additional cost to the Owner.
- I. In paved areas or areas subject to vehicular traffic where the Engineer determines soil conditions adjacent to the trench prohibit adequate compaction of soil backfill, crusher run stone shall be required for backfill. The Contractor shall be paid for the backfill material at the unit price bid for crusher run stone.
- J. No more than 100 feet of trench shall be open at any given time.

3.9 TESTING

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

END OF SECTION 02221

02226 UTILITY REMOVAL AND ABANDONMENT

PART 1 GENERAL

1.1 SUMMARY

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

1.2 REFERENCE STANDARDS

- A. ASTM D 698 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 REMOVAL

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

3.2 ABANDONMENT OF MANHOLES

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

3.3 SALVAGED PARTS

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

END OF SECTION 02226

02240 DEWATERING

PART 1 GENERAL

1.1 SUMMARY

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

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 GENERAL

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

END OF SECTION 02240

02250 SHEETING AND BRACING

PART 1 GENERAL

1.1 SUMMARY

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

1.2 SITE CONDITIONS

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

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 INSTALLATION

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

3.2 REMOVAL

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

END OF SECTION 02250

02300 TUNNELING OR BORING

PART 1 GENERAL

1.1 SCOPE

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

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

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

1.2 SUBMITTALS

- A. Submit material certificates and product data for steel encasement pipe which certify conformance and compliance to specified requirements.
- B. Submittals shall meet all requirements of Section 01340.

PART 2 PRODUCTS

2.1 ENCASEMENT PIPE

- A. Steel encasement pipes shall be smooth wall welded steel pipe, or steel liner plate conforming to ASTM Designation A139, Grade B. The outside of the pipe shall be coated in accordance with AWWA Standard C203. Minimum yield strength shall be 35,000 PSI.

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

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

2.2 STEEL TUNNEL LINER PLATES

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

PART 3 EXECUTION

3.1 GENERAL

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

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

3.2 EXCAVATION

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

3.3 INSTALLATION

- A. The alignment and grade shall be carefully maintained and the encasement pipe installed in a straight line.
- B. The space outside the encasement and the ground shall be filled with grout, sand or pea gravel, as directed by the Engineer. The Engineer will direct that this space be filled if the space is large enough to cause any earth settling.
- C. After encasement pipes are installed, the ductile iron carrier pipe shall be installed in the encasement pipe using slip-on joints. The ends of the encasement pipe shall be sealed as shown on the drawings.
- D. The carrier pipe shall be supported and blocked inside the encasement pipe at 10' intervals to true line and grade and in such a manner to prevent horizontal or vertical movement. Steel straps may be used as shown on the drawings, or other means as approved by the Engineer.

END OF SECTION 02300

02531 SANITARY SEWER FORCE MAINS

PART 1 GENERAL

1.1 SUMMARY

- A. Work consists of the furnishing and installing of sanitary sewer force mains and appurtenances.
- B. Related Sections
 - 1. Section 02316 - Trench Excavation and Backfill

1.2 SUBMITTALS

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

PART 2 PRODUCTS

2.1 DUCTILE IRON PIPE (DIP)

- A. Pipe shall be minimum Class 50 (Class 53 for flanged joints) in compliance with ASTM A 377, ANSI A21.50, and ANSI A21.51. Pipe shall be furnished with push-on, mechanical or flanged joints.
- B. Flanged joints for flanged pipe and fittings shall be furnished with 125 pound flanges drilled in accordance with ANSI B 16.1. 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 cement mortar lined and seal coated, in accordance with ANSI-A 21.4. Exterior of all pipe fittings and specials shall be coated with either a coal tar or asphaltic base bituminous pipe coating in accordance with ANSI-A 21.8.
- E. Gaskets for flanged pipe shall be suitable for ANSI A21.10 or 125 pound ANSI B16.1 flanges. Gaskets shall be neoprene and shall have a minimum thickness of 1/16" for 8" diameter and smaller pipe and 3/32" for 10" diameter and larger. Rubber gaskets for mechanical and push-on joints shall conform to the requirements of ANSI A21.11.
- F. Tracer wire
 - a. Provide minimum 12-gage solid copper tracer wire encased in 30 mil HDPE insulation for all force mains.
 - b. Provide tracer wire connection point at each manholes and cleanout.

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.
- B. Pipe shall be BOLT-LOK restrained joint pipe as manufactured by Griffin Pipe Products Co. or approved equal.

2.3 JOINT RESTRAINT

- A. Provide MEGALUG Series 1100 as manufactured by EBAA Iron Sales, Inc. or approved equal.

2.4 REPAIR COUPLING

- A. Provide Smith-Blair 226 or 227 repair couplings, or approved equal.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Ductile Iron Pipe shall be installed in accordance with AWWA C-600.
- B. Pipe shall be laid with bell ends facing in the direction of pipe laying, beginning at the bottom of the slope and proceed upward with the bell ends of the new pipe upgrade.
- C. Force mains in relation to water lines must conform to subsection 67.300.A.14.e of the SC DHEC "Standards for Wastewater Facility Construction: R.61-67".
- D. 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.
- E. 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.
- F. 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. All piping shall be thoroughly flushed prior to pressure testing. Flushing shall be accomplished by providing a flushing velocity of no less than 2 1/2 feet per second in the pipeline.
- D. Pressure Test.
1. Test each valved section of new piping to a hydrostatic pressure of 150 pounds per square inch. Each valve section shall be independently tested in accordance with AWWA C 600. 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 02531

02575 PAVEMENT REMOVAL AND REPAIR

PART 1 GENERAL

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

PART 2 PRODUCTS

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

PART 3 EXECUTION

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

B. SUBGRADE PREPARATION

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

C. CUTTING AND REPLACING PAVEMENT

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

G. SURFACE COURSE

- a. 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.
- b. Where the trench patch crosses a SCDOT roadway, the roadway shall be resurfaced for a distance of 50 feet on each side of the trench patch. The limit of surface course shall be feathered into the existing pavement.

- H. **CONCRETE PAVEMENT AND CURB AND GUTTER:** The replacement of concrete pavements, and concrete curb and gutters shall meet all requirements of Section 720 of the SCDOT specifications.
- I. **CUTTING AND REPLACING SIDEWALK.** Where sidewalk is cut for installation of pipe or other utilities, Contractor shall cut it neatly in advance of trench and replace as described below or as shown on the plans. Where installation is along the line of sidewalk, sidewalk may be removed, with Engineer's approval and replaced in kind.
- a. Sidewalk cutting shall be as described for pavement cutting above.
 - b. Trench Backfill under sidewalk shall be as describe in Subgrade Preparation (3.B) 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.

END OF SECTION 02575

02730 SANITARY SEWER SYSTEMS

PART 1 GENERAL

- A. **SCOPE:** Work in this section consists of the supply and installation of all gravity sanitary sewer lines including layout, identification of other utility crossings or conflicts, establishment and maintenance of required alignment and grade, cleaning, and testing as shown on the drawings and specified herein.
- B. **Related Work:**
- a. Section 02221 Trench Excavation, Bedding and Backfill
 - b. Section 02290 Boring and Jacking
 - c. Section 02731 Ductile Iron Gravity Sewer Pipe (DIP)
 - d. Section 02732 Polyvinyl Chloride (PVC) Gravity Sewer Pipe
- C. **OTHER REQUIREMENTS**
- a. All pipe elevations shown on the Drawings are invert elevations (i.e., the bottom inside of pipe), unless otherwise shown.
- D. **SUBMITTALS**
- a. Submit material certifications and product data for all pipe, couplings and fittings demonstrating conformance to specifications.
- E. **QUALITY ASSURANCE:** Comply with all applicable standards contained herein and with the provisions of the following codes and standards except as otherwise shown or specified:
- a. South Carolina Department of Health and Environmental Control: All applicable rules and regulations.
 - b. All requirements of the sewer service agency that will own, operate and maintain this sewer.
- F. **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.

PART 2 PRODUCTS

A. PIPE:

- a. Unless specifically noted on the drawings, the Contractor may use any one of the specified materials.
- b. Steel Pipe for stream crossing and other locations shall be used where shown on the Plans. Pipe shall be high strength steel seamless or welded pipe to meet ASTM A139 Grade B, ASTM A53 Grade B and AWWA C200. Length and Diameter shall be as shown on the Plans. Pipe shall be in one place. 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 defective more than 1/360 span. Interior and exterior coating shall be Tnemec series 431 perma shield, minimum 40 mils thick or approved equal. Sandblast to commercial standard SSPC SP-6 prior to coating. Apply lining to manufacturer’s recommendations.
- c. Steel encasement pipes shall be smooth wall welded steel pipe, or steel liner plate conforming to ASTM Designation A139, Grade B. The outside of the pipe shall be coated in accordance with AWWA Standard C203. Minimum yield strength shall be 35,000 PSI. Minimum pipe wall thickness shall be as follows:

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

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

B. COUPLINGS:

- 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. Unless otherwise stated, couplings shall be Mission Rubber Company, Inc., MR Series Flex-Seal adjustable repair couplings, or approved equal and shall conform to ASTM C425.
- c. Coupling to connect steel pipe shall be steel, Dresser, Rockwell or equal to suit the piping to be connected. Coat with two coats coal tar epoxy after installation.

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

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

D. PRECAST CONCRETE MANHOLES

- 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.

E. FOUNDATION MATERIAL

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

F. FLEXIBLE PIPE CONNECTORS

- a. Flexible connectors shall conform to ASTM C923. All clamps and metal accessories shall be stainless steel. Provide Kor-N-Seal as manufactured by NPC Inc. or approved equal.

G. CAST-IN-PLACE CONCRETE

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

H. MANHOLE STEPS

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

I. MANHOLE FRAMES AND COVERS

- a. **Standard Manhole** frames and covers shall be gray iron, Class 35B, conforming to ASTM A48 or AASHTO M105, and AASHTO M306. Manhole frames and covers shall be for heavy duty use with standard weights of 190 pounds min. for each frame, and 90 pounds min. for each cover. Castings shall be free from blow holes, porosity, hard spots, shrinkage distortion, or other defects. Casting shall be well cleaned and coated with asphalt paint which shall result in smooth coating, tough and tenacious when cold, not tacky and not brittle. Bearing surfaces between frame and cover or grate shall be machined to prevent rocking and rattling. Provide U.S. Foundries 668 Ring and YF Cover or approved equal. Covers shall be cast with Metro's logo as shown on Standard Detail.
- b. **Watertight Manhole** frames and covers shall be gray iron, Class 35B, conforming to ASTM A48 or AASHTO M105, and AASHTO M306. Manhole frames and covers shall be for heavy duty use with standard weights of 190 pounds min. for each frame, and 90 pounds min. for each cover. Castings shall be free from blow holes, porosity, hard spots, shrinkage distortion, or other defects. Casting shall be well cleaned and coated with asphalt paint which shall result in smooth coating, tough and tenacious when cold, not tacky and not brittle. Bearing surfaces between frame and cover or grate shall be machined to prevent rocking and rattling. Provide U.S. Foundries 668 Ring and YF Cover or approved equal. Covers must be fitted with adjustable camlocks and TGS gaskets. Covers shall be cast with Metro's logo as shown on Standard Detail.

J. 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, alkalis or organic materials. Mortar shall not be allowed to stand for longer than one hour after water is added.

K. 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

A. 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 which is not in true alignment or shows undue settlement after laying, or is damaged, shall be taken up and re-laid without extra compensation.
- 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.

B. 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 bell ends facing in the direction of pipe-laying, beginning at the bottom of the slope and proceed upward with the bell ends of the new pipe upgrade.
- d. Pipe joints shall be made up in strict accordance with the manufacturer's directions.

- e. Sewer lines in relation to water lines must conform to Section 38.3 of the "Recommended Standards for Wastewater Facilities" 1990 Edition as a minimum. Sewers shall be laid at least 10 feet horizontally from any existing or proposed water main. The distance shall be measured edge to edge. In cases where it is not practical to maintain a ten foot separation, the appropriate reviewing agency shall be contacted to request a deviation. Such deviation may allow installation of the sewer closer to a water main, provided that the water main is in a separate trench or on an undisturbed earth shelf located on one side of the sewer and at an elevation so the bottom of the water main is at least 18 inches (46 cm) above the top of the sewer.
- f. Sewers crossing water mains shall be laid to provide a minimum vertical distance of 18 inches between the outside of the water main and the outside of the sewer. This shall be the case where the water main is either above or below the sewer. The crossing shall be arranged so that the sewer joints will be equidistant and as far as possible from the water main joints. Where a water main crosses under a sewer, adequate structural support shall be provided for the sewer to prevent damage to the water main.
- g. When it is impossible to obtain proper horizontal and vertical separation as stipulated above, the sewer shall be constructed equal to water pipe, and shall be pressure tested to assure water-tightness prior to backfilling.

C. INSTALLATION OF PIPE REPAIR COUPLINGS

- 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 Inspector 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.

D. 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. Frames and covers shall be properly set in a bed of mortar and aligned to fit the top section of the structure. Use grade rings to adjust frames & covers to final grade. Seal all joints between frame, grade rings and precast sections with butyl sealant. No more than 10" of grade rings will be allowed.
- 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 one inch per foot to the channel. The channel and invert shall be constructed with a minimum of 3,500 psi concrete or brick and mortar fill with concrete finish minimum one inch thick. Where sewer changes directions, the manhole channel shall be constructed with a smooth curve with a radius as large as the diameter of the manhole will allow. The bench at the edge of the channel shall be level.
- 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, excavate and expose outside wall, and apply bituminous or cement waterproofing.

E. CLEANING

All foreign matter and dirt shall be cleaned from the inside of the pipe before installing and

shall be kept clean during and after installation. All lines, upon completion or at such time as directed, shall be cleaned, inspected and tested.

F. INSPECTION AND TESTING

- 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. Infiltration and exfiltration shall not exceed a rate of 200/gpd/in. of pipe diameter/mile of sewer for any section between successive manholes. Infiltration shall be measured by the Contractor using a suitable weir or other device as approved by the Engineer.
- c. Air Testing. All new sewer lines including service lines shall be subjected to a low-pressure air test to determine the presence of damaged pipe or faulty installation. The Contractor will furnish all facilities and personnel for conducting the tests. The Contractor may desire to make an air test prior to backfilling for his own purposes. However, the required air test shall be made after backfilling has been completed and compacted and in the presence of the Engineer and/or Owner. The test shall be performed as outlined below.
 - i. Low pressure testing shall be performed with a continuous monitoring gauge no less than 4 inches in diameter with minimum divisions of 0.10 psi and an accuracy of 0.04 psi \pm . All air shall pass through a single, above ground control panel visible to the Engineer.
 - ii. Determine the groundwater elevation and determine the average groundwater head above the section being tested. Adjust the test pressures by adding 0.43 psi per foot of groundwater head.
 - iii. Determine the test time for the section being tested using *Low Pressure Air Testing Times* located at the end of this specification section. Add in time for service laterals connected to the line being tested.
 - iv. Plug all openings in test section.
 - v. Pressurize the section to 4.0 psi and allow pressure to stabilize (maintain 4.0 psi for a minimum of 2 minutes). Do not over-pressurize the section. No one will be allowed in the manhole during testing.
 - vi. At a reading between 3.5 and 4.0 psi, shut off pressure supply and start timing using a stop watch or other acceptable timing device. Measure the pressure drop for the period of time as computed above (Item iii).
 - vii. If the pressure drops 1.0 psi or more during the elapsed time, then the section has failed.

- d. 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 D2321-11 latest edition.
- e. 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 (sec.)
48	60
60	75
72	90
84	105
96	120
120	150

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

G. 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

02731 DUCTILE IRON SEWER PIPE

PART 1 GENERAL

1.1 SCOPE

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

1.2 REFERENCE STANDARDS

- A. American National Standard Institute (ANSI) and American Water Works Association (AWWA):
 - a. ANSI/AWWA C110/A21.10 Ductile Iron and Gray Iron Fittings for Water and Other Liquids.
 - b. ANSI/AWWA C111/A21.11 Rubber Gasket Joints for Ductile Iron and Gray Iron Pressure Pipe and Fittings.
 - c. ANSI/AWWA C151/A21.51 Ductile Iron Pipe for Water and Other Liquids, as modified by these specifications.
 - d. AWWA C600 Installation of Ductile Iron Water Mains and Their Appurtenances.
- B. American Society for Testing and Materials (ASTM):
 - a. ASTM A 746 – Standard Specification for Ductile Iron Gravity Sewer Pipe

1.3 QUALITY ASSURANCE

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

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

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

1.4 INSPECTION, TEST REPORTS, MARKINGS, AND SUBMITTALS

- A. All pipe and fittings to be installed under this Contract shall be inspected and tested at the place of manufacture by the manufacturer to verify compliance with the Specifications.
- B. Pipe shall be subject to inspection and approval at the factory, place of coating, point of delivery, and before and after installation as specified above. The Engineer shall have the right to reject any pipe whose manufacture, in his sole opinion, is inconsistent with the Specifications and to take independent samples of the materials being used at any time.
- C. The manufacturer shall perform factory testing as specified herein and in accordance with the standards. Copies of test reports shall be submitted to the Engineer before the pipe is shipped to the site.
- D. In the event that any of the test results fail to meet the Specifications, all pipe represented by such tests shall not be shipped to the job site and shall be subject to rejection. The Contractor may perform additional tests from the pipe represented by the failed tests if he desires to verify the inadequacy of the original tests. The Engineer will review the test results and advise on the suitability of the pipe.
- E. Pipe which has been rejected by the Engineer shall not be shipped to the site or shall be removed from the site of the work by the Contractor and replaced with pipe which meets these Specifications.
- F. All pipe and fittings shall be stenciled in durable white paint on opposite exterior sides or coded with the following information:
 - a. Manufacturer name or trade mark.
 - b. Date and place of manufacture.
 - c. Size, type, thickness or class, and wall thickness.
 - d. Standard produced to (ANSI/AWWA).
 - e. 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 A-746 and ANSI A21.50, ANSI/AWWA C151/A21.51 and shall be Thickness Class 50 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. Gaskets shall be neoprene, SBR, Buna-N Nitrile, or EPDM. 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 C 110/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 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.
 - a. 12-inch x 6-inch fittings shall be mechanical joint (MJ), domestic manufacture with interior lining as specified in paragraph 2.1.G. Provide transition gaskets in conformance to AWWA C.111/A21.11 to accommodate the transition from MJ to SDR 35. Fittings on the 6-inch lateral to accommodate pipe bends and alignment to the existing service laterals shall conform to paragraph 02732.2.A (*Paragraph added by Addendum Number 2*).
- F. HARCO Tees manufactured by the Harrington Corp., Lynchburg, Virginia, are an approved equal to the DIP tees specified. The appropriate HARCO tee shall be provided for the specific pipe materials connecting to the tee.

- G. Interior Lining: Unless stated otherwise on the plans, the interior of all ductile iron pipe and fittings shall be cement mortar lined and seal coated, standard thickness, in accordance with ANSI-A 21.4.
- H. 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 not to 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.
- I. Exterior of all pipe fittings and specials shall be coated with either a coal tar or asphaltic base bituminous pipe coating in accordance with ANSI-A 21.8. Specials not available with cement mortar lining shall be furnished with a bituminous inside coating in accordance with ANSI-A 21.8.
- J. Bolts, nuts, gaskets and any other material needed for the complete installation of all pipe joints shall be furnished.
- K. Epoxy Interior Coating: Where hydrogen sulfide corrosion or other corrosion exists, the Owner may specify that ductile iron pipe be coated with Tnemec series 431 epoxy liner. The epoxy lining shall be applied to a minimum 40 mils dry film thickness and shall cover the entire inside of the pipe.

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

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

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

Expansion joints shall be Ex-Tend 200 Expansion Joints as manufactured by Ebaa Iron Sales, Inc. or approved equal.

PART 3 EXECUTION

3.1 GENERAL

- A. Ductile iron pipe shall be installed in accordance with AWWA C-600 latest edition.
- B. Bedding shall be Class C as shown on the detail drawings for gravity sewer.

END OF SECTION 02731

02732 POLYVINYL CHLORIDE SEWER PIPE

PART 1 GENERAL

1.1 SCOPE

- A. This section establishes the criteria for acceptance of Polyvinyl Chloride (PVC) pipe.
- B. Related Work.
 - a. Section 02221 Trench Excavation, Bedding and Backfill
 - b. Section 02730 Sanitary Sewer Systems
- C. DRAWINGS AND DATA. Drawings and data shall be submitted in accordance with the Section 01300. Drawings and data shall include, but not be limited to, the following:
 - a. Details of joints.
 - b. Gasket material.
 - c. Pipe length.
 - d. Certification in accordance with ASTM D3034, Section 11, ASTM F679, Section 10, or ASTM F794.

1.2 REFERENCE STANDARDS

- A. American Society for Testing and Materials (ASTM):
 - a. ASTM C 1173 – Standard Specification for Flexible Transition Couplings for Underground Piping Systems.
 - b. ASTM D 1784 – Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
 - c. ASTM D 2241 – Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).
 - d. ASTM D 3034 – Type PSM PVC Sewer Pipe and Fittings.
 - e. ASTM D 3139 – Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
 - f. ASTM D 3212 – Standard Specifications for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
 - g. ASTM F 477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

PART 2 PRODUCTS

2.1 SDR-35 PVC PIPE

- A. General. All PVC pipe shall meet or exceed the performance requirements of ASTM D3034 cell classification 12454 as defined under ASTM D 1784. Push-on and/or mechanical joints shall conform to ASTM D 3212. 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.
- B. Smooth Wall PVC Pipe shall conform to the following requirements:

<u>Pipe Size</u>	<u>ASTM (latest edition)</u>	<u>Other Requirements</u>
6 to 15 inch	D3034	SDR 35, Min./Stiffness Factor 46
18 to 27 inch	F679	Stiffness Factor 46

- 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 HARCO SDR-35 gasketed sewer fitting.
- E. Pipe or fittings having spiral external reinforcing ribs will not be acceptable. Pipe or fittings having concentric external reinforcing ribs will not be acceptable in any pipe size less than 24 inch.

2.2 C-900 PVC PIPE

- A. General. Products delivered under this specification shall meet the requirements of AWWA C900.
- B. Pipe shall be made from unplasticized PVC compounds having a minimum cell classification of 12454 as defined in ASTM D 1784. The compound shall qualify for Hydrostatic Design Basis (HDB) of 4000 psi for water at 73.4°F, in accordance with the requirements of ASTM D 2837.
- C. Nominal outside diameters and wall thicknesses of restrained joint pipe shall conform to the requirements of AWWA C900. Integral bell joint pipe shall be furnished in 4", 6", 8", 10" and 12" sizes, in Class 150(DR18). Pipe shall be furnished in standard lengths of 20 feet.
- D. 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 D 3139.
- E. 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.
- F. Every pipe shall pass the AWWA C900 hydrostatic proof test requirements of 4 times the pressure class for 5 seconds.

G. Marking

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

- Nominal Size (for example, 4")
- PVC
- Dimension Ratio (for example, DR25)
- AWWA pressure class (for example, PC 150)
- ANSI/AWWA C900-97 (or latest edition)
- Manufacturer's name or trademark and production record code
- Seal (mark) of the testing agency verifying the suitability of the pipe material for potable water service

PART 3 EXECUTION

3.1 GENERAL

Flexible Conduit PVC Pipe shall be installed in accordance with ASTM D 2321-11.

3.2 JOINTING METHODS

- A. PVC sewer pipe and fittings shall be jointed in accordance with the recommendations of the latest ASTM Standards and detailed instructions of the manufacturer.
- B. All manhole connections shall be as shown on the detail.

END OF SECTION 02732

02733 SANITARY SEWER SERVICE CONNECTIONS

PART 1 GENERAL

1.1 SCOPE

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

1.2 SUBMITTALS

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

1.3 QUALITY ASSURANCE

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

1.4 REFERENCE STANDARDS

- C. American Society for Testing and Materials (ASTM):
 - a. ASTM D3034 – Type PSM PVC Sewer Pipe and Fittings.
 - b. 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. In-line 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-35 pipe meeting all requirements of ASTM D3034, latest edition. In line wyes on ribbed PVC pipe shall have SDR 35 branches and meet all requirements of ASTM F949, latest edition.
- C. DIP 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. Wyes or Tees are to be placed on the sewer lateral and services installed during installation of the lateral sewer. Saddles are not acceptable.
- D. Service connection to manholes shall be installed with inverts and benches to prevent solids deposition in manhole.

3.3 INSPECTION AND TESTING

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

END OF SECTION 02733

02768 MANHOLE LINING

PART 1 GENERAL

1.1 SCOPE OF WORK

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

1.2 RELATED WORK

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

1.3 SUBMITTALS

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

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

1.4 REFERENCE STANDARDS

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

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

1.5 QUALIFICATIONS

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

1.6 GUARANTEE

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

1.7 QUALITY ASSURANCE

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

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

1.8 DELIVERY, STORAGE AND HANDLING

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

1.9 SITE CONDITIONS

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

PART 2 PRODUCTS

2.0 DESIGN CRITERIA

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

2.1 CONDITION A: CEMENTITIOUS MANHOLE LINING - WALLS AND BENCHES

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

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

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

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

2.2 CONDITION A: CEMENTITIOUS MANHOLE LINING - INVERT CHANNEL COATING

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

2.3 CONDITION B: EPOXY MANHOLE LINING

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

Color		Any
Solids Content		100%
Solvent Content		0%
Compressive Strength	ASTM D695	135,000 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. Acceptable 100% Solids Epoxy products are:
 - a. Raven 405 (RLS Solutions)
 - b. Mainstay DS-5 (Madewell Products Corporation)
 - c. Standard Epoxy 4553 (Standard Cement Materials, Inc.)

- d. Neopoxy NPR-5303 Epoxy
- e. or approved equal.

PART 3 EXECUTION

3.1 INSTALLATION - GENERAL

- A. The Contractor shall complete manhole installation prior to lining including surface preparation, patching of voids and sealing of leaks, invert channel coating, and other required manhole rehabilitation work. The Contractor shall dispose of any resulting material.
- B. The Contractor shall notify all property owners who discharge sewage directly to the manhole being surfaced that their service will be discontinued while the lining is being placed, cured and active pipe and service connections reopened.
- C. The Contractor shall provide bypass pumping of sewage flows where and when the rehabilitation work is being performed.
- D. Prior to placing the lining, the Inspector and the manufacturer's representatives (when on site) along with the Contractor must inspect and approve the surface preparation work. The Contractor shall notify the Inspector when the manholes are ready for inspection. The Contractor is responsible for ensuring proper installation conditions including temperature and moisture.
- E. If the drawings call for a flexible frame-chimney seal, then the lining shall be installed to 1 inch below the bottom of the manhole frame. The termination of and surface of the lining shall be suitable for proper installation of the manhole frame-chimney seal specified in Section 02763. If a frame-chimney seal is not required, then manhole lining shall be installed to the bottom of the manhole frame.
- F. Temperature limitations must be handled as appropriate and as approved by the manufacturer.
- G. A complete, watertight seal shall be provided at pipe and manhole wall connections.
- H. The Contractor shall reopen all of the existing active pipe connections in each sewer manhole following lining.

3.2 INSTALLATION - CEMENTITIOUS LINERS

- A. The Contractor shall furnish and place cementitious lining in each manhole as shown on the Drawings and where directed by the Inspector. The installation of the lining shall be in complete accordance with the applicable provisions of ASTM F 2551 and the manufacturers' specifications. A representative of the manufacturer shall be present during actual installation of lining of the first ten (10) manholes.
- B. All bottom and horizontal surfaces including the benches shall have the lining applied to the required thickness by hand troweling or spray-on methods. Cementitious linings

that are spray-applied shall be troweled smooth after application.

- C. All side vertical surfaces shall have the monolithic lining applied to the required thickness by a spray-on method in one pass or application. All lining shall be troweled smooth after spray application.

3.3 INSTALLATION - EPOXY LINERS

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

3.4 FIELD TESTING AND ACCEPTANCE

- A. Field acceptance of manhole lining shall be based on the Inspector's evaluation of the proper surfacing of the manhole per field inspections. Acceptance shall also be based on the Inspector's evaluation of the appropriate installation and curing test data.
- B. Minimum Liner Thickness:
 - 1. The cementitious lining shall provide a continuous monolithic surfacing with uniform thickness throughout the manhole interior, and this depth shall be verified by the use of a feeler gauge or by counting the number of bags required. Special attention shall be given to the chimneys of brick manholes to insure that liner material covers and seals the bottom joints at all masonry units.
 - 2. If the thickness of the cementitious lining is not uniform or is less than specified, it shall be repaired or replaced.
 - 3. Epoxy Liner Thickness Measurement: During application of corrosion resistant liner, a wet film thickness gauge, meeting ASTM D 4414, shall be provided by the Contractor and used. Measurements shall be taken, documented and attested by the Contractor for submission to the Owner. Additional measurements may be made by the Inspector.
- C. The Inspector may enter the manholes to inspect the benching, invert channels, manhole wall/pipe connections, surface preparation, and other parts of the work. The Contractor shall provide forced air ventilation, gas monitors and detectors, harnesses, lights, etc. for the Inspector to enter the manhole and perform the inspection in complete accordance with OSHA requirements.

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

- J. If any defective lining is discovered after it has been installed, it shall be repaired or replaced in a satisfactory manner within 72 hours. This requirement shall apply for the entire guarantee period.

3.5 DOCUMENTATION

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

END OF SECTION 02768

DIVISION 3 – CONCRETE

03300 CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.1 DESCRIPTION

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

1.2 TOLERANCES

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

1.3 APPLICABLE PUBLICATIONS

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

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

A615 Deformed and Plain Billet-Steel Bars for Concrete Reinforcement

C33 Concrete Aggregates

C94 Ready-Mixed Concrete

C150 Portland Cement

C171 Sheet Material for Curing Concrete

C260 Air-Entraining Admixtures for Concrete

C494 Chemical Admixtures for Concrete

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

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

PART 2 PRODUCTS

2.1 FORMS

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

2.2 MATERIALS FOR CONCRETE

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

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

2.3 CONCRETE MIXES

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

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

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

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

2.4 REINFORCING STEEL

ASTM A615, deformed Grade 60

2.5 SHEET MATERIALS FOR CURING CONCRETE

ASTM C171.

2.6 LIQUID CURING COMPOUNDS

Select one of the following:

"Clear Bond" by Guardian Chemical Co.

"Dress & Seal" by L & M Construction Chemicals Inc.

"Spartan-Cote" by Burke

"Kure-N-Seal 0800" by Sonneborn Building Products

PART 3 EXECUTION

3.1 FORMWORK

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

3.2 REINFORCEMENT

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

3.3 PLACING, PROTECTION AND CURING CONCRETE

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

3.4 FINISHES

A. Vertical Surfaces in Channel in Screen Vault:

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

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

B. Slab Finishes:

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

END OF SECTION 03300

03310 GROUT

PART 1 GENERAL

1.1 SUMMARY

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

PART 2 PRODUCTS

2.1 MATERIALS

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

2.2 GROUT MIX

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

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

- B. Material quantities shown are surface dry quantities.

PART 3 EXECUTION

3.1 INSTALLATION

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

END OF SECTION 03310