

CITY OF JOHNSON CITY
STANDARD SPECIFICATIONS
FOR
SANITARY SEWER CONSTRUCTION
2015

SEWER ONLY

APPROVAL EXPIRES
MAY 19 2018
TENN DEPT OF ENVIRONMENT & CONSERVATION
DIVISION OF WATER RESOURCES

APPROVED FOR CONSTRUCTION
THE DOCUMENT BEARING THIS STRAP HAS BEEN RECEIVED AND REVIEWED BY THE
TENNESSEE DEPARTMENT OF ENVIRONMENT AND CONSERVATION
DIVISION OF WATER RESOURCES
AND IS HEREBY APPROVED FOR CONSTRUCTION BY THE COMMISSIONER.

MAY 19 2015

THIS APPROVAL IS VALID FOR ONE YEAR
THE APPROVAL SHALL NOT BE CONSIDERED AS CREATING A PRESUMPTION OF CORRECT
OPERATION OR AS WARRANTING BY THE COMMISSIONER THAT THE APPROVED FACILITIES
WILL REACH THE DESIGN GOAL.

BY *Adrian Baker* **EPS II**
TITLE



WPN 15-0232 Expires May 19, 2018

SECTION 01560
TEMPORARY CONTROLS

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

- A. Provide and maintain methods, equipment and temporary construction, as necessary to provide controls over environmental conditions at the construction site and related areas; remove physical evidence of temporary facilities at completion of work.

1.02 RELATED REQUIREMENTS

- A. Section 01510: Temporary Utilities
- B. Section 01570: Traffic Regulations
- C. Section 01710: Cleaning

1.03 DUST CONTROL

- A. Provide positive methods and apply dust control materials to minimize raising dust from construction operation, and provide positive means to prevent air-borne dust from dispersing into the atmosphere.

1.04 WATER CONTROL

- A. Provide methods to control surface water to prevent damage to the Project, the site, or adjoining properties.

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1. Control fill, grading and ditching to direct surface drainage away from excavations, pits, tunnels and other construction areas; and to direct drainage to proper runoff.
- B. Provide, operate and maintain hydraulic equipment of adequate capacity to control surface and water.
- C. Dispose of drainage water in a manner to prevent flooding, erosion or other damage to any portion of the site or to adjoining areas.

1.05 DEBRIS CONTROL

- A. Maintain all areas under Contractor's control free of extraneous debris.
- B. Initiate and maintain a specific program to prevent accumulation of debris at construction site, storage and parking areas, or along access roads and haul routes.
 1. Provide containers for deposit of debris as specified in Section 01710-Cleaning.
 2. Prohibit overloading of trucks to prevent spillage on access and haul routes.
 - a. Provide periodic inspection of traffic areas to enforce requirements.
- C. Schedule periodic collection and disposal of debris as specified in Section 01710-Cleaning.
 1. Provide additional collections and disposals of debris whenever the periodic schedule is inadequate to prevent accumulation.

1.06 POLLUTION CONTROL

- A. Provide methods, means and facilities required to prevent contamination of soil, water or atmosphere by the discharge of noxious substances from construction operations.
- B. Provide equipment and personnel, perform emergency measures required to contain any spillage, and to remove contaminated soils or liquids.
 1. Excavate and dispose of any contaminated earth off-site, and replace with suitable compacted fill and topsoil.

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- C. Take special measures to prevent harmful substances from entering public waters.
 - 1. Prevent disposal of wastes, effluents, chemicals, or other such substances adjacent to streams, or in sanitary or storm sewers.
- D. Provide systems or control of atmospheric pollutants.
 - 1. Prevent toxic concentrations of chemicals.
 - 2. Prevent harmful dispersal of pollutants into the atmosphere.

1.07 EROSION CONTROL

- A. Plan and execute construction and earth work by methods to control surface drainage from cuts and fills, and from borrow and waste disposal areas, to prevent erosion and sedimentation.
 - 1. Hold the areas of bare soil exposed at one time to a minimum.
 - 2. Provide temporary control measures such as silt fences, hay bales, berms and dikes, slope drains, check dams and temporary seeding.
- B. Construct fills and waste areas by selective placement to eliminate surface silts or clays which will erode.
- C. Periodically inspect earthwork to detect any evidence of the start of erosion, apply corrective measures as required to control erosion.
- D. Comply with all erosion control regulations including the TDEC Erosion and Sediment Control Handbook.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

NOT USED

END OF SECTION

SECTION 01710

CLEANING

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

- A. Execute cleaning, during progress of the Work, and at completion of the Work, as required by General Conditions.

1.02 RELATED REQUIREMENTS

- A. Section 02221: Trenching, Backfilling and Compaction
- B. Section 02845: Lawn and Grass Landscaping

1.03 DISPOSAL REQUIREMENTS

- A. Conduct cleaning and disposal operations to comply with codes, ordinances, regulations, and anti-pollution laws.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

3.01 DURING CONSTRUCTION

- A. Execute periodic cleaning to keep the Work, the site and adjacent properties free from accumulations of waste materials, rubbish and windblown debris, resulting from construction operations.
- B. Provide on-site containers for the collection of waste materials, debris and rubbish.
- C. Remove waste materials, debris and rubbish from the site periodically and dispose of at legal disposal areas away from the site.
- D. Clean-up, including placement of gravel roadway and seed, shall not lag behind trenching and excavation by more than 400 linear feet.

3.02 FINAL CLEANING

- A. Employ skilled workmen for final cleaning.
- B. Broom clean exterior paved surfaces; rake clean other surfaces of the grounds.
- C. Prior to final completion, Contractor shall conduct an inspection of all work areas to verify that the entire work area is clean.

END OF SECTION

SECTION 01720
OPERATIONAL DEFINITIONS
FOR
SEWER LINE AS-BUILT NOTES

OBJECTIVE

To create a standard process to accurately gather field measurements and other information on sewer line installations. This information will be transferred from the installation plans to the original design drawings for future reference as well as incorporated into the Johnson City Geographic Information System.

As-Built Requirements

Prior to final acceptance of the sanitary sewer, the proponent shall submit one reproducible and four signed and sealed set of as built plans. After the surveyor/engineer has certified the locations, the Engineer of Record shall certify that the system depicted on the as-built plan was constructed in substantial conformance with approved plans and will function as intended. A certification by the surveyor/engineer accepting responsibility for accuracy of information supplied on the as-built drawings and a statement that all mains are within easements and/or public right-of-ways. In addition, a digital file of the complete set of drawings must be submitted in AutoCAD format.

As-built plans shall be defined as and contain the following information:

1. As-built sanitary sewer systems shall indicate the offset of sanitary sewers from property lines or easement lines and alignment distance from centerline of road at 300+/-ft. intervals and shall include, but not limited to length of sewer, invert elevation, rim elevation, percentage of grade, manhole location. At least two (2) horizontal ties and one (1) vertical tie to all manholes, sewer lateral/main wyes, sewer lateral terminatory ends, force main valves, and all force main fittings that delineate change of either horizontal and or vertical direction. These ties are to be from permanent point such as property corners, curbs, pavement intersections etc. Right of way, easements and lot lines shall be accurately shown. Lot and block numbers and street names shall be included.

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2. Pertinent easement information, showing Official Record Book and page number.
3. Distance from manhole to manhole and distance from downstream manhole to each sewer lateral/main wye. Finished invert and manhole rim elevations in addition to sewer lateral terminating end elevations.
4. Lead locations shall be shown in plan view with dimensions from the nearest downstream manhole.
5. Lead stub elevations, taken at the time of installation shall be shown in plan view.
6. Separation between reuse or force mains and water mains if they exist within 10 feet of water mains.
7. Distance of mains from buildings or structures within 20 feet of the sewer main.
8. Locations shall be shown on the plans with an accuracy of +/- one foot.
9. As-built sanitary sewer plans shall list the type, brand name and lengths of pipe used.
10. All as-built plans shall bear the seal (or otherwise noted) of a registered professional engineer licensed in the state of Tennessee, installer's name – address – phone number, date of installation, development name and owner's name.
11. Elevations should be referenced from the North America Vertical Datum of 1988 and noted as such on the As-built.

END OF SECTION

SECTION 02110
CLEARING AND GRUBBING

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Clearing, grubbing, removal and disposal of vegetation, rocks, roots and debris within the limits of the work except objects designated on the drawings to remain.
- B. Preserve from injury or defacement all vegetation and objects to remain.

1.02 RELATED WORK

- A. Section 02050: Demolition
- B. Section 02210: Grading and Excavation

1.03 LIMITS OF WORK

- A. Rights-of-way area established by Engineer.
- B. Construction area including the area bounded by any written permanent and temporary construction easements as established by Engineer.
- C. Approved borrow pit areas.
- D. Designated stockpiles of construction material other than borrow material.

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1.04 PROTECTION

- A. Protect living trees not marked for removal and outside the construction area. Treat cut or scarred surfaces of trees or shrubs with a paint prepared especially for tree surgery.
- B. Protect bench marks and existing structures, roads, sidewalks, paving and curbs against damage.
- C. Maintain designated temporary roadways, walkways and detours, for vehicular and pedestrian traffic.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

3.01 PREPARATION

- A. Maintain benchmarks, monuments and other reference points. Re-establish if disturbed or destroyed at no cost to Owner.

3.02 CLEARING AND GRUBBING

- A. Clear rights-of-way, borrow pit and other stockpile areas of objectionable material to the ground surface except for trees and stumps.
- B. Cut trees and stumps to within six inches of the ground surface or low water level in swampy areas where embankments are to be constructed provided undercutting or other corrective measures are not stipulated.
- C. Cut trees and stumps outside the construction area marked for removal by the Engineer to within six inches of the ground surface.

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- D. Remove low hanging, unsound or unsightly branches on trees or shrubs designated to remain.
- E. Trim branches of trees extending over the roadbed to a clear height of twenty feet above the roadbed surface.
- F. Grub construction area of protruding obstructions except sound undisturbed stumps and roots six inches or less above the ground which will be a minimum of 5 feet below sub-grade or embankment slope provided undercutting, topsoil stripping or other corrective measures are not stipulated.
- G. Grub borrow pit and stockpile areas of all objectionable material. Strip overburden over the material to be obtained in stockpile areas.
- H. Perform clearing and grubbing well in advance of construction or material removal activities.

3.03 BACKFILLING AND SURFACE PREPARATION

- A. Backfill and compact all depressions resulting from clearing and grubbing with suitable materials.
 - 1. Backfill embankment areas to natural ground elevation.
 - 2. Backfill excavation areas below finished sub-grade to finished sub-grade.
- B. Perform backfilling a satisfactory distance ahead of construction operations.
- C. Prepare areas designated on the drawings to receive erosion control matting to smooth surfaces that have been shaped, fertilized and seeded.

3.04 DEBRIS REMOVAL

- A. Promptly remove cleared debris from site.
- B. Obtain permission from applicable regulatory authority for disposal of debris to waste disposal site.

END OF SECTION

SECTION 02221

TRENCHING, BACKFILLING, AND COMPACTION

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Excavation for piped utility material.
- B. Provide necessary sheeting, shoring and bracing.
- C. Prepare trench bottom with appropriate materials.
- D. De-water excavation as required.
- E. Place and compact granular beds, as required, and backfill.

1.02 RELATED WORK

- A. Section 02110: Clearing and Grubbing
- B. Section 02210: Grading and Excavation
- C. Section 02480: Pavement Replacement
- D. Section 03001: Concrete Work

1.03 PRECAUTIONS

- A. Notify Tennessee One-Call when necessary to locate, and protect existing utilities or when necessary to disturb existing utility facilities and abide by their requirements for repairing and replacing. Call three working days prior to

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excavation at 811.

- B. Protect all vegetation and other features to remain. Minimize damage to all existing trees, shrubs, and flowers.
- C. Protect all benchmarks and survey points. Property corners determined by the engineer to be carelessly destroyed shall be replaced. Replacement shall be performed by a Registered Land Surveyor (TN) and approved by engineer.

PART 2 PRODUCTS

2.01 BEDDING AND BACKFILL MATERIALS - WATER LINES

- A. Class I Material: Angular, 1/4 to 1 inch graded stone including a number of fill materials that have regional significance such as crushed stone, cinders, slag and crushed shells meeting the following graduation requirements:

<u>SIEVE SIZE</u>	<u>PERCENT PASSING</u>
1"	100
3/4"	90-100
3/8"	20-55
#4	0-10
#8	0-5

- B. Class II Material: Coarse sands and gravels with a maximum particle dimension of 1-1/2 inch including variously graded sands and gravels containing small percentages of fines, generally granular and non-cohesive, either wet or dry.
- C. Class III Material: Fine sand and clayey gravels, including fine sands, sand-clay mixtures, and gravel-clay mixtures.
- D. Class IV Material: Silt, silty clays, and clays, including inorganic clays and silts of medium to high plasticity and liquid limits.
- E. Class V Material: Organic soils, as well as, soil containing frozen earth, debris, rocks larger than 1-1/2 inches and other foreign material.

PART 3 EXECUTION

3.01 PREPARATION

- A. Install barriers and other devices to protect areas adjacent to construction.
- B. Protect and maintain all benchmarks and other survey points.

3.02 EXCAVATION TRENCHES

- A. Perform in such a manner as to form a suitable trench in which to place the pipe and so as to cause the least inconvenience to the public.
- B. Maximum width at the crown of the pipe should be wide enough for 6" rock on each side of the pipe. With trench depth greater than 5', the trench should be 4' wide to accommodate a ditch box or other shoring.
- C. Cut pavement along neat, straight lines with either a pavement breaker or pavement saw.
- D. Align trench as shown on the Plans unless a change is necessary to miss an unforeseen obstruction.
- E. When unstable soil is encountered at the trench bottom, remove it to a depth required to assure support of the pipeline and backfill to the proper grade with coarse aggregate AASHTO M-43, Size No. 2 or 3.
- F. Remove rock encountered in trench excavation to a depth of 6 inches below the bottom of the pipe barrel, backfill with an approved material, and compact to uniformly support the pipe. In no case shall solid rock exist within six (6) inches of the finished pipeline.
- G. When rock borings or soundings are provided, they are for information only and do not guarantee existing conditions. Make such investigations as deemed necessary to determine existing conditions.

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3.03 SHEETING, SHORING AND BRACING

- A. When necessary or when directed by the Engineer, furnish, put in place, and maintain such sheeting, bracing, etc., as may be required to support the sides of the excavation and to prevent movement.
- B. Take care to prevent voids outside the sheeting.
- C. If voids are formed, immediately fill and ram to the satisfaction of the Engineer.
- D. Devise plans for performing this work subject to the approval of the Engineer.
- E. Unless adjacent facilities will be injured, remove all sheeting, shoring, and bracing after backfill has been placed to a depth of 18 inches over the pipeline.
- F. Cut shoring off at the top of the pipe and leave the lower section in the trench.

3.04 USE OF EXPLOSIVES

- A. Conduct all blasting operations in accordance with prevailing municipal, state or other agency regulations, codes, ordinances, or laws.
- B. Exercise due caution when blasting adjacent to existing structures and pipelines.
- C. If structures or pipelines are damaged, promptly replace or repair them at no expense to Owner.
- D. Contractor liable for damages to private property due to sewer back-ups or flooding after blasting damage to mainlines or service laterals.
- E. Do not conduct blasting operations within 25 feet of water, sewer, gas or other utility lines, unless otherwise directed by Engineer.
- F. Cover all shots with blasting mats to prevent flying material.

3.05 DISPOSAL OF EXCAVATED MATERIAL

- A. Satisfactorily dispose of all excess excavated material that cannot be used for or is not suitable for embankments.

3.06 UNAUTHORIZED EXCAVATION

- A. All excavation outside or below the proposed lines and grades shown on the Plans or directed by the Engineer.
- B. Backfill areas of unauthorized excavation with the type material necessary (earth, rock or concrete) to insure the stability of the structure of construction involved.

3.07 REMOVAL OF WATER

- A. Keep excavated areas free of water while work is in progress.
- B. Well-pointing shall be performed if required.
- C. Take particular precautions to prevent the displacement of structures or pipelines as a result of accumulated water.

3.08 OBSTRUCTIONS

- A. Obstructions shown on the Plans are for information only and do not guarantee their exact locations nor that other obstructions are not present.
- B. When utilities or obstructions are not shown on the plans but are present off the roadway at the location of the proposed pipeline route, the Contractor may request to relocate the pipeline in the roadway if necessary to avoid disturbing the utility or obstruction.
- C. Exercise due care in excavating adjacent to existing obstructions and do not disturb same unless absolutely necessary.
- D. In the event obstructions are disturbed, repair or replace as quickly as possible to the condition existing prior to their disturbance.

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- E. If desired by the utility company, pay for the repair or replacement work performed by the forces of the utility company or other appropriate party.

3.09 GRAVITY SANITARY SEWER BEDDING

- A. Always maintain proper grade and alignment during the bedding and tamping process.
 - 1. Any pipe dislodged during this process shall be replaced.
 - 2. Dig bell holes to assure uniform support of the pipe.
- B. Bedding for PVC Sewers:
 - 1. Completely encapsulate each sewer pipe section with granular material from a distance of 6" below the bottom of the pipe to a distance of 6" above the top of the pipe for the entire width of the ditch, compacted to 60% relative density, ASTM D-2049. Use Class I angular material.
- C. Bedding for Ductile Iron Pipe Sewers:
 - 1. Lay each sewer pipe section on a 6" bed of granular material and backfill to the springline of the pipe with granular material, compacted to 60% relative density, ASTM D-2049.
 - 2. In unimproved areas, use Class I or II granular material.

3.10 INITIAL BACKFILLING

- A. Do not begin backfilling before the Engineer has inspected the grade and alignment of the pipe, the bedding of the pipe, and the joints between the pipe. If backfill material is placed over the pipe before an inspection is made, reopen the trench in order for an inspection to be made.
- B. Perform backfilling by hand, together with tamping, until fill has progressed to 18" above the top of the pipe.
 - 1. Deposit Class I granular material (where required) or loose soil free from lumps, clods, frozen material or stones in layers approximately 6" thick.
 - 2. Compact by hand, or with manually operated machine tampers actuated by compressed air or other suitable means.

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3. Use tamps and machines of a suitable type which do not crush or otherwise damage the pipe.

3.11 FINAL BACKFILLING

- A. Backfill material up to three feet above the top of the pipe should not exceed 6 inches in diameter at its greater dimension.
- B. After the backfill has reached a point 18" or more above the top of the pipe, perform final backfilling depending upon the location of the work and danger from subsequent settlement.
- C. Backfilling in Unimproved Areas:
 1. Dispose of and replace all soft or yielding material which is unsuitable for trench backfill with suitable material.
 2. Deposit backfill to the surface of the ground by dragline, bulldozer, or other suitable equipment in such a manner so as not to disturb the pipe.
 3. Neatly round sufficient surplus excavated material over the trench to compensate for after settlement.
 4. Dispose of all surplus excavated material.
 5. Prior to final acceptance, remove all mounds to the elevation of the surrounding terrain.
- D. Backfilling Beneath Driveways and Streets where Non-Rigid and Rigid Type Surfacing is to be Replaced:
 1. Use select backfill material, crushed limestone, or crushed gravel of high weight and density, as directed by the Engineer.
 2. Carefully deposit in uniform layers, not to exceed 12" thick, compacted to at least 95 percent standard proctor but not less than a minimum of 90 lb/ft³ dry density.
 3. Compact each layer thoroughly by rolling, ramming and tamping with tools suitable for that purpose in such a manner as to not disturb the pipe.

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A. Backfilling beneath Streets

1. Backfilling methods and materials beneath the streets shall be flowable fill in accordance with the requirements of the City of Johnson City, in accordance with Section 02300.
2. The pipe shall be covered with Class 1 material 6" – 12" above the top of the pipe.
3. The flowable fill shall be placed up to 3" from the pavement surface (or the base of the existing pavement).

B. Backfilling of Shoulders Along Streets and Highways:

1. Backfilling methods and materials for shoulders along streets and highways shall be in accordance with the requirements of governing local, county, or state departments maintaining the particular roadway or highway.
2. Replace with similar materials, all shoulders which may be damaged or destroyed as a result of pipe trenching.
3. Where shoulders along state highways have seal coat surfaces replace with double bituminous seal in accordance with Section 02480.

C. Crushed Stone or Pavement Maintenance and Shoulder Replacement:

1. Where possible, salvage and reuse all base material that is removed during construction.
2. Wet and thoroughly compact crushed stone and blade to tie into the existing surface prior to final acceptance.
3. Base material placed as a portion of pavement replacing items, will not be directly measured for payment.
4. Crushed stone used for pavement maintenance will not be a pay item.

END OF SECTION

SECTION 02300

HIGHWAY, STREET, AND RAILWAY CROSSINGS

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

- A. All pipelines crossings highways, streets, railroads and elsewhere if shown on the plans, shall be installed in a casing pipe by boring or jacking unless open cut or tunneling is specifically called for on the plans or permitted by the Engineer.
- B. Highway and street crossings, except where open cut is permitted, shall be constructed with no interruption of traffic. Where open cut is permitted not more than one half of the traveled way shall be closed to traffic at any one time.
- C. Permits or permission for work along federal, state, county and city highways, as well as crossing permits, will be obtained by the Contractor, and they shall cooperate closely with the Department of Transportation and the Railroads during the construction of the crossings.

PART 2 PRODUCTS

2.01 CARRIER PIPE

- A. Carrier pipe and joints shall be of accepted material and construction as provided in these specifications, subject to the approval of the Department of Transportation and the Railroads. Joints for carrier line pipe operating under pressure shall be mechanical "O" Ring push-on or welded type. The pipe shall be laid with sufficient slack (no tension) in the line or with an expansion joint near the point of crossing.

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2.02 CASING PIPE

- A. Casing pipe and joints shall be of leak-proof construction, and conform to the following:

TABLE OF MINIMUM WALL THICKNESS FOR STEEL CASING PIPE	
Normal Thickness	Normal Diameter
<u>Inches</u>	<u>Inches</u>
0.188	Under 14
0.219	14 & 16
0.250	18
0.281	20
0.312	22
0.344	24
0.375	26
0.406	28 & 30
0.438	32
0.469	34 & 36
0.500	38, 40 & 42

Steel pipe shall have a minimum yield strength of 35,000 psi.

- B. Casing pipe shall have a bituminous coating, applied cold, which shall be Koppers Company, Inc., bitumastic No. 50, Reilly Ca No. 5, Barrett Coal Tar Paint No. 34 YB, approved equal. The coating shall be applied in accordance with the manufacturer's directions. The coating shall be thinned only when permitted by the Engineer and then with not more than 5 percent of an approved solvent. The consistency of the coating shall be such that it can be applied easily with a brush or spray in one coat to a coverage not greater than 70 square feet per gallon on smooth metal. One coat approximately 1/32-inch thick on a plate suspended vertically shall show no appreciable flowing or sagging while still wet. The material shall dry to a firm film within 24 hours at 75 degrees F to 80 degrees F, at a spreading rate 70 square feet per gallon.
- C. When casing is installed without benefit of a protective coating, the wall thickness shown above shall be increased to the nearest standard size, which is a minimum of 0.063 inches greater than the thickness shown except for diameters under 12-3/4 inches.
- D. Cast iron pipe may be used for casing provided the method of installation is by open trench. Cast iron pipe shall conform to American Standard's Association

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Specification A21. The pipe shall be of the mechanical joint type or plain end pipe with compression type couplings. The strength of cast iron pipe to sustain external loads shall be computed in accordance with ASA A21.1 "Manual for the Computation of Strength and Thickness of Cast Iron Pipe."

- E. The inside diameter of the casing pipe shall be at least three (3) inches greater than the largest outside diameter of the carrier pipe, joints or couplings, for carrier pipe less than six inches in diameter. For carrier pipe six inches and over in diameter, it should be at least four (4) inches greater. It shall, in all cases, be great enough to allow the carrier pipe to be removed subsequently without disturbing the casing pipe or roadway.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Casing pipe shall be so installed as to prevent leakage of any substance from the casing throughout its length, except at ends. Casing shall be so installed as to prevent the formation of a waterway under the roadway with an even bearing throughout its length, and shall slope to one end.
- B. Installation by open trench methods shall comply with Department of Transportation Specifications covering "Installation of Pipe Culverts."
- C. Bored or jacked installations shall have a bored hole diameter essentially the same as the outside diameter of the casing pipe plus the thickness of the protective coating. If voids shall develop or if the bored hole diameter is greater than the outside diameter to the pipe (including coating) by more than approximately one inch, remedial measures as approved by the Engineer shall be taken. Boring operations shall not be stopped if such stoppage would be detrimental to the highway or railroad.
- D. Where the ends of the casing are below ground, they shall be suitably protected against the entrance of foreign material, but shall not be tightly sealed.
- E. Where the ends of the casing are at or above ground surface and above high water level, they may be left open, provided drainage is afforded in such a manner that leakage will be conducted away from roadway or structures.

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- F. Casing pipe under primary highways shall have a clear dimension of not less than four feet from the top of roadway to top of casing at its closest point. Under secondary roads this distance may be three feet. Railroads require 4.5 feet of clearance to a spur line, and 5.5 feet to a main line.

- G. Bedding, haunching and backfill material for open cut installation of casing pipe shall be crushed stone unless under a city street, then the backfill shall be flowable fill.

END OF SECTION

SECTION 02479

BASE TREATMENT FOR ASPHALT PAVEMENT REPAIR

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Placing and compacting base material.
- B. This section is for areas that are not backfilled with flowable fill.

1.02 RELATED WORK

- A. Section 02110: Clearing and Grubbing
- B. Section 02210: Grading and Excavating
- C. Section 02221: Trenching, Backfilling and Compaction
- D. Section 02513: Asphaltic Concrete Pavement
- E. Section 02515: Portland Cement Concrete Pavement

1.03 REFERENCE STANDARDS

- A. Compact all Sub-grade materials to 100% of maximum density unless otherwise specified.
 - 1. Determine maximum density and optimum moisture in accordance with the "Standard Method of Test for Moisture Density Relationship of Soils Using a 5.5 Pound Rammer and a 12-inch Drop", AASHTO Designation T 99, Method A.

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- B. Compact Type I Base materials to an average dry density of at least 100% of theoretical density based upon 83% of a solid volume, unless otherwise specified.
 - 1. No individual test shall be less than 97% of theoretical density.
 - 2. The theoretical density of limestone aggregates shall be based on bulk specific gravity AASHTO T-85.
 - 3. The theoretical density of all other aggregates shall be based on bulk specific gravity AASHTO T-84 and T-85.

- C. Compact Type II Base materials to at least 95% of maximum density, unless otherwise specified.
 - 1. No individual test shall be less than 92% of maximum density. Determine maximum density and optimum moisture in accordance with the "Standard Method of Test for Moisture Density Relationship of Soils Using a 5.5 Pound Rammer and a 12-inch Drop", AASHTO Designation T 99, Method D.

PART 2 PRODUCTS

2.01 MINERAL AGGREGATE MATERIALS - GENERAL

- A. Mineral aggregate: sound, tough, and durable fragments of crushed stone, crushed slag, crushed or uncrushed gravel or chert.

- B. Fine aggregate: natural sand, silt-clay or other inert materials with similar characteristics conforming to AASHTO M-6, M-29 and M-45 requirements except as specified herein.

- C. Coarse aggregate: AASHTO M-43, except as specified herein, consisting of crushed stone, crushed slag, crushed or uncrushed gravel, crushed or uncrushed chert, or a combination thereof, or other inert materials with similar characteristics, having hard strong durable pieces free from adherent coatings.

- D. Coarse aggregates: graded to standard sizes between the limits specified and to the gradation requirements set forth in the following table:

2.02 MINERAL AGGREGATE BASE MATERIALS

A. Base aggregates shall conform to the requirements of article 2.01 and shall be of two classes: Type I and Type II.

B. Base aggregate gradations:

Grading C	
Sieve Size	Percent Passing by Weight
1-1/2"	100
1"	90-100
3/8"	40-65
No. 100	4-15
Grading D	
1-1/2"	100
1"	85-100
3/4"	60-95
3/8"	50-80
No. 4	40-65
No. 16	20-40
No. 100	9-18

C. Type I aggregate: crushed stone, crushed slag, crushed gravel or crushed chert and other fine grained mineral matter.

1. Crushed stone: free from adherent coatings, clay, or other soils with wear not exceeding 50% and sodium sulfate soundness loss not exceeding 15%.
2. Crushed slag: quality as for crushed stone having a uniform density.
3. Crushed gravel and chert: screened and all oversize material crushed and fed back over the screen in a uniform manner.
4. Coarse aggregate wear for those retained on the No. 4 sieve shall not exceed 30%.
5. Material passing the No. 40 sieve: non-plastic, or with a liquid limit not exceeding 25 and a plasticity index not exceeding 6.
6. Only grading D aggregate shall be used.

D. Type II aggregate: crushed stone, crushed slag, crushed or uncrushed gravel, crushed or uncrushed chert, or a combination of these materials, and other fine

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grained material. The quality of Type II aggregate shall be the same as for Type I aggregate except as follows:

1. Gravel or chert: screened and the oversize material wasted or crushed and blended in a uniform manner with the remainder of the material.
 2. Gravel or chert: no more than 12% clay.
 3. Coarse aggregate wear for those retained on the No. 4 sieve shall not exceed 40%.
 4. Additional binder or mineral aggregate may be incorporated into the material to meet gradation, density, or bonding requirements.
 5. Grading C or D shall be used.
- E. Furnish test reports on quality of all aggregates for approval by the Engineer prior to blending or mixing. If requested by the Engineer, furnish samples for testing by an independent laboratory. Test methods for aggregate base quality shall be by the following AASHTO methods:

Test	Method
Sampling	T-2
Percentage of wear	T-96
Soundness	T-104
Unit weight	T-19
Sieve analysis	T-27

PART 3 EXECUTION

3.01 PREPARATION

- A. Clear construction areas as stipulated in Section 02110.
- B. Maintain benchmarks, monuments and other reference points.

3.02 PLACING AGGREGATE BASE

- A. Base course shall consist of a 6 inch thickness of approved materials.

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- B. Base shall be maintained at Contractor's expense until final pavement placement.
- C. Install base course immediately after placement and compaction of trench backfill material. Maintenance shall include, filling pot holes, work necessary to confine stone to trench area by sweeping with mechanical sweepers, and watering surface for dust control.
- D. The sub-grade shall be checked and approved by the Engineer at least 500 feet in advance of spreading any mineral aggregate. This distance may be shortened by permission of the Engineer to as little as 200 feet between November first and April first or during periods of prolonged wet weather.
- E. Mineral aggregate bases shall not be spread on a sub-grade that is frozen or contains frost.
- F. Hauling over material already placed will not be permitted until it has been spread, mixed, shaped and compacted to the required density.
- G. All pavement which has been damaged by settlement of backfill shall be removed.

3.03 COMPACTING AGGREGATE BASES

- A. For compaction testing purposes, each completed layer will be divided into lots of approximately 10,000 square yards. Smaller lots may be considered when approved by the Engineer.
- B. Five density tests will be performed on each lot and the results averaged.

END OF SECTION

SECTION 02480
PAVEMENT REPLACEMENT

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

- A. Preparation, placement, and compaction of a mineral aggregate base.
- B. Preparation, placement, and compaction of bituminous pavements.
- C. Preparation and placement of portland cement concrete pavements.

1.02 RELATED WORK

- A. Section 02221: Trenching, Backfilling and Compaction

PART 2 PRODUCTS

2.01 GENERAL

- A. All materials shall conform to those as specified on the plans or by the Engineer.
- B. Materials to replace State Highway paving shall conform to the specifications set forth by the Tennessee Department of Transportation.

PART 3 EXECUTION

3.01 PREPARATION

- A. Prior to replacing concrete or asphalt pavement, a six inch rock base shall be placed and compacted according to THD #303, unless area has been backfilled with flowable fill.
- B. Road repair should meet permit requirements by Federal, State, County or City

3.02 PAVEMENT REPLACEMENT

- A. Where concrete pavement is replaced minimum thickness shall be six inches and reinforced with 6"x6" No. 6/6 welded wire fabric.
- B. Concrete for paving shall have a minimum compressive strength of 3000 psi.
- C. Asphalt paving shall consist of a prime coat (THD #402), three inches of bituminous base course binder (THD #307), tack coat (THD #403), and a one and one-half inch (1 1/2") inch asphaltic concrete surface course (THD #411) after rolling.

END OF SECTION

SECTION 02485

LAWN AND GRASS LANDSCAPING

PART 1 GENERAL

1.01 RELATED WORK

- A. Preparation of landscape area including loosening, pulverizing and fertilizing.
- B. Placement of seed, sprigging, sod and topsoil including mulch, where required.
- C. Watering of landscaping.

1.02 RELATED WORK

- A. Section 02110: Clearing and Grubbing

PART 2 PRODUCTS

2.01 SEED MATERIALS

- A. Inspect and test seed for germination and purity prior to mixing.
- B. Uniformly mix by Group:

Seeding Dates	Grass Seed	Percentages
February 1 to July 1	Kentucky 31 Fescue	80%
	Korean Lespedeza	15%
	English Rye	5%
June 1 to August 15	Kentucky 31 Fescue	55%
	English Rye	20 %
	Korean Lespedeza	15%

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June 1 to August 15	German Millet	10%
April 15 to August 15	Bermudagrass (hulled)	70%
	Annual Lespedeza	30%
August 1 to December 1	Kentucky 31 Fescue	70%
	English Rye	20%
	White Clover	10%
February 1 to December 1	Kentucky 31 Fescue	70%
	Crown Vetch	25%
	English Rye	5%

- C. All seed shall meet the requirements of the Tennessee Department of Agriculture.
- D. Furnish the Engineer a certified laboratory report showing the analysis of the seed to be furnished. The report shall bear the signature of a senior seed technologist.
- E. Inoculate for Legumes:
 1. Nitrogen fixing bacteria cultures adapted to the particular seed to be treated.
 2. Furnish in containers of a size sufficient to treat the specified quantity of seed to be planted.

2.02 MULCH MATERIALS

- A. Hay composed of approved stalks from grasses, sedges, or legumes; or straw composed of stalks from rye, oats, wheat, or other approved grains.
- B. Air dried and reasonably free from noxious weeds, weed seeds, and other detrimental plant growth.
- C. Suitable for spreading with mulch blower machinery.
- D. Wood fiber mulch, when used, shall meet the following specifications.
 1. Moisture Content 10% \pm 2%
 2. Organic Matter 99.4% \pm 0.2%
 3. Ash Content 0.6% \pm 0.2%
 4. Water Hold Capacity (per hundred...1050 grams minimum grams of oven dry fiber)

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E. Mulch Binders:

1. Cut back asphalt, Grade RC-70 or RC-250 conforming to AASHTO M-81, M 82 of M-141, for the type and grade specified.
2. Emulsified asphalt, Type SS-1 conforming to AASHTO M-140. In addition to Type SS-1, a special mixing material AE-3 or a special priming material AE-P may be specified.

2.03 JUTE MESH

- A. Open plain weave of single jute yarn and non-toxic to vegetation.
- B. Tag jute rolls for identification with 58 warp ends per yard, 41 weft ends per yard and weighing approximately 0.9 pounds per square yard with an acceptable tolerance of 5 percent.

2.04 STAPLES

- A. New and unused, machine made of No. 11 gauge steel wire formed into a "U" shape.

2.05 SOD MATERIALS

- A. Live dense, well-rooted growth of permanent grasses, free from Johnson grass, nutgrass, and other undesirable grasses or weeds and well-suited for the proposed application to particular soils.
- B. Cleanly cut in strips having a reasonably uniform thickness of not less than 2-1/2 inches, a uniform width of approximately 8 inches, and a minimum length of 12 inches.

2.06 COMMERCIAL FERTILIZERS

- A. Unless otherwise specified, inorganic 10-20-10 nitrogen, phosphoric acid, and potash for seeding and 15-15-15 or 1-1-1 for sodding.

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- B. Furnish in standard containers with the brand name, weight and guaranteed analysis of the contents clearly marked.
- C. Comply with Federal, State and local laws.
- D. Ammonium Nitrate shall be a standard commercial product, having a minimum of 33.5 percent nitrogen.
- E. Agricultural limestone shall contain a minimum of 85% of calcium carbonate and magnesium carbonate combined, and be of particular size that 85% will pass a No. 10 mesh sieve.

2.07 WATER

- A. Free from harmful organisms or other objectionable materials.

2.08 TOPSOIL

- A. Natural, friable fertile, fine sandy loam possessing characteristics of representative topsoil in the vicinity which produce heavy growths of vegetation.
- B. Free from subsoil, noxious weeds, stones larger than one inch in diameter, lime, cement, ashes, slag or other deleterious matter.
- C. Well drained in its original position and free from toxic quantities of acid or alkaline elements.

PART 3 EXECUTION

3.01 SEEDING

- A. Scarify, disc, harrow, rake, or otherwise work each area to be seeded until it has been loosened and pulverized to a depth as directed by the Engineer.
- B. Uniformly incorporate fertilizer into the soil for a depth of approximately 1/2" at the rate of:

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1. Not less than 20 lbs. per 1000 square feet for grade 10-10-10 or equivalent.
 2. Not less than 100 lbs. per 1000 square feet for agricultural limestone.
- C. Fertilizer need not be incorporated in the soil as specified above when mixed with seed in water and applied with power sprayer equipment.
- D. Sow seed of the specified group as soon as preparation of the seed bed has been completed.
- E. Sow uniformly by means of a rotary seeder, hydraulic equipment, or other satisfactory means at the rate of 10 pounds per 1,000 square feet, unless otherwise specified.
- F. Inoculate Group "C" seed and seeds of legumes, when sown alone, before sowing in accordance with the recommendations of the manufacturer of the inoculant.
- G. Do not perform seeding during windy weather, or when the ground surface is frozen, wet or otherwise non-tillable. No seeding shall be performed during December through February unless otherwise permitted.
- H. When specified, provide seeding with mulch:
1. Spread hay or straw mulch evenly over the seeded area at an approximate rate of 75 pounds per 1,000 square feet immediately following the seeding operations. This rate may be varied by the Engineer, depending on the texture and condition of the mulch material and the characteristics of the area seeded.
 2. Hold hay or straw mulch in place by the use of a mulch binder applied at the approximate rate of 4 gallons per 1,000 square feet as required.
 3. Cover bridges, guardrails, signs and appurtenances, if the mulch binder is applied in such a way that it would come in contact with or discolor the structures.
 4. When wood fiber mulch is used, uniformly apply at the rate of 28 to 35 pounds per 1,000 square feet with hydraulic mulching equipment.

3.02 SPRIGGING

- A. Lightly incorporate fertilizer into the soil for a depth 1/2" at the rate of:
1. 12 lbs. per 1,000 square feet for grade 0-20-20 or equivalent.

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2. 100 lbs. per 1,000 square feet for agricultural limestone.
- B. Perform sprigging during September-November or April-May and only when the soil is in tillable or workable condition.
 - C. Do not set crowns during windy weather or when the ground surface is frozen.
 - D. Set crowns as soon as preparation of the sprig bed has been completed.
 - E. Set crowns at the rate of three sprigs per square yard by means of a tree-planting bar or equal.
 - F. When specified, perform mulching before sprigging:
 1. Spread mulch material evenly over the area to be planted at the rate of 100 lbs. per 1,000 square feet. This rate may be varied by the Engineer depending upon the texture and condition of the mulch material and the ground surface.
 2. Cover with a uniform layer of mulch so that 20 to 25 percent of the ground is visible. The mulch shall be loose enough to allow sunlight to penetrate and air to circulate slowly, but thick enough to partially shade the ground and to reduce erosion.
 3. Hold the mulch in place with mulch binders applied at the rate directed by the Engineer, not to exceed 0.1 gallon per square yard, as required to hold the mulch in place.

3.03 SODDING

- A. Place sod at all locations shown on the Plans or where directed.
- B. Loosen the surface of the ground to be sodded to a depth of not less than one inch with a rake or other device.
- C. If necessary, sprinkle with water until saturated for a minimum depth of one inch and keep moist until the sod is placed.
- D. Immediately before placing the sod, fertilize the prepared surface uniformly at the rate of:
 1. 12 lbs. per 1,000 square feet for grade 10-10-10 or equivalent.
 2. 100 lbs. per 1,000 square feet for agricultural limestone.

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- E. Place sod as soon as practical after removal from the point of origin, and keep in a moist condition during the interim.
- F. Carefully place, by hand, on the prepared ground surface with the edges in close contact and, as far as possible, in a position to break joints.
- G. Each strip of sod laid shall be fitted and pounded into place using 10 inch by 10 inch wood tramps, or other satisfactory implements.
- H. Immediately after placing, thoroughly wet and roll with an approved roller or hand-tamp as approved by the Engineer.
- I. On slopes of two to one or steeper, pinning or pegging may be required to hold the sod in place.

3.04 TOPSOIL

- A. Prepare landscape area to receive topsoil in close conformity to the lines and grades shown on the drawings or match with existing grades prior to line in installations.
- B. Place a 6" layer of topsoil over all areas disturbed by construction activities.
- C. Topsoil shall be free of rocks, sticks, roots, or frozen clods.

END OF SECTION

SECTION 02528

CONCRETE CURBS, GUTTERS AND SIDEWALKS

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Formwork complete with shoring, bracing and anchorage.
- B. Concrete reinforcement complete with required supports, spacers and related accessories.
- C. Cast-in-place concrete for curbs, gutters and sidewalks.
- D. Joint work

1.02 RELATED WORK

- A. Section 02110: Clearing and Grubbing
- B. Section 02210: Grading and Excavation
- C. Section 02215: Base and Sub-grade Treatment
- D. Section 03001: Concrete Work

PART 2 PRODUCTS

- 2.01 Use Class "A" concrete as specified in Section 03001.**

2.02 FORM MATERIALS

- A. Either wood or metal, free from warp with sufficient strength to resist the pressure of the concrete without springing, extending for the full depth of concrete.
- B. Use curbed forms of proper radius on all radial sections and of acceptable design to Engineer.
- C. Use 1/8" thick metal templates between 10" section with:
 - 1. Width - same as curb, gutter or sidewalk.
 - 2. Depth - at least 1/4" more than curb, gutter or sidewalk depth.
 - 3. Lugs or other devices to hold templates in position and permit removal without causing damage to concrete.
- D. Use a metal strike-off template to shape the top surface of gutters or sidewalks.

2.03 JOINT MATERIALS

- A. 1/2" thick performed filler, unless otherwise specified.
- B. Cut to full cross-section of curb, gutter and/or sidewalk.
- C. True, even and of satisfactory appearance.

PART 3 EXECUTION

3.01 PREPARATION

- A. Clear construction area in accordance with Section 02110.
- B. Compact sub-grade by tamping or rolling as specified in Section 02215.
- C. Thoroughly wet base or sub-grade prior to placing concrete.

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3.02 FORMWORK

- A. Place forms so finished concrete will be true to line, grade and cross-section as shown on the drawings.
- B. Uniform section lengths - Maximum of 10 feet and minimum of 6 feet.
- C. Place joints at locations shown on drawings or in line with joints of adjoining construction, unless otherwise shown on drawings.
- D. Brace and stake forms to maintain vertical and horizontal alignment until their removal.
- E. Carefully set templates and leave in place until the concrete has set sufficiently to hold its shape. Remove templates while forms are still in place.
- F. Provide construction joints between new construction and all adjoining construction and around all utility appurtenances extending into sidewalks, unless otherwise specified.
- G. Clean and coat forms with light oil immediately before placing concrete.

3.03 CONCRETE PLACING

- A. Deposit the concrete on the base:
 - 1. When central or transit mixed concrete is used, place the mixture where it will require as little rehandling as possible.
 - 2. Continuously place between transverse joints without the use of intermediate bulkheads.
 - 3. Perform necessary hand spreading with shovels, or other approved tools.
 - 4. Do not allow workmen to walk in the freshly mixed concrete with boots or shoes coated with foreign substances.
- B. Consolidate concrete against and along the faces of all forms and along the full length and on both sides of all joint assemblies, by means of vibrators inserted in the concrete.

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1. Do not permit vibrators to come in contact with a joint assembly, the grade, or a side form.
 2. Do not operate the vibrator longer than 5 seconds in any one location.
 3. Operate vibrators mounted on a machine only while in motion.
- C. Deposit concrete as near to expansion and contraction joints as possible without disturbing them, but do not dump from the discharge bucket or hopper onto a joint assembly unless the hopper is well centered on the joint assembly.
- D. Should any concrete materials fall on or be worked into the surface of a complete slab, remove immediately by approved methods.

3.04 FINISHING CONCRETE - GENERAL

- A. When necessary, strike-off concrete using transverse templates resting upon the side forms.
- B. Remove templates, then the forms when the concrete has set sufficiently to hold its shape.
- C. Finish surface with floats and straightedges, when required, to a smooth even finish.
- D. Round edges at templates and expansion joints with an edging tool of 1/4" radius.
- E. Remove all tool marks with a wetted brush or wooden float.
- F. Clean the top and ends of expansion joint materials and trim to slightly below the concrete surface.
- G. Remove forms, without exerting pressure on the concrete, at any time when such removal will not damage the concrete.
- H. Protect concrete work until finally accepted.
- I. Remedy damaged work, that has not been accepted, by removing and reconstructing each section that is damaged.

3.05 FINISHING CURBS AND GUTTERS

- A. No plastering will be permitted.
- B. Unless otherwise specified, the edges of the curb and gutter shall be rounded to a radius of 3/4".
- C. Finish the back of curbs not less than 3" below the top of backfill against the curb.
- D. Any exposed surface or surfaces against which some rigid type of construction is to be made shall be left smooth and uniform so as to permit free movement of the curb, gutter or combined curb and gutter.
- E. When the use of curb machines is permitted, finish as specified above except that contraction joints may be sawed a minimum depth of 1/4 the thickness of the section at intervals not less than 6 feet nor more than 10 feet in lieu of constructing the curbs in sections.
- F. Place weep holes or drainage openings through curbs as indicated on the Plans or as directed by the Engineer, with at least one-half cubic foot of coarse aggregate behind each opening.

3.06 FINISHING SIDEWALKS

- A. When the surface of the concrete is free from water and just before the concrete obtains its initial set, finish and sweep lightly with a broom in order to produce a sandy texture.
- B. The longitudinal surface variations shall be not more than 1/4" under a 12' straightedge, nor more than 1/8" on a 5' transverse section.
- C. The surface of the concrete shall be so finished as to drain completely at all times.
- D. Round the edges with an edging tool having a radius of 1/2".
- E. Divide the surface of sidewalks into blocks by use of a grooving tool.
 - 1. Space the grooves approximately 5' apart with the blocks rectangular unless otherwise ordered by the Engineer.

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2. Cut the grooves to a depth of not less than 1".
 3. Edge the grooves with an edging tool having a radius of 1/4".
 4. Place grooves in median pavement in line with corresponding joints in adjoining construction or as directed by the Engineer.
- F. Unless otherwise indicated on the Plans, place marks or grooves at right angles to the center-line of driveways and approximately 8" apart.
1. These markings shall be between 1/8" and 1/4" in depth and shall be made with a suitable marking tool.
 2. A grooving tool, 6 to 8 inches in width, with multiple grooves for grooving alternate strips 8" apart, may be used.
 3. All marking edges shall be rounded satisfactorily.
- G. Do not place grooves in the surface of sidewalks reinforced for beam action where the full thickness of concrete is required for strength.
- H. Do not allow pedestrians, vehicles or loads upon concrete sidewalks until 12 hours after finishing concrete, or until the Engineer has determined that the concrete has attained sufficient strength for such loads.

END OF SECTION

SECTION 02605

SEPARATION OF PIPE UTILITIES

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

- A. Location of piped utilities to separate water mains from sewer facilities.

1.02 RELATED WORK

- A. Section 02305: Boring and Jacking
- B. Section 2722: Sanitary Sewerage Systems

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

3.01 RELATION TO WATER MAINS

Horizontal Separation: Whenever possible, sewers should be laid at least 10 feet horizontally from any existing or proposed water main. The distance should be measured edge to edge. Should local conditions prevent a lateral separation of 10 feet, a sewer may be laid closer than 10 feet to a water main if it is laid in a separate trench and if the elevation of the top (crown) of the sewer is at least 18 inches below the bottom (invert) of the water main.

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Vertical Separation: Whenever sewers must cross under water mains, the sewer shall be laid at such elevation that the top of the sewer is at least 18 inches below the bottom of the water main. When the elevation of the sewer cannot be varied to meet the above requirement, the water main shall be relocated to provide this separation or reconstructed with mechanical-joint pipe for a distance of 10 feet on each side of the sewer. One full length of water main should be centered over the sewer so that both joints will be as far from the sewer as possible. When it is impossible to obtain proper horizontal and vertical separation as stipulated above, the sewer shall be designed and constructed equal to the water main pipe and shall be pressure-tested to assure water-tightness.

3.02 SEWER FACILITIES

- A. Do not install water mains or sewer facilities which pass through or contact each other.

END OF SECTION

SECTION 02722

SANITARY SEWERAGE SYSTEMS

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Installation of sanitary sewerage systems.

1.02 RELATED WORK

- A. Section 02221: Trenching, Backfilling and Compaction
- B. Section 02305: Boring and Jacking
- C. Section 02605: Separation of Piped Utilities
- D. Section 03001: Concrete Work

PART 2 PRODUCTS

2.01 POLYVINYL CHLORIDE PIPE (PVC) AND FITTINGS

- A. Manufactured from virgin, National Sanitation Foundation (NSF) approved resin conforming to ASTM D-1784.
- B. Unless otherwise specified, all PVC pipe and fittings shall conform to ASTM D-3034 and have a Standard Dimension Ratio (SDR) of 35 or conform to ASTM F-789.
- C. The gaskets used for joining PVC sewer pipe shall conform to ASTM F-477.
- D. All PVC gravity sewer pipe shall be clearly marked with the Manufacturer's name, nominal diameter, SDR, ASTM D-3034 designation, and NSF approved seal.

2.02 DUCTILE IRON PIPE AND FITTINGS

A. Pipe:

1. Manufactured in accordance with ANSI A-21.50 (AWWA C-151) and ANSI A-21.10 (AWWA C-110).
2. Protecto 401 Ceramic Epoxy lined ductile iron pipe and fittings for force mains and gravity sewer lines which shall meet the following lining material specifications:

The material used for lining the pipe and fittings must have a successful history of protecting sewer pipelines. The material must be a high build multi-component Amine cured Novalac Epoxy lining. The standard of quality is Protecto 401 Ceramic Epoxy. Any request for substitution must meet the following criteria and be accompanied by:

 - a. The permeability rating when tested according to Method A of ASTM E-96-66, Procedure A with a test duration of 42 days as reported by an independent laboratory.
 - b. A statement from the manufacturer of the submitted material attesting to the fact that at least 20% of the volume of the lining contains ceramic quartz pigment.
 - c. A laboratory report containing test data for Immersion in Acids, Bases, and Deionized Water at elevated temperatures using ASTM-D 714-56 (1974) for the rating method. The report should also contain data on ASTM D-2794 Direct Impact and ASTM-G 53-77 Moisture and Ultraviolet Light Exposure.
 - d. A statement concerning recoatability and repair to the lining.
3. A minimum of 1 mil thick bituminous coating on the outside surface.
4. Clearly mark with manufacturer's name, D.I. or Ductile, weight, class or nominal thickness, and casting period.
5. Unless otherwise specified or shown on the plans, ductile iron pipe shall be class 50 or 200 psi working pressure, minimum thickness.

B. Fittings:

1. Fittings 4" - 24": Pressure rated at 350 psi.
2. Fittings 30" - 36": Pressure rated at 250 psi.
3. Joints meeting the requirements of ANSI A-21.11 (AWWA C-111), mechanical joints or push on joints.

2.03 HIGH DENSITY POLYETHYLENE (HDPE) PIPE AND FITTINGS

A. Materials used for the manufacturer of polyethylene pipe and fittings shall be PE3408 high density polyethylene meeting cell classification 345464C per ASTM D3350; and meeting Type III, Class B or Class C, Category 5, Grade P34 per ASTM D1248; and Shall be listed in the name of the pipe and fitting Manufacturer in PPI TR-4, Recommended Hydrostatic Strengths and Design Stresses for Thermoplastic Pipe and Fittings Compounds, with a standard grade rating of 1600 psi at 73 degrees per ASTM D2837. The Manufacturer shall certify that the materials used to manufacture pipe and fittings meet these requirements.

1. Permanent identification of piping service shall be provided by co-extruding multiple equally spaced color stripes into the pipe outside surface or by solid colored pipe shell. The striping material shall be the same material as the pipe material except for color. The following colors shall be used to identify piping service (pressure service):
 - A. Blue – potable water
 - B. Green – wastewater or force main
 - C. Purple – reclaimed water
 - D. Black – raw water

B. HDPE Pipe (4" and larger) shall conform to AWWA C906, DR-11, Ductile Iron Pipe (DIP) size and NSF 61 Standard. HDPE pipe for water or reclaimed water piping (not approved for sewer force mains) with pipe size 4 inch through 12 inch may be DR-17 conforming to AWWA C906 and NSF 61. A break-away link is required for pulling DR-17 HDPE pipe lengths greater than 500 LF (for additional information refer to 3.04 PULL-BACK OPERATIONS). For pipe sizes 24-inch and larger, the HDPE may be IPS size, DR 11. Polyethylene pipe shall be manufactured in accordance with ASTM F714, Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Controlled Outside Diameter and shall be so marked. Each production lot of pipe shall be tested for (from material or pipe) melt index, density, % carbon, dimensions and either quick burst or ring tensile strength (equipment permitting). Nominal pipe sizes only are indicated on the drawings and bid form. Outside diameter of pipe is generally 1 to 2-inches greater than the nominal pipe diameter.

1. Polyethylene fittings and custom fabrications shall be molded or fabricated by the pipe manufacturer or trained personnel. Butt fusion outlets shall be made to the same outside diameter, wall thickness and tolerances as the mating pipe. All fittings and custom fabrications shall be

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fully rated for the same internal pressure as the mating pipe. Fabricated fittings must have the same working pressure as the mating pipe.

2. Molded fittings shall be manufactured in accordance with ASTM D3261, Butt Heat Fusion Polyethylene (PE) Plastic Pipe and Tubing and shall be so marked. Each production lot of molded fittings shall be subjected to the test required under ASTM D3261.
3. Fabricated fittings shall be made by heat fusion joining specially machined shapes cut from pipe, polyethylene sheet stock or molded fittings. Fabricated fittings shall be rated for internal pressure service equivalent to the full service pressure rating of the mating piece. Directional fittings 16" and larger such as elbows, tees, crosses, etc., shall have a plain end inlet for butt fusion and flanged directional outlets.
4. Electro Fusion Branch Services shall meet AWWA C906, outlet shall comply with ASTM D3261, and shall be specifically manufactured for HDPE pipe. This saddle may be utilized for wet-tap applications. These electro fusion fittings shall be designed and manufactured in accordance with ASTM Specifications F1055 for use with HDPE (DIPS) pipe.
5. Polyethylene Flange adapters shall be made with sufficient throughbore length to be clamped in a butt joining machine without the use of a stubend holder. The sealing surface of the flange adapter shall be machined with a series of small v-shaped grooves to provide gasket less sealing or to restrain the gasket against blow-out. Below ground flange adapter may be utilized for 30" and larger, DIP and valves. Adapters for 24 inch and smaller utilize an MJ adapter (see below).
6. Flange adapters shall be fitted with lap joint flanges, pressure rated equal to or greater than the mating piece. Convolute style backup rings are referred over the flat stock rings. The lap joint flange bore shall be chamfered to provide clearance to the flange adapter radius. Flange bolts and nuts shall be Grade 2 or higher.
7. Mechanical connections of HDPE pipe (4" through 24" diameter) to Ductile Iron or PVC piping, mechanical joint fittings or valves shall be through a self-restraining, fusible mechanical joint adapter with or without an integral, internal stainless steel insert. Mechanical joint adapters shall be of the same SDR rating as the pipe. A separate, loose stainless steel type insert will only be allowed for pipe sizes 4" through 8". Provide the mechanical joint adapter, including but not limited to longer

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tee bolts or all- thread rods with nuts at the mechanical joint bell. Note that PE flanged adapters may be utilized for pipe sizes 30" and larger.

8. HDPE to MJ cast transition couplings may only be utilized for 8" and smaller pipe size. A stainless steel stiffener is required, sized at the proper ID of the HDPE pipe. The transition coupling must be epoxy lined (3 mils minimum for sewer use). Acceptable coupling is a Power Seal model 3520 or approved equal.
9. Polyethylene pipe and fittings may be joined using approved electro fusion couplings. Fittings shall be PE3408 HDPE, Cell Class 345464C as determined by ASTM D3350-99. Electro fusion fittings shall have a manufacturing standard of ASTM F1055. Fittings shall have a pressure rating equal to the pipe. All electro fusion fittings shall be suitable for use as pressure conduit per AWWA C906 and have a nominal burst value of 3.5 times the working pressure of the fitting. To minimize the "toe-in" problems when installing an electro fusion fitting coupling larger than 12 inch size, the Contractor shall remove 12 inches (minimum) from all associated "factory ends" and use a re-rounding clamp on the associated pipe. The Contractor shall mark pipe insertion depth prior to assembly and construct in accordance with the manufacturer's instructions.

2.04 POLYETHYLENE TUBING LINES (LOW PRESSURE SEWER LINES ONLY)

- A. Tubing shall be manufactured of PE 3408, High Density Polyethylene (HDPE), in accordance with AWWA C901, ASTM D1248, ASTM D2239, ASTM D2737 and ASTM D3350. The tubing shall have a minimum working pressure of 200 psi. Polyethylene tubing shall be copper tube size or IPS SDR-9 and shall be colored black or green. HDPE pipe shall have ultraviolet (UV) inhibitors for protection against direct sunlight for 1 year. Inserts for polyethylene tubing may be utilized, at the contractor's option and if used, shall be 316 stainless steel. The use of brass fittings (including couplings) is acceptable if not located under the roadway. The use of brass couplings, tees and "Y" fittings are acceptable on poly service tubing, if not located under the roadway. Tubing shall be approved for use with potable water by the National Sanitation Foundation (NSF-14) and shall be continuously marked at intervals of not more than four feet with the following:

- A. Nominal size
- B. Pressure rating
- C. NSF seal
- D. Manufacturer's name or trademark
- E. Standard dimension ratio

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F. ASTM specification

2.05 CONCRETE MATERIALS

- A. Class "A" in accordance with Section 03001.

2.06 CASTING FOR FRAME AND COVERS

- A. Gray iron, Class 30, unless otherwise specified, meeting AASHTO M-108.
- B. Cleaned and coated with bituminous paint that will produce an acceptable finish that is not affected by exposure to hot or cold weather.
- C. Frames and covers for use on watertight manholes shall be machined to a smooth uniform bearing complete with polyvinyl gasket set inside the bolt circle that will provide a watertight seal.
- D. All frame openings shall be full 24-inch diameter to provide clear access conforming to OSHA regulations.

2.07 PRECAST MANHOLES

- A. AASHTO M-199 SR or ASTM C-478.
- B. Openings shall be provided for the required number and size pipes and shall be marked to insure installation at proper locations.
- C. Use o-ring joints or "Mastic" joint in accordance with ASTM C-443 or ASTM C-361 at all joints between sections in sanitary sewer manholes.
- D. Use Type II cement for increased sulfate resistance.
- E. Provide manholes with lift holes that do not completely penetrate the wall of manhole sections.
- F. Manhole bases for depths greater than 15' are to be double reinforced wire mesh with a minimum height of 1' of concrete above the pipe opening. Steel in all manhole sections over 15' should meet ASTM C-76 class II or higher. Base sections for manholes over 15' should have an extended bottom slab.

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- G. Verify on plans for any coatings or admixtures required near forcemain discharge points.

2.08 MANHOLE STEPS

- A. ASTM C-478
- B. Cast Iron Steps: ASTM A-48, Class 30B
- C. Aluminum Steps: Fabricated from aluminum alloy 6601, T6
- D. Polypropylene plastic molded around a steel rod.
- E. Manhole steps shall be corrosion resistant, free from sharp edges, burrs, or other projections which may be a safety hazard and shall be of sufficient strength to have a live load of 300 pounds imposed at any point.
- F. The minimum width of cleat shall be 10 inches.
- G. The legs and struts shall be of sufficient length for the cleat to project a minimum clear distance of 4" from the wall when the step is securely embedded in the manhole wall.
- H. The top surface of the cleats shall be designed to prevent foot slippage.

2.09 PIPE ENTRANCE COUPLINGS FOR MANHOLES

- A. Connections between pipes and manholes shall be watertight, made with flexible gaskets and meeting quality standards of ASTM C-443. Internal aluminum band material shall conform to specification 6061-T6, T651. External band shall be 304 Stainless Steel conforming to ASTM Specification A-167. Use Korn-N-Seal Boot, PSX Boot, or equivalent. Provide connection for all pipes including service connections.

PART 3 EXECUTION

3.01 PREPARATION FOR INSTALLING GRAVITY SEWER BY OPEN CUT

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- A. Prior to laying pipe, prepare suitable bedding according to Section 02221.
- B. Before placing pipe in the trench, field inspect for cracks or other defects; remove defective pipe from the construction site.
- C. Swab the interior of the pipe to remove all undesirable material.
- D. Prepare the bell end and remove undesirable material from the gasket and gasket recess.

3.02 INSTALLING GRAVITY SANITARY SEWER BY OPEN CUT METHODS

- A. Lay pipe true to the lines and grades from the grade and alignment stakes, or equally usable references.
 - 1. Where laser equipment is used, provide offset hubs at every manhole location for the purposes of checking grade between the sections.
 - 2. Where batter boards are used, furnish stakes at intervals of 50 feet along the route of the pipeline on lines smaller than 18-inches. For lines 18-inches and larger, use 25 foot intervals.
 - 3. Set stakes at such distance from centerline of excavations as is suitable for the excavating method and machinery used.
 - 4. Provide and use accurately set batter boards at each 50 and 25 foot interval in establishing the bottom invert of each pipe laid
- B. Accurately establish the centerline of each pipe using a string stretched between targets and a plumb line extended to the centerline of the pipe.
- C. Carefully inspect all pipes and each fitting prior to its placement in the trench, and reject and remove any defective pipe or fitting from the job site.
- D. Lay pipe progressively up grade, with bell upstream, in such a manner as to form close, concentric joints with smooth bottom inverts. Joining of all pipes shall be in accordance with manufacturer's specifications.
- E. Bed each pipe section in accordance with Section 02221.
- F. Unless otherwise specified, provide all gravity sewer lines with a minimum of 3 feet of cover in roadways and 2-1/2 feet of cover in open areas, unless ductile iron pipe or concrete encasement is used. Any lines crossing a State Highway shall

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have a minimum depth of cover of 4 feet. All depths of cover are measured to the top of the pipe.

- G. Do not allow walking on completed pipelines until backfill has been placed to a depth of at least 6 inches above the crown of the pipe.
- H. Keep the interior of the pipe free of all unneeded material, and upon completion of a section between any two manholes it shall be possible to view a complete circle of light when looking through the pipe.
- I. When laying pipe ceases, close the open ends of the pipe with a suitable plug for preventing the entrance of foreign materials.
- J. Couplings and adapters used for joining dissimilar gravity pipe materials and for repairing and rejoining sections of gravity sewer shall meet the requirements of ASTM C-594.
- K. All couplings and adapters for gravity sewer pipe shall be of rubber, elastic and metallic materials that will not be attacked by municipal wastewater or aggressive elements in the soil and conform to ASTM C-425, Section 5.
- L. Pipe material for gravity sewer lines fifteen inches and smaller shall be PVC, unless otherwise specified.
- M. Connect new lines to existing manholes as shown on the drawings and include flow channel reconstruction; all repairs to the existing structure shall be watertight and to the satisfaction of the Engineer.
- N. Sewage flow must be maintained in the existing sewer interceptor. Whenever pipe-laying progresses to a point where this flow must be interrupted the Contractor shall plug the sewer upstream of the construction and provide pump bypassing to a downstream manhole. All downstream pipes, manholes and appurtenances must be tested and acceptable to the Owner and the Engineer prior to receiving sewage flow. When working in areas where interruption of sewer flow may occur, the Contractor shall have at the site pumps, lines and all other equipment in readiness to provide pump bypassing.
- O. Contractor shall plan work and arrange work schedules to minimize the length of time sewer service is interrupted. At no time shall sewerage be discharged on the ground or to any watercourse.

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- P. New connections to existing customers and tie-in of lateral sewers shall be accomplished as determined necessary and at the times requested by the Engineer and Owner. Connections, excavation to determine existing sewer locations, plugs both temporary and permanent, existing line abandonment and permanent sealing shall be considered incidental items necessary for construction of this project.

- Q. Check dams shall be installed in the bedding and backfill of all new or replaced sewer lines to limit the drainage area subject to french drain effect of gravel bedding. Major rehabilitation projects should also include check dams in the design. Dams shall consist of compacted clay bedding and backfill at least three feet thick to the top of the trench and cut into the walls of the trench two feet. Alternatively, concrete may be used, keyed into the trench walls. Dams shall be placed no more than 500 feet apart. The required location is upstream of each manhole. All stream crossings shall include check dams on both sides of the crossing.

- R. Downspouts or other conduits carrying storm or ground water shall not be connected to the sanitary sewer.

3.03 PILOT HOLE FOR HORIZONTAL DRILLING OF PE PIPE

- A. Prior to drilling, the Contractor shall utilize all verified location information to determine the drill pathway. Marked up drawings (see Site Preparation paragraph) shall be on the work site at all times and referred to during the drilling operations.

- B. The Contractor shall provide and maintain instrumentation necessary to accurately locate the pilot hole (both horizontally and vertically), measure pilot string torsional and axial and measure the drilling fluid discharge rate and pressure. The City of Johnson City shall have access to the instrumentation and reading at all times during the operation.

- C. The pilot hole shall be drilled along the path shown on the plans and profile drawings or as directed by the City of Johnson City representative in the field. Unless approved otherwise, the pilot hole tolerances shall be as follows:
 - 1. Elevation as shown on the plans

 - 2. Alignment shall be within center of right-of-way or easement and within +/- 5 feet of manhole station

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3. The pilot hole radius shall be no less than 80% of the maximum bending radius as recommended by the pipe manufacturer of the pipe being installed. In no case shall the bending radius be less than 30 pipe diameters, unless approved otherwise by the City of Johnson City.
4. The exact pilot hole entry point shall be within +/- 5 feet of the location station shown on the drawing or as directed by the City of Johnson City representative in the field.
5. The exit point location shall be within +/- 5 feet of the location station shown on the drawing or as directed by the City of Johnson City representative in the field.
6. If not noted on the plans, 6" HDPE pipe and smaller shall be installed with a depth of 3-5 feet and 8" HDPE pipe through 12" pipe shall be installed with a depth of 3-6 feet unless it is required to install the pipe deeper due to utility conflicts. HDPE pipe larger than 12" shall be specifically designed by the engineer and approved by the City of Johnson City. Where utilities cross under roads, the depth of cover shall comply with applicable road permits.
7. The minimum separation requirements between HDPE water mains and nonwater mains shall be 10' horizontal and 2' vertical.

3.04 PULL- BACK OPERATIONS

- A. After successfully reaming the bore hole to the required diameter, the Contractor will pull the pipe through the bore hole. In front of the pipe will be a swivel and reamer to compact the bore hole walls. Once the pull-back operations have commenced, operations must continue without interruption until the pipe is completely pulled into the bore hole. During pull-back operations, the Contractor will not apply more than the maximum safe pull pressure at any time. Maximum allowable tensile force imposed on the pull section shall be equal to 80% of the pipe manufacturer's safety pull (or tensile) strength.
 1. Torsional stress shall be minimized by using a swivel to connect a pull section to the reaming assembly.
 2. The pull-back section of the pipeline shall be supported during pull-back operations so that it moves freely and the pipe is not damaged.

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3. External pressures shall be minimized during installation of the pull-back section in the reamed hole. Damaged pipe resulting from external pressure shall be replaced at no cost to the City of Johnson City.
 4. Buoyancy modifications shall be at the discretion of the Contractor and shall be approved by the City of Johnson City representative. The Contractor shall be responsible for any damage to the pull section resulting from such modifications.
 5. In the event that the pipe becomes stuck, the Contractor will cease pulling operations to allow any potential hydro-lock to subside. After subsidence, pulling operations may be restarted. If the pipe remains stuck, the Contractor will notify the City of Johnson City representative to discussion of options and then work will proceed accordingly.
 6. For HDPE DR-17 pipe with a pulling length greater than 500 LF, the Contractor shall utilize a break-away link. The Contractor shall provide a break-away link between the swivel pipe or a combination swivel and break link. Break-away links shall be rated at 80% of the pipe manufacturer's safe pull (tensile) strength. Break pins shall be color coded for easy identification.
 7. The Contractor shall provide rated break-away link for each material and pipe size(s) required for the project.
- B. Locate wire shall be provided on all installations. For HDD projects, the locate wire shall be 12 AWG copper-clad carbon steel with 30 mils (min) of insulation. For open-cut projects, the locate wire construction and testing shall meet the locate wire requirements of 10 AWG, single strand, UF rated, copper wire with 30 mil (min) of insulation. The external color shall be either white or yellow. The locate wire shall be brought to grade within a valve box or location station box at all "entry point locations" and all "exit point locations". For HDD projects, there is no maximum length or interval between the locate wire stations. The testing and report requirements shall be required as follows: If the locate line breaks or if it is not continuous (from end to end), the Contractor shall, at the Contractor's expense, provide soft-digs for the portions of the main with 12-feet or less of cover (every 50 LF along the main) to confirm as-built data. This soft-dig data shall be recorded on the as-built drawings.

3.05 PE PIPE ASSEMBLY

- A. Pipe shall be welded/fused together in one length, if space permits. Pipe may be placed on pipe rollers before pulling into the bore hole to minimize damage to the pipe. For pipes 16" and larger, a re-rounding clamp tool shall be utilized

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during the electro-fusion process to ensure pipe roundness. For pipe sizes larger than 12", mechanical scrappers (per the fitting manufacturer's recommendation) shall be utilized during the electrofusion work. It is critical that all original oxidized pipe surface be removed in order for the fusion to take place. The scrapping process requires that approximately 0.10" of the outer "skin" be removed in order to penetrate the oxidation and contamination barrier. Oxidized pipe surface simply will not bond.

- B. Cuts or gouges that reduce the wall thickness by more than 10% is not acceptable and must be cut out and discarded.
- C. When requested by the City of Johnson City representative, butt fusion testing will be performed. The test fusion shall be allowed to cool completely and then fusion test straps shall be cut out. The test strap shall be 12" (minimum) or 30 times the wall thickness in length with the fusion in the center and 1" (minimum) or 1.5 times the wall thickness in width. Bend the test strap until the ends of the strap touch. If the fusion fails at the joint, a new fusion shall be made, cooled completely and re-tested.
- D. Polyethylene pipe and fittings may be joined together or to the materials by means of flanged connections (flanged adapters, electrofused couplings and back-up rings) or mechanical couplings designed for joining polyethylene pipe or for joining polyethylene pipe to another material. Mechanical couplings shall be fully pressure rated and fully thrust restrained such that when installed in accordance with the manufacturer's recommendations, a longitudinal load applied to the mechanical coupling will cause the pipe to yield before the mechanical coupling disjoins. External joint restraints shall not be used in lieu of fully restrained mechanical couplings.
- E. Mechanical joints and flange connections shall be installed in accordance with the manufacturer's recommended procedures. Flange faces shall be centered and aligned to each other before assembling and tightening the bolts. In no case shall the flange bolts be used to draw the flanges into alignment. Bolt threads shall be lubricated and flat washers shall be fitted under the flange nuts. Bolts shall be evenly tightened according to the tightening pattern and torque recommendations of the manufacturer. At least 1 hour after initial assembly, flange connections shall be re-tightened following the tightening pattern and torque step recommendations of the manufacturer. The final tightening torque shall be 100 ft-lbs or less as recommended by the manufacturer.
- F. For HDPE pipe 24 inch and larger, unless approved otherwise by the City of Johnson City, a foundation bed of granular material (57 stone) shall be placed under and around all ductile iron fittings and valves for additional support of the

heavy system components. A foundation bed of granular material shall be provided for all valves 20-inch and larger. For granular materials, the minimum vertical limit is 12 inches under the fitting or valve, up to 1/3 of the overall height of the fitting or valve. The minimum horizontal limits of the granular material shall be 12 inches in all directions beyond the outer edges of the fitting or valve. The compaction of soils below the granular material shall be at 98% of the maximum density. Payment for this work shall be included in the associated fitting or valve unit cost. All spool pieces between 24 inch and larger ductile iron fittings and valves shall be at least 5-feet long. No joint deflection shall be allowed at the fittings or valves.

G. Discarded pipe sections are not to be left in the ditch

3.06 SEWER MANHOLES - GENERAL

- A. Unless otherwise specified, all manholes shall have an inside diameter of not less than 4 feet and a vertical wall height of not less than 2.5 feet.
- B. The clear opening in the manholes shall be not less the 2.0 feet.
- C. Depth of the manhole shall be the vertical distance from the lowest invert in the manhole to the top of the frame and cover assembly.
- D. Backfill manholes with the same material used for pipelines.
- E. Mechanically tamp Class I material a distance of at least one full pipe length to prevent settlement of pipelines.
- F. Frame and cover shall not be installed in curb-lines.

3.07 STANDARD PRECAST CONCRETE MANHOLES

- A. ASTM C-478, with o-ring joints or "Double Mastic" joints in accordance with ASTM C-433 or ASTM C-361 and manufacturer's recommendation. Use Type II cement.
- B. The base of the manhole shall be Class C concrete not less than 8" in depth with inverts not less than 4" in depth.
- C. Shape manhole inverts from Class B concrete to be smooth, accurately shaped, and in accordance with the Plans. Inverts shall be of such shape and slope to provide smooth transition between inlet and outlet sewers and to minimize

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turbulence. Channeling height shall be to the springline of the sewers. Benches shall be sloped from the manhole wall toward the channel to prevent accumulation of solids.

- D. Inlets and outlets from each manhole shall drop 0.10 foot across the manhole and shall be finished smooth and flush with the sides of the manhole walls so as not to obstruct the flow of liquid through the manhole.
- E. When possible, the base of the manhole shall sit on dry, consolidated and undisturbed soil.
- F. When wet or unconsolidated material occurs or when over-excavation of the base occurs, provide a subbase with minimum of 12" of Class I, granular material, well compacted with mechanical tamping equipment.
- G. When completed, the manhole shall be free from channel obstructions and leakage.
- H. Use of concrete grade rings will be limited to a vertical height of eight to twelve inches, with joints between each ring sealed with preformed gasket material.
- I. If manhole does not pass vacuum test then all section joints shall be grouted inside and outside
- J. All manholes shall be vacuum tested prior to backfilling operations. See Section 3.10-J

3.08 MANHOLE STEPS

- A. Materials for manhole steps should be highly corrosion-resistant meeting ASTM C-478 standards. The use of galvanized steel should be avoided and aluminum or plastic with reinforcing bar is preferred.
- B. Set manhole steps at intervals of 15 inches along the wall of the manhole.
- C. The treads of the steps shall be free from mortar or other material when the manhole is completed.

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- D. In precast manholes, the holes left to receive the steps shall be mortared smooth following placement of the steps.
- E. Steps shall be installed in a straight line.
- F. Steps shall be oriented in plan view to accommodate proper positioning of frame and cover.

3.09 MANHOLE FRAMES AND COVERS

- A. Seal manhole frames and covers in place with mastic.
- B. The bearing surfaces between cast frames and covers shall be machined, fitted together, and match marked to prevent rocking.
- C. All castings shall be of the types, dimensions and weights as shown on the Plans and shall be free of faults, cracks, blowholes, or other defects.

3.10 DROP MANHOLE ASSEMBLIES

- A. Drop manhole assemblies shall be constructed as outlined on the plans.
- B. The material used in the drop pipe construction shall be ductile iron and class "B" concrete, as specified by the Engineer.
- C. Concrete shall completely encase the drop to a height of 2' above bend to prevent dislodging.
- D. Inside drops will be used only where shown on the plans or specifically approved by the Water and Sewer Services Engineering Department.

3.11 SEWER SERVICE ASSEMBLIES

- A. Where shown on the plans or located in the field, install fittings for individual service assemblies.
 - 1. The standard collector tap shall consist of a tee connected with a 6 inch diameter branch.

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2. Use vertical risers when the depth of the collector line is greater than 8 feet or when their use will facilitate connection of individual services.
 3. Cap the ends of tee branches not to be used immediately with stoppers of the same material and joints used on the collector lines.
 4. Provide flexible coupling for 6-inch services to manholes as specified in 2.07.
- B. Cut in 6" tee on existing lines for new service assemblies.
- C. Service pipe shall be a minimum 6" diameter and shall be installed as shown in the Plans.
1. Cap the ends of service pipe and cover the same as for collectors and interceptors (where possible).
 2. The minimum grade on service pipes shall be 1 percent or 1/8" per foot.
- D. Bed all sewer service assemblies in accordance with Section 02221.

3.12 CLEAN OUTS

- A. Clean-outs shall be installed flush with the ground at the property line or edge of easement and have a flush screw-in cap
- B. Clean-outs that are installed within paved areas shall be covered with a valve box cover that is marked "sewer" or a traffic bearing clean-out cover constructed of cast iron or bronze with gasket seal. Both options shall be held in place by concrete at least 4" thick.

3.13 INITIAL PROOF TESTING OF SANITARY SEWERS

- A. It is the intent to specify a "test as you go" procedure in order to establish confidence in the installation and avoid the unnecessary delay of final acceptance.
- B. Before a reach of pipeline is approved for payment, successfully proof test that reach for grade, alignment, cleanliness, and leakage.
- C. In the event that four or more reaches fail to satisfactorily pass proof testing procedures, cease pipe laying until deficiencies are identified and corrected.

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- D. The basis for grade, alignment and cleanliness testing will be visual inspection. Leakage testing will be by means of low-pressure air as specified hereinafter.
1. Proof test flexible pipeline installation for deflection by pulling a “go-no-go” test mandrel through the line after the initial backfill has been in place at least 24 hours. No pipe shall exceed a deflection of 5%. The test shall be run with a rigid ball or an engineer-approved 9-arm mandrel having a diameter equal to 95% of the inside diameter of the pipe. The test must be performed by manually pulling the test device through the line.
- E. Manholes will be inspected and tested by the Engineer before or during incorporation in the work. However, the inspection and testing of manholes shall not relieve the Contractor of the responsibility for furnishing material that conforms to the specifications. The Owner may retest all materials that have been accepted at the source after delivery and may reject those that do not conform to the specifications. Stored manholes may be reinspected prior to use. Work in which untested manholes are used without the written permission of the Engineer may be considered unacceptable.

3.14 FINAL TESTING

- A. Before the job is accepted and before house services are connected, a final testing procedure is to be followed.
- B. All sewers and manholes shall be built practically watertight and the Contractor shall adhere rigidly to materials and workmanship. After completion of certain line segments, the Contractor shall immediately air test sections thereof. If leakage is above limits specified, the sewer will be replaced. The Owner may request infiltration/exfiltration tests after project completion on selected line segments but all line shall be first air tested.
- C. Prior to acceptance of completed sewer lines, the lines shall be inspected and tested to ensure compliance with the following provisions. After the sewer lines have been brought to completion and prior to final inspection, the Contractor shall clean out the downstream segments. Each individual line will be cleaned by pushing appropriate tools from manhole to manhole to remove any and all debris and obstructions or may, if possible, flush clean with water or remove by hand. Water may be turned into the system to determine whether the completed lines are true to line and grade as laid out or as shown on the drawings. All lines or sections of lines that are laid with improper line or grade, that contain broken sections of pipe, that are obstructed in such a manner that

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they cannot be satisfactorily corrected otherwise, or are deflected in excess of the allowable, shall be removed and replaced.

D. Sections of sewer line that are built to waterline standards due to conflicts with waterline crossings shall be tested per Force Main Leakage Test (Section K).

E. Low Pressure Air Test: Test entire system as follows:

1. The section of sewer to be tested shall have been backfilled.
2. Both ends of the pipe section being tested shall be sealed airtight.
3. Pressurize the sealed pipe to 4 psig above the average back pressure of ground water over the sewer pipe at the time of the test and allow the air pressure to stabilize for at least two minutes.
4. After the stabilization period, adjust the pressure to 3.5 psig and measure the time in minutes and seconds for the pressure to drop to 2.5 psig. If ground water is present, the starting air pressure shall be increased to 3.5 psig above the level of the ground water and the time measured.
5. The time measured for the pressure drop to occur shall be not less than that shown in the following table:

Specification Time for Length Shown

Pipe Diameter	<u>100'</u>	<u>150'</u>	<u>200'</u>	<u>250'</u>	<u>300'</u>	<u>350'</u>	<u>400'</u>	<u>450'</u>
6"	5:40	5:40	5:40	5:40	5:40	5:40	5:42	6:24
8"	7:34	7:34	7:34	7:34	7:36	8:52	10:08	11:24
10"	9:26	9:26	9:26	9:53	11:52	13:51	15:49	17:48
12"	11:20	11:20	11:24	14:15	17:05	19:56	22:47	25:38
15"	14:10	14:10	17:48	22:15	26:42	31:09	35:36	40:04
18"	17:00	19:13	25:38	32:03	38:27	44:52	51:16	57:41
21"	19:50	26:10	34:54	43:37	52:21	61:00	69:48	78:31
24"	22:47	34:11	45:34	56:58	68:22	79:46	91:10	102:33
27"	28:51	43:16	57:41	72:07	86:32	100:57	115:22	129:48
30"	35:37	53:25	71:13	89:02	106:50	124:38	142:26	160:15
33"	43:05	64:38	86:10	107:43	129:16	150:43	172:21	193:53
36"	51:17	76:55	102:34	128:12	153:50	179:29	205:07	230:46

E. Repair or replace any line that fails any of the above tests and retest.

F. If flexible pipe is used, pull an approved go-no-go deflection mandrel of 95/100 pipe diameter through all reaches of gravity sewer main. No sections will be accepted that exhibits a deflection of more than 5 percent.

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- G. Sewer service assemblies shall be installed and capped at locations directed by the Engineer, and shall be included in Final Testing.
- H. All tests shall be witnessed by the Inspector representing the Water and Sewer Services Engineering Department.
- I. Vacuum Testing for Manholes

All precast manholes including frames shall be vacuum tested as follows:

- 1. Manholes should be tested after assembly and prior to backfilling.
- 2. All pipe openings shall be plugged by pneumatic or mechanical plugs and braced to sustain 10" mercury vacuum. The rim to cone joint shall be tested on all manholes with watertight covers. No one shall be inside the manhole during testing. The test shall be at 10 in. mercury.
- 3. Installation and operation of vacuum equipment and indicating devices shall be in accordance with equipment specification for which performance information has been provided by the manufacturer and approved by the City of Johnson City Water and Sewer Services Department.

Minimum Time to Hold 1 in. Mercury Drop

MH Dia.	MH height	Hg	Time (minimum)
4'	10' or less	1 in.	1 min. 0 sec.
4'	10-15'	1 in.	1 min. 15 sec.
4'	15-25'	1 in.	1 min. 30 sec.

- 4. For manholes five feet in diameter, add an additional 15 seconds and for manholes six feet in diameter, add an additional 30 seconds to the time requirements for four-foot diameter manholes.
- 5. If the manhole fails the test, necessary repairs shall be made and the vacuum test and repairs shall be repeated until the manhole passes the test or the manhole shall be tested in accordance with the standard exfiltration test and rated accordingly. All leaks shall be sealed from the outside of the manhole. No visible leaks shall be observed inside the manhole.

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6. If manhole joint mastic is completely pulled out during the vacuum test, the manhole shall be disassembled and the mastic replaced.
- K. Sewer Force Main Leakage Test
1. Concurrently conduct a leakage test with the pressure test.
 2. Leakage Defined: The quantity of water that must be supplied into the newly laid pipe to maintain the specified test pressure after the air in the pipeline has been expelled and the pipe has been filled with water.
 3. Allowable Leakage
 - a. Determine allowable leakage by:
$$L = \frac{ND(P)^{1/2}}{7400}$$
Where L is the allowable leakage in gallons per hour; N is the number of joints in the tested pipeline; D is the nominal diameter of the pipe in inches; and P is the average test pressure during the leakage test in psi.

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- b. Allow leakage at various pressures:
Allowable Leakage per 1000 ft. of pipeline*

Ave. Test Pressure	(Gallons per Hour)																
	Nominal Pipe Diameter – Inches																
PSI	2	3	4	6	8	10	12	14	16	18	20	24	30	36	42	48	52
450	0.32	0.48	0.64	0.95	1.27	1.59	1.91	2.23	2.55	2.87	3.18	3.82	4.78	5.73	6.69	7.64	8.60
400	0.30	0.45	0.60	0.90	1.20	1.50	1.80	2.10	2.40	2.70	3.00	3.60	4.50	5.41	6.31	7.21	8.11
350	0.28	0.42	0.56	0.84	1.12	1.40	1.69	1.97	2.25	2.53	2.81	3.37	4.21	5.06	5.90	6.74	7.58
300	.026	0.39	0.52	0.78	1.04	1.30	1.56	1.82	2.08	2.34	2.60	3.12	3.90	4.68	5.46	6.24	7.02
275	0.25	0.37	0.50	0.75	1.00	1.24	1.49	1.74	1.99	2.24	2.49	2.99	3.73	4.48	5.23	5.98	6.72
250	0.24	0.36	0.47	0.71	0.95	1.19	1.42	1.66	1.90	2.14	2.37	2.85	3.56	4.27	4.99	5.70	6.41
225	0.23	0.34	0.45	0.68	0.90	1.13	1.35	1.58	1.80	2.03	2.25	2.70	3.38	4.05	4.73	5.41	6.03
200	0.21	0.32	0.43	0.64	0.85	1.06	1.28	1.48	1.70	1.91	2.12	2.55	3.19	3.82	4.46	5.09	5.73
175	0.20	0.30	0.40	0.59	0.80	0.99	1.19	1.39	1.59	1.79	1.98	2.38	2.98	3.58	4.17	4.77	5.36
150	0.19	0.28	0.37	0.55	0.74	0.92	1.10	1.29	1.47	1.66	1.84	2.21	2.76	3.31	3.84	4.41	4.97
125	0.17	0.25	0.34	0.50	0.67	0.84	1.01	1.18	1.34	1.51	1.68	2.01	2.52	3.02	3.53	4.03	4.53
100	0.15	0.23	0.30	0.45	0.60	0.75	0.90	1.05	1.20	1.35	1.50	1.80	2.25	2.70	3.15	3.60	4.05

* For Mechanical or push-on joint pipe with 18-ft. nominal lengths. To obtain the recommended allowable leakage for pipe with 20-ft. nominal lengths, multiply the leakage calculated from the above table by 0.9. If the pipeline under test contains sections of various diameters, the allowable leakage will be the sum of the computed leakage for each site.

- c. When testing against closed metal-seated valves, an additional leakage per closed valve of 0.078 gal. /hr./in. of nominal valve size shall be allowed.

L. Acceptance of Installation

1. If any test of pipe laid discloses leakage greater than that specified above, locate and repair the defective material until the leakage is within the specified allowance.
2. Repair all visible leaks regardless of the amount of leakage.

3.15 FORCE MAIN

Polyvinyl Chloride (PVC) plastic pipe shall be used for force main construction. PVC pipe shall be made from Type 1, Grade 1 PVC, and shall meet the requirements of ASTM D2241 or AWWA C900, or SDR-21, or as specified on the plans and ASTM D3139 for PVC joints. Rubber gaskets for PVC pipe shall be

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molded as an integral part of the bell. Tracer tape shall be installed in trench prior to backfilling.

3.16 TESTING OF FORCE MAIN AND GRAVITY D.I.P. SECTIONS

Force main shall be tested following guidelines in Section 3.14K. Gravity D.I.P. sections closer than 10 feet parallel to potable water lines shall be pressure tested as per Section 3.14K.

3.17 COMBINATION AIR RELEASE ASSEMBLIES

- A. A combination air release valve shall be placed at the necessary high points in the force main to prevent air locking.
- B. Furnish in 1" nominal diameter for 8" mains and smaller, and in 2" nominal diameter for 10" mains and larger, unless otherwise specified or shown on the plans.
- C. Cover air release assembly with a large meter box, adding risers as necessary.
 - 1. 1" ARV are installed in 18" meter box.
 - 2. 2" ARV are installed in 17" x 30" (nominal dimensions) meter box
- D. Place crushed stone from the top of the main to 12" below the bottom of the main.
- E. Combination air release assemblies shall consist of the following:
 - 1. Double strap, bronze service clamp with neoprene gasket (for PVC lines).
 - 2. Copper or brass pipe of the nominal diameter required by the main size.
 - 3. Red brass corporation stop
 - 4. Copper or brass elbow
 - 5. Ball valve
 - 6. An air and vacuum valve coupled with an air release valve. Consists of a cast iron body, stainless steel float, bronze linkage, bronze trim, that is suitable for use in mains having a pressure of 200 psi.
 - 7. Shall be single body
 - 8. Shall be manufactured in the USA by ARI or equal.

END OF SECTION

SECTION 03001

CONCRETE WORK

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Formwork, complete with shoring, bracing and anchorage.
- B. Concrete reinforcing, complete with supports, spacers and accessories.
- C. Cast-in-place Concrete.

1.02 RELATED WORK

- A. Section 02110: Clearing and Grubbing
- B. Section 02210: Grading and Excavation
- C. Section 02215: Base and Subgrade Treatment

PART 2 PRODUCTS

2.01 AGGREGATE MATERIALS

- A. Fine Aggregate: Natural sand or other inert materials with similar characteristics conforming to AASHTO M-6 with the following exceptions:
 - 1. Freeze-thaw tests for soundness will not be required.
 - 2. Wash fine aggregates in the processing operations.
 - 3. Process limestone or dolomite from material which has been scalped to remove quarry fines.

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4. The material from which the fine aggregate is processed shall have a maximum wear or 40% by the Los Angeles test.
5. Deleterious substances shall not exceed 0.5% by weight for clay lumps, coal and lignite and 3.0% for material passing the No. 200 sieve and other deleterious substances.
6. Well graded from coarse to fine and, when tested by means of laboratory sieves, conforming to:

Sieve Size	Total Percent Passing by Weight
3/8 inch	100
No. 4	95-100
No. 16	60-90
No. 50	10-30
No. 100	0-10
No. 200	0-3

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B. Coarse Aggregate: Crushed Stone, crushed slab, gravel, chert, or a combination thereof, or other inert materials with similar characteristics, having hard strong durable pieces free from adherent coatings conforming for AASHTO-M-43, except as specified otherwise.

1. Graded to standard sizes between the limits specified conforming to the gradation requirements set forth in the following table:

**Sizes of Coarse Aggregate
AASHTO M-43**

Size Number	Nominal Size Square Openings (1)	Amounts Finer Than Each Laboratory Sieve (Square Openings), Percentage By Weight															
		4	3 ½	3	2 ½	2	1 ½	1	¾	½	⅜	No.4	No.8	No.16	No.50	No.100	
1	3 ½ to 1 ½	100	90-100		25-60		0-15		0-5								
2	2 ½ to 1 ½			100	90-100	35-70	0-15		0-5								
24	2 ½ to ¾			100	90-100		25-60		0-10	0-5							
3	2 to 1				100	90-100	35-70	0-15		0-5							
357	2 to No. 4				100	95-100		35-70		10-30		0-5					
4	1 ½ to ¾					100	90-100	20-55	0-15		0-5						
467	1 ½ to No. 4					100	95-100		35-70		10-30		0-5				
5	1 to 1 ½						100	90-100	20-55	0-10	0-5						
56	1 to ¾						100	90-100	40-75	15-35	0-15	0-5					
57	1 to No. 4						100	95-100		25-60		0-10	0-5				
6	¾ to ¾							100	90-100	20-55	0-15	0-5					
67	¾ to No. 4							100	90-100		20-55	0-10	0-5				
68	¾ to No. 8							100	90-100		30-65	5-25	0-10	0-5			
7	½ to No. 4								100	90-100	40-70	0-15	0-5				
78	½ to No. 8								100	90-100	40-75	5-25	0-10	0-5			
8	¾ to No. 8									100	85-100	10-30	0-10	0-5			
89	¾ to No. 16									100	90-100	20-55	5-30	0-10	0-5		
9	No. 4 to No. 16										100	85-100	10-40	0-10	0-5		
10	No. 4 to 0 (2)											100	85-100				10-0

- (1) In inches, except where otherwise indicated. Numbered sieves are those of the United States Standard Sieve Series.
- (2) Where Size No. 10 (Screening) is specified in asphalt pavement design the percent passing the No. 4 sieve shall be 90-100 and the percent passing the No. 200 sieve shall be from 5-16.

- 2. Furnish coarse aggregate for concrete base and pavement in two sizes: no. 4 and No. 67. The two sizes shall be manufactured to produce Size No. 467, when combined in the proper proportions at the batching plant.
- 3. Coarse aggregate for structural concrete shall be Size No. 57 or Size No. 67, as specified or directed.

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4. Coarse aggregate for concrete curbing placed by machine-extrusion shall be Size No. 7 or 78.
5. Conform to AASHTO M-80, except that the amount of deleterious substances shall not exceed the following limits:

	Maximum Percent by Weight
a. Soft or non-durable fragments (fragments which are structurally weak, such as shale, soft sandstone, limonite concretions, gypsum, weathered schist, or cemented gravel)	3.0
b. Coal or lignite	1.0
c. Clay lumps	0.25
d. Material passing the No. 200 sieve	0.75
e. Thin or elongated pieces (length greater than five (5) times average thickness)	10.0
f. Other local deleterious substances	1.0
g. Items a, b, c, d, and f, combined shall not exceed	5.0

2.02 CEMENT

- A. Use Portland cement unless otherwise specified.
- B. Portland Cement: AASHTO M-85 or ASTM C-150
- C. Portland Blast Furnace Slag Cement: AASHTO M-151 or ASTM C-205

2.03 WATER

- A. Either potable or reasonably clean and free of oil, salt, acid, alkali, sugar, vegetable matter, sewage or other injurious foreign matter. Test water not known to be potable in accordance with AASHTO T-26.

2.04 CHEMICAL ADDITIVES:

- A. Conform to AASHTO M-194, ASTM C-494, ASTM C-260, and AASHTO M-154 covering the following 6 types:

Type A - Water reducing admixtures

Type B - Retarding admixtures

Type C - Accelerating admixtures

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Type D - Water reducing and retarding admixtures

Type E - Water reducing and accelerating admixtures

2.05 AIR - ENTRAINING ADMIXTURES

- A. ASTM C-260, CSA A-23, or AASHTO M-154.

2.06 CONCRETE PROPORTIONING

- A. Base Proportioning on a predetermined cement content.
- B. Adjust the quantity of water to meet slump requirements, not exceeding the maximum allowed.
- C. Unless otherwise specified, air entrainment shall be 5% with a tolerance of plus 3% or minus 2%.
- D. Submit a mix design to Engineer for approval prior to commencing work.
- E. Collect compression test specimens using ASTM C-31 or AASHTO T-23.
- F. Test compression strength specimens using ASTM C-39 or AASHTO T-22.
- G. Test slump using ASTM C-143 or AASHTO T-119.

2.07 CONCRETE CLASSIFICATIONS

- A. Class A Concrete (Structures): Unless otherwise specified and shown on the Plans, all concrete shall be Class A.
 - 1. Fine Aggregate: Proportion by dry weight of fine to coarse aggregates between 30-45%.
 - 2. Coarse Aggregates: Sizes as follows:
 - Size No. 57 - Structural Concrete
 - Size No. 57 or No. 67 - Prestressed and precast concrete
 - Size No. 7 or No. 78 - Extruded concrete curbs
 - 3. Minimum Compressive Strength: 28 day, 4000 psi, average any 3 cylinders.

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4. Slump: 1 to 3 inches for mass concrete and heavy reinforced section; 2 to 4 inches for slabs, columns, girders, walls, etc. Vary consistency to meet job requirements, provided there is no increase in the maximum water-cement ratio specified in the mix design.
 5. Mixing Water: Deduct the moisture content of the aggregate from the amount of mixing water required.
- B. Class "P" Concrete (Base and Pavement):
1. Fine Aggregate: Do not use sand manufactured from limestone for traffic lane pavements.
 2. Coarse Aggregate: Size No. 67.
 3. Minimum Compressive Strength: 14 day, 3500 psi, average of any 3 cylinders.
 4. Slump: ½ - 1 ½ inches, workable consistency.
 5. Mixing Water: Include surface moisture but not moisture absorbed by the aggregate.
- C. Class B1 Concrete: Use for anchors, kickers, encasement for pipelines, subfoundations, mass footings, and fill, unless otherwise specified.
1. Fine Aggregate: Proportion by dry weight of fine to coarse aggregates between 30-45%. Test for potential alkali reactivity per ASTM C-289-71. Use natural river sand or specially approved manufactured sand, only.
 2. Coarse Aggregate: Size No. 57.
 3. Minimum Cement Content: 5.0 bags (470 lbs.) per cubic yard.
 4. Minimum Compressive Strength: 28 day, 2500 psi, average of any 3 cylinders.
 5. Slump: 5 to 8 inches for pipe encasements and 2 to 4 inches in subfoundations and other specified areas.
 6. Mixing Water: Maximum amount of water per 94 lb. Bag of Portland cement shall be 6.5 gallons. Deduct the moisture content of the aggregate from the amount of water required.

2.08 CONCRETE MIXING

- A. Obtain approval of all equipment prior to commencement of concrete placing operations.

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- B. Mix and handle concrete in accordance with the general requirements of TDOT.
- C. Give Engineer free access to the mixing site for inspection of equipment and mixing operations.
- D. Check and compensate for, if applicable, moisture content of aggregates prior to mixing.
- E. Mix batches only in quantities required for immediate use.
- F. Remove from the project site, all concrete reaching the site in a preset conditions or which fails slump requirements.

2.09 CONCRETE CURING MATERIALS

- A. Cure all concrete surfaces not protected by forms by keeping the surface moist or by the application of a membrane-forming curing compound.
- B. Initially, wet cure for a period of at least (24) hours. During the initial curing period, keep the surface moist and protected by burlap mats or other approved materials.
- C. Water: Water used in curing Portland cement concrete shall not contain any substances which will damage the surface of the concrete.
- D. Sand and Earth: Free of stones or other materials which will damage the surface of the concrete.
- E. Liquid Membrane-Forming Compounds: AASHTO M-148.
- F. Polyethylene Sheeting: AASHTO M-171.
- G. Burlap: AASHTO M-182, Class 3 or 4.
- H. Straw: Reasonably clean and free of any material that will damage the surface of the concrete.

2.10 EXPANSION AND CONSTRUCTION JOINTS

- A. Performed Bituminous Fillers: AASHTO M-33.
- B. Hot-Poured Elastic Type: AASHTO M-173
- C. Performed Elastomeric Compression Joint Seals: AASHTO M-260.

2.11 REINFORCEMENT STEEL

- A. Bar Reinforcement for Concrete Structures:

- 1. Steel bars for reinforcement of concrete structures shall be billet steel bars conforming to the requirements of ASTM A-615, grade 40 or 60.
- 2. Reinforcing bars shall be deformed and shall have minimum section areas shown in the following table.

Sizes and Areas of Reinforcing Bars
Dimensions are for Round Sections

Bar Designation Number (a)	Nominal Diameter (Inches)	Cross-Sectional Area (Sq. In.)	Perimeter (Inches)	Weight (Pounds Per Ft.)	Notes (b)
2	0.250	0.05	0.786	0.167	
3	0.375	0.11	1.178	0.376	
4	0.500	0.20	1.571	0.668	
5	0.625	0.31	1.963	1.043	
6	0.750	0.44	2.356	1.503	
7	0.875	0.60	2.749	2.044	
8	1.000	0.79	3.142	2.670	
9	1.128	1.00	3.544	3.400	
10	1.270	1.27	3.990	4.303	
11	1.410	1.56	4.430	5.313	

NOTES:

(a) Bar numbers denote nominal diameters of round bars in eighths-of-an inch. The nominal diameter of a deformed bar is equivalent to the diameter of a plain bar having the same weight per linear foot as the deformed bar.

(b) ¼ inch diameter bar in plan round only.

- B. Dowel Bars: Plain steel bars.
- C. Tie Bars: Deformed in accordance with ASTM A-305 except that No. 2 bars may be either deformed or plain. Tie bars which are to be bent during construction

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shall conform to ASTM A-614 grade 40.

D. Welded Steel Wire Fabric: Welded steel wire fabric for concrete reinforcement shall:

1. Conform to the requirements of ASTM A-185 for smooth wire or ASTM A-47 for deformed wire.
2. Wire used in the manufacture of welded wire fabric shall conform to Cold Drawn Steel Wire ASTM A-82.

END OF SECTION

SECTION 04001

STANDARD SPECIFICATION FOR LINING DUCTILE IRON PIPE FOR SEWER SERVICE

1.01 CONDITION OF DUCTILE IRON PRIOR TO SURFACE PREPARATION

- A. All ductile pipe and fittings shall be delivered to the application facility without asphalt, cement lining, or any other lining on the interior surface. Because removal of old linings may not be possible, the intent of this specification is that the entire interior of the ductile iron pipe and fittings shall not have been lined with any substance prior to the application of the specified lining material and no coating shall have been applied to the first six inches of the exterior of the spigot ends.

1.02 LINING MATERIAL

- A. The standard of quality is Protecto 401 Ceramic Epoxy. The material shall be an amine cured novalac epoxy containing at least 20% by volume of ceramic quartz pigment. Any request for substitution must be accompanied by a successful history of lining pipe and fittings for sewer service, a test report verifying the following properties, and a certification of the test results.
1. A permeability rating of 0.00 when tested according to Method A of ASTM E-96-66, Procedure A with a test duration of 30 days.
 2. The following test must be run on coupons from factory lined ductile iron pipe:
 - a. ASTM B-117 Salt undercutting after two years. Spray (scribed panel) – Results to equal 0.0
 - b. ASTM G-95 Cathodic Disbondment 1.5 volts @ 77°F. Results to equal no more than 0.5mm undercutting after 30 days.
 - c. Immersion Testing rated using ASTM D-714-87.
 - 1) 20% Sulfuric Acid – No effect after two years.
 - 2) 140°F 25% Sodium Hydroxide – No effect after two years.
 - 3) 160°F Distilled Water - No effect after two years.
 - 4) 120°F Tap Water (scribed panel) – 0.0 undercutting after two

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years with no effect.

3. An abasion resistance of no more than 3 mils (.075mm) loss after one million cycles using European Standard EN 598: 1994 section 7.8 Abrasion resistance.

2.01 APPLICATION

- A. Applicator: The lining shall be applied by a competent firm with a successful history of applying linings to the interior of ductile iron pipe and fittings.
- B. Surface Preparation: Prior to abrasive blasting, the entire area to receive the protective compound shall be inspected for oil, grease, etc. Any areas with oil, grease, or any substance which can be removed by solvent, shall be solvent cleaned to remove those substances. After the surface has been made free of grease, oil or other substances, all areas to receive the protective compounds shall be abrasive blasted using sand or grit abrasive media. The entire surface to be lined shall be struck with the blast media so that all rust, loose oxides, etc., are removed from the surface. Only slight stains and tightly adhering oxide may be left on the surface. Any area where rust reappears before lining must be reblasted.
- C. Lining: After the surface preparation and within 8 hours of surface preparation, the interior of the pipe shall receive 40 mils nominal dry film thickness of Protecto 401. No lining shall take place within the substrate or ambient temperature is below 40 degrees Fahrenheit. The surface also must be dry and dust free. If flange pipe or fittings are included in the project the lining shall not be used on the face of the flange.
- D. Coating of Bell Sockets and Spigot Ends: Due to tolerances involved, the gasket area and spigot end up to 6 inches back from the end of the spigot end must be coated with 6 mils nominal, 10 mils maximum using Protecto Joint Compound. The Joint Compound shall be applied by brush to ensure coverage. Care should be taken that the Joint Compound is smooth without excess buildup in the gasket seat or on the spigot ends. Coating of the gasket seat and spigot ends shall be done after the application of the lining.
- E. Number of Coats: The number of coats of lining material applied shall be as

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recommended by the lining manufacturer. However, in no case shall this material be applied above the dry thickness per coat recommended by the lining manufacturer in printed literature. The maximum or minimum time between coats shall be that time recommended by the lining material manufacturer. **To prevent delamination between coats, no material shall be used for lining which is not indefinitely recoatable with itself without roughening of the surface.**

- F. Touch-Up & Repair: Protecto Joint Compound shall be used for touch-up or repair in accordance with manufacturer's recommendations.

3.01 INSPECTION AND CERTIFICATION

A. Inspection

1. All ductile iron pipe and fitting 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 Rating.
2. The interior lining of all pipe and fittings shall be tested for pinholes with a nondestructive 2,500 volt test. Any defects found shall be repaired prior to shipment.
3. Each pipe joint and fitting shall be marked with the date of application of the lining system along with its numerical sequence of application on that date and records maintained by the applicator of his work.

- B. Certification: The pipe or fitting manufacturer must supply a certificate attesting to the fact that the applicator met the requirements of this specification, and that the material used was as specified.

4.01 HANDLING

- A. Protecto 401 lined pipe and fittings must be handled only from the outside of the pipe and fittings. No forks, chains, straps, hooks, etc. shall be placed inside the pipe and fittings for lifting, positioning, or laying.

END OF SECTION

SECTION 04002

PROCEDURE FOR SEALING CUT ENDS AND REPAIRING FIELD DAMAGED AREAS OF PROTECTO
401 LINED PIPE AND FITTINGS

- I. Procedures for sealing cut ends and repairing field damaged areas of PROTECTO 401 lined pipe and fittings:
 - A. Remove burrs caused by field cutting of ends or handling damage and smooth out the edge of the lining if rough.
 - B. Remove all traces of oil, grease, asphalt, dust, dirt, etc.
 - C. Remove any damaged lining caused by field cutting operations or handling and clean any exposed metal by sanding or scraping. Sandblasting or power tool cleaning roughening is also acceptable. It is recommended that any loose lining be removed by chiseling, cutting, or scraping into well adhered lined area before patching. Be sure to overlap at least 1" of lining in the area to be repaired.
 - D. With the area to be sealed or repaired absolutely clean with suitably roughened, apply a coat of Protecto Joint compound using the following procedure:
 1. Mixing Procedure – The repair kit for Protecto 401 contains two small cans of Protecto Joint Compound. Protecto Joint Compound is a two component epoxy and the contents of the small container shall be mixed with the contents of the large container. If less than the full contents of each can is to be mixed, the material may be mixed using the mixing ratio printed on the labels. After Part B is added to Part A, the mixture shall be thoroughly agitated. All activated material must be used within one hour of mixing.
 2. Application of Material – After the material has been thoroughly mixed, it can be applied to the prepared surface by brush. Brushing is usually best due to the fact that the areas to be repaired are usually small. Practices conducive to a good coating are contained in the technical data sheet for Protecto Joint Compound.
 - E. It is important to coat the entire freshly cut exposed metal surface of the cut pipe end. To ensure proper sealing, overlap at least one inch of the lining with this repair material.

END OF SECTION