TECHNICAL SPECIFICATIONS FOR UTILITY INSTALLATION

Water Management Department

City of Franklin, Tennessee

WPN 20.0069
Franklin Standard Specifications
APPROVED FOR CONSTRUCTION

THE DOCUMENT BEARING THIS STAMP HAS BEEN RECEIVED AND REVIEWED BY THE

TENNESSEE DEPT. OF ENVIRONMENT & CONSERVATION

DIVISION OF WATER RESOURCES

AND IS HEREBY APPROVED FOR CONSTRUCTION BY THE COMMISSIONER

Julie A. Haase P.E.

February 25, 2020

THIS APPROVAL SHALL NOT BE CONSTRUED AS CREATING A PRESUMPTION OF CORRECT OPERATION OR AS WARRANTING BY THE COMMISSIONER THAT THE APPROVED FACILITIES WILL REACH THE DESIGNED GOALS.

APPROVAL EXPIRES FIVE YEARS FROM ABOVE DATE

HISTORIC
FRANKLIN
TENNESSEE

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HISTORIC FRANKLIN TENNESSEE

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HISTORIC FRANKLIN TENNESSEE

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PART 1 – GENERAL

1.1 PURPOSE STATEMENT

A. These Specifications are guidelines for Engineers, Contractors, and Developers for the planning, design, and construction of water distribution systems, sanitary sewer collection systems, reclaimed water systems and associated appurtenances within the City of Franklin, Tennessee Water Management Department service area. The Specifications identify standards, criteria, submittal requirements, and approval procedures to be used for projects within the City of Franklin.

B. These Specifications shall govern the construction materials and installation of water, sanitary sewer, and reclaimed water systems that are, or will become, the responsibility of the City of Franklin to operate and maintain as part of their system.

C. These Specifications are intended to meet or exceed the requirements of the State of Tennessee's Department of Environment and Conservation (TDEC).

D. These Specifications are not intended to serve as a step-by-step design and construction method nor can this manual address every situation that may arise. The application of sound engineering/surveying principles combined with the information contained herein is necessary to complete the planning, design, and construction of water, sanitary sewer, and reclaimed water systems.

1.2 DEFINITIONS

A. Contractor: The person, firm, or corporation with whom Developer has executed an agreement and is responsible for the work.

B. Developer: One who owns a proposed development where water, sanitary sewer or reclaimed water infrastructure is to be installed.

C. Engineer: One who prepared the construction plans for the installation of water, sanitary sewer or reclaimed water and is the Engineer of Record. The Engineer must be licensed in the State of Tennessee.

D. Owner: City of Franklin, Tennessee

E. Project: The organized process to construct infrastructure within the City of Franklin, Tennessee.

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F. Resident Project Representative: City of Franklin Water Management Department Inspector or its designee.

G. Subcontractor: An individual or entity having a direct contract with Contractor or with any other Subcontractor for the performance of a part of the Work at the site.

H. Surveyor: One who measures and records locations for the installation of water, sanitary sewer or reclaimed water. The Surveyor must be licensed in the State of Tennessee.

I. Work: Any and all obligations, duties and responsibilities necessary to the successful completion of the Project assigned to or undertaken by Contractor.

1.3 SUMMARY

A. The following are acronyms used throughout this document:
   1. AWWA: American Water Works Association
   2. COF: City of Franklin
   3. TDEC: Tennessee Department of Environment and Conservation
   4. WMD: Water Management Department
   5. RPR: Resident Project Representative

1.4 CONTACT INFORMATION

A. City of Franklin Water Management Department
   124 Lumber Drive
   Franklin, TN 37064
   (615) 794-4554

B. City of Franklin Fire Department Administration
   109 3rd Avenue South, Suite 130
   Franklin, TN 37064
   (615) 791-3270

C. City of Franklin Engineering Department
   109 3rd Avenue South, Suite 133
   Franklin, TN 37064
   (615) 791-3218

D. Tennessee Department of Environment and Conservation (TDEC)
   Division of Water Pollution Control (DWPC)
   L & C Tower Annex, 6th Floor

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401 Church Street
Nashville, TN 37243
(615) 532-0625

E. Tennessee Department of Environment and Conservation (TDEC)
Division of Water Supply (DWS)
L & C Tower Annex, 6th Floor
401 Church Street
Nashville, TN 37243
(615) 532-0191

F. City of Franklin Streets Department
124 Lumber Drive
Franklin, TN 37064
(615) 791-3254

G. Williamson County Highway Department
302 Beasley Drive
Franklin, TN 37064
(615) 790-5596

H. City of Franklin Police Department
Communications Division
900 Columbia Avenue
Franklin, TN 37064
(615) 794-2513

I. Williamson County Office of Public Safety
304 Beasley Drive
Franklin, TN 37064
(615) 790-5752

J. City of Franklin Traffic Operations Center City Hall
109 3rd Avenue South
Franklin, TN 37064
(615) 791-3218

1.5 GENERAL REQUIREMENTS

A. General: The Contractor shall have full use of premises and dedicated easements for

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construction operations, including use of project site, during construction. Contractor's use of premises is limited only by Owner's right to perform Work or to retain other contractors on portions of project and conditions of any easement or right-of-way occupancy permits.

B. Prior to commencement of Work, the Contractor shall review the construction site with the Resident Project Representative to make permanent record of such existing damage as cracks, malfunctioning utility equipment and fixtures, or other similar damage. This record shall serve as a basis for determination of subsequent damage to the structures and adjacent areas due to Contractor's operations. Any damage to these structures and adjacent areas not noted in original review record shall be reported immediately to Owner. Permanent record shall include photographs and/or video graphic recording.

C. Erosion Control: Erosion prevention and sediment control measures must be in place prior to commencement of Work. All erosion control shall be in compliance with the City of Franklin's Best Management Practices Stormwater Management Manual.

D. Fire Precautions: Fire or use of any fire- or explosion- producing tools or equipment will be permitted on the premises only when review has been completed by the City of Franklin and the required jurisdictional permits have been obtained.

E. Manufacturers Qualifications: The manufacturers of all materials and equipment used must be approved by the Owner and regularly engaged in the manufacture of the particular material or equipment for the use and service to which it will be subjected.

F. Compliance with state and local laws: Comply with all applicable requirements of state and local laws and ordinances to the extent that such requirements do not conflict with federal laws or regulations.

G. Protection of public and private property: The Contractor shall be responsible for preservation of and shall take special care in working areas to protect public and private property. The Contractor shall replace or repair at his own expense any damaged water pipes, power and communication lines, or other public utilities, roads, curbs, gutters, sidewalks, drain pipes, drainage ditches, all properties and fixtures (both permanent and temporary), and all plantings, including grass or sod on the site of the Work. Leave the site in original or better condition after all cleanup has been done.

H. Markers: Preserve all surveyed and privately owned markers and monuments; do not remove or disturb any such markers without prior approval from the owner of the marker. Any removal and replacement of such markers shall be at the expense of the Contractor.

I. Pavement repair and/or replacement: Whenever existing asphalt is removed, restore traffic over the disturbed area as quickly as possible by backfilling with at least 12 inches of

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compacted Class A, Grade D crushed stone to within 2 inches of the existing surface and then applying a 2 inch layer of cold mix. Add material and otherwise maintain such surface until the permanent pavement is restored by the Contractor or until acceptance by the Owner. All roadway construction shall be in compliance with the Franklin Transportation and Street Technical Standards.

J. Department of Transportation Permits: The Contractor must obtain a street cutting permit and bore permit from the Owner, if applicable. All such Work shall be coordinated with and be subject to the approval of said transportation department and Owner. The Contractor shall be responsible for permits and bonding for Work not provided for on the Drawings.

K. Approved Chemicals: All chemicals used during project construction or furnished for project operation, whether herbicide, pesticide, disinfectant, polymer, reactant, or of other classification, must show approval of either EPA or USDA. The use of all such chemicals and the disposal of residues shall be in strict conformance with manufacturer's instructions. Material Safety Data Sheets (MSDS) must be available on site for inspection. All chemicals shall be transported and stored in original containers.

L. Catalog Data for Owners: Provide duplicate complete, bound sets of a compilation of catalog data of each manufactured item of mechanical and electrical equipment used in the Work, for transmittal to the Owner prior to acceptance. Include descriptive data and printed installation, operating, and maintenance instructions (including a parts list for each item of equipment). Provide a complete double index as follows:
   1. List the products alphabetically by name.
   2. List alphabetically the names of manufacturers whose products have been incorporated in the Work, together with their addresses and the names and addresses of the local sales representative.

M. Installation, Testing and Guarantee: Install all materials and equipment exactly in accordance with the manufacturer's recommendations. The completely installed system shall be guaranteed against any and all defects of manufacture, materials, workmanship, or installation for a minimum period of one year from the date of acceptance by the Owner.

N. Operation and Maintenance of the Systems and Instruction to Owner: Where the specifications for equipment require that a factory service representative provide operation and maintenance instruction to the Owner for that equipment, this service shall be performed by prior arrangement with the Owner after and in addition to the manufacturer's instructions to the Contractor for installation and start-up. The individual performing the instructions to the Owner is to be trained and/or certified by the manufacturer as its authorized operation, maintenance, and service specialist. If the said specialist is not a regular, full-time employee of the manufacturer, the specialist's qualifications shall be

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submitted to the Owner for review and approval prior to scheduling the site visit for instructions to the Owner.

O. Drawings of Record: Provide and keep up-to-date a complete record set of drawings, which shall be corrected daily to show every change. Keep this set of prints at the job site and use only as a record set. This shall not be construed as authorization for the Contractor to make changes in the approved layout without definite instructions in each case. Turn the set over to the Owner upon Final Completion of the project. Record drawings must be submitted to and approved by the Owner prior to acceptance of the project. Refer to Division 01 Section "Project Record Documents" for additional information.

P. Preservation of Existing Vegetation: Take reasonable care during construction to avoid damage to vegetation. Where the area to be excavated is occupied by trees, brush, or other uncultivated vegetable growth, clear such growth from the area, and dispose of it in a manner satisfactory to the Owner. Leave undisturbed any trees, cultivated shrubs, flowers, etc., situated within public right-of-ways and/or easements through private property but not located directly within excavation limits. Take special precautions (including the provision of barricades and the temporary tying back of shrubbery and tree branches) for the protection and preservation of such objects throughout all stages of construction; the Contractor will be held liable for any damage that may result to said objects from excavation or construction operations. Refer to the COF Zoning Ordinance for Tree Protection Standards and Tree Removal Permit requirements.

Q. Existing Utilities: The Contractor shall notify Tennessee One-Call and the owner of all other underground utilities no less than 3 business days or 72 hours in advance of excavation and/or proposed utility interruption. The Contractor is responsible for locating all existing utilities prior to construction and shall carefully protect from damage all utilities in the vicinity of the Work at all times. The Contractor shall be responsible for repairing any utilities that were properly located and marked. If it is necessary to repair, remove, and/or replace any such utility in order to complete the Work properly, do so in compliance with the rules, regulations, and approval of the particular utility involved.

Existing utilities shall remain in service at all times during construction. Contractor shall provide any temporary piping necessary to maintain utility service to existing customers.

R. Contractor shall comply with the requirements of the Manual on Uniform Traffic Control Devices published by the U.S. Department of Transportation Federal Highway Administration in supplying adequate signage, flagging, personnel, etc. for the entire project. The Contractor shall be responsible for the placement and removal of all signage. Submit a traffic control plan to the authority having jurisdiction.

S. The Contractor shall maintain an acceptable flow of traffic through construction areas. If a roadway must be closed in order to construct the Work, the Contractor shall notify, at a

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minimum, the Franklin Police Emergency Communications, Williamson County Emergency Operations Center, City of Franklin Traffic Operations Center, local school superintendent(s), and local U.S. Postal Service office(s) at least two days prior to roadway closure. If lanes must be closed in order to construct the Work, the Contractor shall notify the City of Franklin Traffic Operations Center at least two days prior to lane closure.

T. Work in Rights-of-Way:
   1. The Contractor shall notify the authorities having jurisdiction prior to entering and working in rights-of-way and shall be responsible for all damages resulting from said Work and for satisfying the requirements of said authorities.
   2. The Contractor shall maintain a suitable and safe condition throughout the right-of-way affected by the Work and provide detours as necessary for public and private traffic.
   3. Materials excavated in rights-of-way shall be hauled to a disposal site immediately and shall not be stockpiled in right-of-way.

U. Inspection of Work: The Contractor shall provide full access to the project site at all times for inspection and observation of Work by the Owner, Engineer, and agents of any local, state, or federal agency having jurisdiction.

PART 2 – PRODUCTS (Not Used)

PART 3 – EXECUTION

3.1 OPERATION OF EXISTING UTILITIES

A. The Work shall be performed so as to cause minimum interference or interruption with the normal operation of the existing utilities. The Contractor shall plan and conduct construction sequencing operations to avoid disturbing existing utilities and equipment, except as may be provided or approved by the Owner.

END OF SECTION

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PART 1 – GENERAL

1.1 INDUSTRY STANDARDS

A. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. Names, telephone numbers, and Web site addresses are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.

AA	Aluminum Association, Inc. (The) www.aluminum.org	(703) 358-2960
AASHTO	American Association of State Highway and Transportation Officials www.transportation.org	(202) 624-5800
ACI	ACI International (American Concrete Institute) www.aci-int.org	(248) 848-3700
ACPA	American Concrete Pipe Association www.concrete-pipe.org	(972) 506-7216
AGA	American Gas Association www.aga.org	(202) 824-7000
AI	Asphalt Institute www.asphaltinstitute.org	(859) 288-4960
AISC	American Institute of Steel Construction www.aisc.org	(800) 644-2400 (312) 670-2400
AISI	American Iron and Steel Institute www.steel.org	(202) 452-7100
ANSI	American National Standards Institute www.ansi.org	(202) 293-8020
AOSA	Association of Official Seed Analysts www.aosaseed.com	(202) 870-2412
APA	Architectural Precast Association www.archprecast.org	(850) 205-5637
ASCE	American Society of Civil Engineers www.asce.org	(800) 548-2723 (703) 295-6300

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ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers www.ashrae.org	(800) 527-4723 (404) 636-8400
ASME	ASME International (The American Society of Mechanical Engineers International) www.asme.org	(800) 843-2763
ASSE	American Society of Sanitary Engineering www.asse-plumbing.org	(708) 995-3019
ASTM	ASTM International (American Society for Testing and Materials International) www.astm.org	(610) 832-9500
AWS	American Welding Society www.aws.org	(800) 443-9353
AWWA	American Water Works Association www.awwa.org	(800) 926-7337 (303) 794-7711
CDA	Copper Development Association Inc. www.copper.org	(800) 232-3282 (212) 251-7200
CGA	Compressed Gas Association www.cganet.com	(703) 788-2700
CLFMI	Chain Link Fence Manufacturers Institute www.chainlinkinfo.org	(301) 596-2583
CRSI	Concrete Reinforcing Steel Institute www.crsi.org	(847) 517-1200
CSI	Construction Specifications Institute (The) www.csiresources.org	(800) 689-2900 (703) 684-0300
EJCDC	Engineers Joint Contract Documents Committee www.ejcdc.org	(608) 798-0698
FCI	Fluid Controls Institute www.fluidcontrolsinstitute.org	(216) 241-7333
FMG	FM Global (Formerly: FM - Factory Mutual System) www.fmglobal.com	(401) 275-3000
FSA	Fluid Sealing Association www.fluidsealing.com	(610) 971-4850

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GSI	Geosynthetic Institute www.geosynthetic-institute.org	(610) 522-8440
HI	Hydraulic Institute www.pumps.org	(888) 786-7744 (973) 267-9700
IEEE	Institute of Electrical and Electronics Engineers, Inc. (The) www.ieee.org	(212) 419-7900
LPI	Lightning Protection Institute www.lightning.org	(800) 488-6864
MBMA	Metal Building Manufacturers Association www.mbma.com	(216) 241-7333
MSS	Manufacturers Standardization Society of The Valve and Fittings Industry Inc. www.mss-hq.com	(703) 281-6613
NACE	NACE International (National Association of Corrosion Engineers International) www.nace.org	(281) 228-6200
NCMA	National Concrete Masonry Association www.ncma.org	(703) 713-1900
NCPI	National Clay Pipe Institute www.ncpi.org	(262) 742-2904
NEMA	National Electrical Manufacturers Association www.nema.org	(703) 841-3200
NFPA	NFPA www.nfpa.org	(800) 344-3555 (617) 770-3000
NRMCA	National Ready Mixed Concrete Association www.nrmca.org	(888) 846-7622 (301) 587-1400
NSF	NSF International (National Sanitation Foundation International) www.nsf.org	(800) 673-6275 (734) 769-8010
NSSGA	National Stone, Sand & Gravel Association www.nssga.org	(800) 342-1415 (703) 525-8788
PPI	Plastic Pipe Institute www.plasticpipe.org	(469) 499-1044

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PCI	Precast/Prestressed Concrete Institute www.pci.org	(312) 786-0300
SAE	SAE International www.sae.org	(724) 776-4841 (877) 606-7323
SSPC	The Society for Protective Coatings www.sspc.org	(877) 281-7772 (412) 281-2331
STI	Steel Tank Institute www.steeltank.com	(847) 438-8265
SWRI	Sealant, Waterproofing, & Restoration Institute www.swrionline.org	(816) 472-7974
TMS	The Masonry Society www.masonrysociety.org	(303) 939-9700
UL	Underwriters Laboratories Inc. www.ul.com	(847) 272-8800
UNI	Uni-Bell PVC Pipe Association www.uni-bell.org	(972) 243-3902

PART 2 – PRODUCTS (Not Used)

PART 3 – EXECUTION (Not Used)

END OF SECTION

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PART 1 – GENERAL

1.1 CLOSEOUT SUBMITTALS

A. Record Drawings:
   1. Submit two paper copy sets of marked up record prints.
   2. Submit *.dwg, *.dgn and *.pdf electronic files.

PART 2 – PRODUCTS

2.1 RECORD DRAWINGS

A. Record drawings must be stamped and signed by licensed surveyor or engineer within the State of Tennessee.

B. Record drawings shall be submitted after final grading of a Project has been completed, including but not limited to curb and gutter, roadway binder, storm drainage and utility installation.

C. Record Prints: Maintain one set of marked-up paper copies of the drawings, incorporating new and revised drawings as modifications are issued.
   1. Preparation: Mark record prints to show the actual installation where installation varies from that shown originally. Provide an inventory chart of all items.
      a. Give particular attention to information on buried elements that would be difficult to identify or measure and record later.
      b. Record data as soon as possible after obtaining it.
      c. Record and check the markup before enclosing concealed installations.
      d. Cross-reference record prints to corresponding archive photographic documentation.
   2. Content: Types of items requiring marking include, but are not limited to, the following:
      a. Include inventory of installed infrastructure:
         1. Length and type of pipe (include size, material, pressure class, etc.).
         2. Number of manholes (include depth, invert, etc.).
         3. Number of valves, hydrants, meters, valve sizes, manufacturer, material, right hand/left hand open/close, etc.
      b. Dimensional changes to drawings.
      c. Revisions to details shown on drawings.
      d. Locations and depths of underground utilities.
      e. Datum used.
      f. Provide profile.
      g. Details not on the original drawings.

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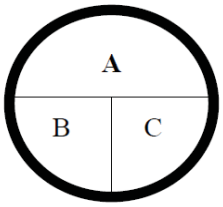
h. For Water Booster Stations, Sanitary sewer pump Stations and Water Storage Facilities:
   1. All revisions in pipe sizes
   2. All revisions to electrical controls
   3. All revisions to ventilation systems
   4. Pump modifications
   5. Include motor and pump info: manufacturer, model, serial #, HP, pump curve, etc.
   6. Changes in elevation for level controls
   7. Equipment layout modifications
   8. Building modifications
   9. Location and elevation of existing utilities
   10. Revisions to electrical circuitry and conduit (where applicable).

i. For Sanitary sewer Lines:
   1. All revisions in pipe sizes, lengths, slopes and angles
   2. Mainline and lateral invert elevations (to the nearest hundredth)
   3. Manhole covers
   4. Flow lines
   5. Changes in offset distances of structures
   6. Location and elevation of existing utilities

j. Property service connections for sanitary sewer laterals shall be shown as follows:



Whereas:

A = The horizontal distance from the center of the wye or tee to the center of the downstream manhole.

B = The horizontal distance from the center of the wye or tee to the end of the lateral.

C = The vertical distance from the top of the ground to the top of the lateral at the plug or property line.

3. Mark the drawings completely and accurately. Use personnel proficient at recording graphic information in production of marked-up record prints.
4. Mark important additional information that was either shown schematically or omitted from original drawings.

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D. Record Digital Data Files: Immediately or before releasing performance bond to maintenance, review marked-up record prints with Owner. Prepare a full set of corrected digital data files of the Contract Drawings, as follows:
   1. Format: *.dwg, *.dgn or *.pdf.
   2. Incorporate changes and additional information previously marked on record prints. Delete, redraw, and add details and notations where applicable.
   3. Refer instances of uncertainty to Owner for resolution.

E. Format: Identify and date each record drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.
   1. Record Prints: Organize record prints and newly prepared record drawings into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
   2. Record Digital Data Files: Organize digital data information into separate electronic files that correspond to each sheet of the drawings. Name each file with the sheet identification. Include identification in each digital data file.
   3. Identification: As follows:
      a. Project name
      b. Date
      c. Designation "PROJECT RECORD DRAWINGS"
      d. City of Franklin Project number

2.2 MISCELLANEOUS RECORD SUBMITTALS

A. Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.

B. Format: Submit miscellaneous record submittals as one paper-copy set and *.pdf electronic file.
   1. Include miscellaneous record submittals directory organized by Specification Section number and title, electronically linked to each item of miscellaneous record submittals.

C. To be submitted with the Record Drawings: Where water, reclaimed water or sanitary sewers are installed in new fill, a compaction letter sealed by a Geotechnical Engineer registered in the State of Tennessee shall be submitted to the Owner prior to installation of said utilities. An acceptable compaction letter shall state that field density testing indicates the fill has been compacted to at least 95% of the maximum dry density according to the Standard Proctor.

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PART 3 – EXECUTION

3.1 RECORDING AND MAINTENANCE

A. Recording: Maintain one copy of each submittal during the construction period for project record document purposes. Post changes and revisions to project record documents as they occur; do not wait until end of Project.

B. Maintenance of Record Documents and Samples: Do not use project record documents for construction purposes. Maintain record documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to project record documents for reference during normal working hours.

END OF SECTION

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PART 1 – GENERAL

1.1 APPLICATION

A. Where cast-in-place concrete is allowed by the WMD the following section shall apply.

1.2 SUBMITTALS

A. General: In addition to the following, comply with submittal requirements in ACI 301.

B. Product Data: For each type of manufactured material and product indicated.

C. Design Mixes: For each concrete mix.

1.3 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed concrete work similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products complying with ASTM C 94 requirements for production facilities and equipment.

C. Source Limitations: Obtain each type of cement of the same brand from the same manufacturer's plant, each aggregate from one source, and each admixture from the same manufacturer.

D. Comply with ACI 301, "Specification for Structural Concrete," including the following.
   1. General requirements, including submittals, quality assurance, acceptance of structure, and protection of in-place concrete.
   2. Formwork and form accessories.
   3. Steel reinforcement and supports.
   4. Concrete mixtures.
   5. Handling, placing, and constructing concrete.
   6. Lightweight concrete.

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PART 2 – PRODUCTS

2.1 FORMWORK

A. Furnish formwork and form accessories according to ACI 301.

2.2 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.

B. Plain-Steel Welded Wire Fabric: ASTM A 185, fabricated from as-drawn steel wire into flat sheets.

2.3 CONCRETE MATERIALS

A. Portland Cement: ASTM C 150, Type I.

B. Normal-Weight Aggregate: ASTM C 33, uniformly graded, not exceeding 1 1/2-inch (38 millimeters) nominal size.

C. Lightweight Aggregate: ASTM C 330.

D. Water: Potable and complying with ASTM C 94.

2.4 ADMIXTURES

A. General: Admixtures certified by manufacturer to contain not more than 0.1 percent water-soluble chloride ions by mass of cement and to be compatible with other admixtures. Do not use admixtures containing calcium chloride.

B. Air-Entraining Admixture: ASTM C 260.

2.5 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz. /sq. yd. (305 g/sq. m) dry.

C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

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D. Water: Potable.

2.6 CONCRETE MIXES

A. Comply with ACI 301 requirements for concrete mixtures.

B. Prepare design mixes, proportioned according to ACI 301, for normal-weight concrete determined by either laboratory trial mix or field test data bases, as follows:
   1. Compressive Strength (28 Days): 4000 psi (27.6 MPa) vaults, water tank foundations.
   2. Compressive Strength (28 Days): 3500 psi (24.1 MPa) pump station slabs.
   3. Compressive Strength (28 Days): 3000 psi (20.7 MPa) concrete encasement, concrete caps, and concrete anchors for water lines. Slump: 4 inches (100 millimeters).

C. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having an air content of 2.5 to 4.5 percent.

2.7 CONCRETE MIXING

A. Ready-Mixed Concrete: Comply with ASTM C 94.
   1. When air temperature is between 85 and 90 deg F (30 and 32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.

PART 3 – EXECUTION

3.1 FORMWORK

A. Design, construct, erect, shore, brace, and maintain formwork according to ACI 301.

3.2 STEEL REINFORCEMENT

A. Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
   1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

3.3 TESTING AND INSPECTION

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

B. Construction Joints: Locate and install so as not to impair strength or appearance of concrete,

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at locations indicated or as approved by Owner.

C. Isolation Joints: Install joint-filler strips at junctions with slabs-on-grade and vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
   1. Extend joint fillers full width and depth of joint, terminating flush with finished concrete surface, unless otherwise indicated.

D. Contraction (Control) Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows:
   1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with groover tool to a radius of 1/8 inch (3 millimeters). Repeat grooving of contraction joints after applying surface finishes. Eliminate groover marks on concrete surfaces.

3.4 CONCRETE PLACEMENT

A. Comply with recommendations in ACI 304R for measuring, mixing, transporting, and placing concrete.

B. Do not add water to concrete during delivery, at Project site, or during placement.

C. Consolidate concrete with mechanical vibrating equipment.

3.5 FINISHING FORMED SURFACES

A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defective areas repaired and patched, and fins and other projections exceeding 1/4 inch (6 millimeters) in height rubbed down or chipped off.
   1. Apply to concrete surfaces not exposed to public view.

B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defective areas. Completely remove fins and other projections.
   1. Apply to concrete surfaces exposed to public view or to be covered with a coating or covering material applied directly to concrete, such as waterproofing, damp proofing, veneer plaster, or painting.
   2. Apply the following rubbed finish, defined in ACI 301, to smooth-formed finished concrete.
      a. Grout-cleaned finish (for tank foundations).

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C. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

3.6 FINISHING UNFORMED SURFACES

A. General: Comply with ACI 302.1R for screening, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Screed surfaces with a straightedge and strike off. Begin initial floating using bull floats or derbies to form a uniform and open-textured surface plane before excess moisture or bleed water appears on the surface.
   1. Do not further disturb surfaces before starting finishing operations.

C. Float Finish: Apply float finish to surfaces of slabs that are to be beneath prefabricated pumping stations.

3.7 TOLERANCES

A. Comply with ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."

3.8 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and follow recommendations in ACI 305R for hot-weather protection during curing.

B. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h (1 kg/sq. m x h) before and during finishing operations. Apply according to manufacturer's written instructions after placing, screening, and bull floating or darbying concrete, but before float finishing.

C. Begin curing after finishing concrete, but not before free water has disappeared from concrete surface.

D. Curing Methods: Cure formed and unformed concrete for at least seven days by moisture curing, moisture-retaining-cover curing, curing compound, or a combination of these as follows:
   1. Moisture Curing: Keep surfaces continuously moist for no less than seven days.
   2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least

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12 inches (300 millimeters), and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

3.9 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified independent testing and inspecting agency to sample materials, perform tests, and submit test reports during concrete placement according to requirements specified in this Section. Perform tests according to ACI 301.
   1. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. (76 cu. m) or fraction thereof of each concrete mix placed each day.
   2. Testing not required on concrete for utility line anchors or encasement.

3.10 REPAIRS

A. Remove and replace concrete that does not comply with requirements in this Section.

END OF SECTION

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PART 1 – GENERAL

1.1 DEFINITIONS

A. Backfill: Materials used to fill an excavation.
   1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
   2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Layer placed between the subbase course and asphalt paving.

C. Bedding Course: Layer placed over the excavated subgrade in a trench before laying pipe.

D. Borrow: Satisfactory soil as defined in Section 2.1A, approved by the Engineer and imported from off-site for use as fill or backfill.

E. Excavation: Removal of material encountered above subgrade elevations.

F. Fill: Materials used to raise existing grades.

G. Rock: Rock material in beds, ledges, unstratified masses, and conglomerate deposits and boulders of rock material ¾ yd^3 (0.57 m^3) or more in volume that cannot be removed by an excavator.

H. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

I. Subbase Course: Layer placed between the subgrade and base course for asphalt paving, or layer placed between the subgrade and a concrete pavement or walk.

J. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below subbase, drainage fill, or topsoil materials.

1.2 SUBMITTALS

A. Blasting plan approved by authorities having jurisdiction, for record purposes.

1.3 QUALITY ASSURANCE

A. Comply with applicable requirements of NFPA 495, "Explosive Materials Code."

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B. Comply with the "Underground Utilities Damage Prevention Act" (TCA Section 65-31-101, et.seq., as amended).

1.4 EXISTING UTILITIES

A. Utilities include above ground and underground pipes, conduits, ducts, and cables.

B. Existing Utilities: Do not interrupt utilities unless permitted in writing by the utility provider and then only after arranging to provide temporary utility services according to requirements indicated:
   1. Notify the utility provider not less than 72 hours in advance of proposed utility interruptions.
   2. Do not proceed with utility interruptions without the utility provider's written permission.
   3. Contact utility-locator service for area where Project is located before excavating.

PART 2 – PRODUCTS

2.1 SOIL MATERIALS

A. Satisfactory Soils: ASTM D 2487 soil classification groups GW, GP, GM, SW, SP, and SM, or a combination of these group symbols; free of rock or gravel larger than 3 inches (75 millimeters) in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

B. Unsatisfactory Soils: ASTM D 2487 soil classification groups GC, SC, ML, MH, CL, CH, OL, OH, and PT, or a combination of these group symbols.
   1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

C. Backfill and Fill: Backfill material for new water lines shall be satisfactory, sifted soil; if none available, must haul from offsite. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.

D. Subbase: Naturally or artificially graded mixture of natural or crushed gravel and crushed stone; ASTM D 2940; with at least 90 percent passing a 1 1/2-inch (38 millimeter) sieve and not more than 12 percent passing a No. 200 (0.075 millimeter) sieve.

E. Base: Naturally or artificially graded mixture of natural or crushed gravel and crushed stone; ASTM D 2940; with at least 95 percent passing a 1 1/2-inch (38 millimeter) sieve and not more than 8 percent passing a No. 200 (0.075 millimeter) sieve.

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F. Bedding: Class B, Natural sandy soil, all of which passes a 3/8-inch (9.5 millimeter) sieve and not more than 10% passes a No. 200 (0.075 millimeter) sieve.

PART 3 – EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.

B. Protect subgrades and foundation soils against freezing temperatures or frost. Provide protective insulating materials as necessary.

C. Provide erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways per the Stormwater Management Ordinance.

3.2 DEWATERING

A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.
   1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.
   2. Install a dewatering system to keep subgrades dry and convey ground water away from excavations. Maintain until dewatering is no longer required.
   3. Meet the requirements of the Tennessee Department of Environment and Conservation (TDEC) and the City of Franklin Stormwater Management Ordinance for stormwater discharge from construction-related activities.

3.3 EXPLOSIVES

A. Explosives: Obtain written permission and required permits from authorities having jurisdiction before bringing explosives to Project site or using explosives on Project site.
   1. Do not damage adjacent structures, property, or site improvements or weaken the bearing capacity of rock subgrade when using explosives.

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3.4 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch (25 millimeters). Extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

3.5 EXCAVATION FOR UTILITY TRENCHES

A. Prior to installation of utility the site shall be within 1 foot of final subgrade elevation along the utility alignment. A grade cut sheet indicating proposed final grade, proposed subgrade, and actual grade elevations shall be submitted and sealed by Engineer or Surveyor.

B. Excavate trenches to indicated gradients, lines, depths, and elevations.

C. Excavate trenches to uniform widths to provide a working clearance on each side of pipe or conduit. Trench walls shall be vertical from trench bottom to 12 inches (300 millimeters) higher than top of pipe or conduit, unless otherwise indicated.
   1. Clearance: See Detail titled Bedding and Backfilling for Pressure Lines.

D. Trench Bottoms: In soil excavate trenches to required elevation. Hand excavate for bell of pipe.
   1. Excavate trenches 6 inches (150 millimeters) deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

3.6 STORAGE OF SOIL MATERIALS

A. Stockpile borrow materials and satisfactory excavated soil materials. Comply with the City of Franklin Stormwater Management Ordinance requirements for stockpiles.
   1. Use proper erosion control measures. Temporarily seed if left undisturbed for fifteen (15) days.
   2. Stockpile soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
   3. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.7 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:
   1. Surveying locations of underground utilities for record documents.
   2. Inspecting underground utilities.

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3. Removing concrete formwork.
4. Removing trash and debris.
5. Removing temporary shoring and bracing, and sheeting.

B. Crushed Stone Refill
   1. This item shall include furnishing, placing and installing refill at the locations as directed by the Engineer during construction. This shall also include the removing and disposing of all unsuitable unclassified material necessary to establish satisfactory foundations and install refill.
   2. Work to be performed shall include all work necessary for the furnishing and replacing of refill. Crushed Stone refill furnished shall be as specified in Article 2.1 of this Section or other size approved by Engineer.

3.8 UTILITY TRENCH BACKFILL

A. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

B. Provide a complete stone backfill for piping within driveways, roadways, and parking areas. If in roadway or paved area, backfill entire trench with No. 67 stone to a height 12 inches below road surface. Final 12 inches shall be filled with compacted road base stone.
   1. Backfill within TDOT right-of-way shall be in accordance with TDOT requirements.

C. Place and compact initial backfill of material, free of particles larger than 2 inches (51 millimeters), to a height of 12 inches (300 millimeters) over the utility pipe.
   1. Carefully compact material under pipe haunches and bring backfill evenly up on both sides and along the full length of utility piping to avoid damage or displacement of utility system.

D. Coordinate backfilling with utilities testing.

E. Fill voids with approved backfill materials while shoring and bracing, and as sheeting is removed. Maximum dimension of individual rock in backfill from 12 inches above pipe to top of ground shall not exceed 6 inches.

F. Place and compact final backfill of satisfactory soil material to final subgrade.

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G. Whenever excavation has been made within easements on private property, the top one (1) inch of backfill material shall be topsoil material consisting of fine, loose earth, free from large clods, vegetable matter, debris, stone, or other objectionable material.

Whenever existing asphalt is removed, restore traffic over the disturbed area as quickly as possible by backfilling with at least 12 inches of compacted Class A, Grade D crushed stone to within 2 inches of the existing surface and then applying a 2 inch layer of cold mix. Add material and otherwise maintain such surface until the permanent pavement is restored by the Contractor or until acceptance by the Owner.

3.9 MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill layer before compaction to within 2 percent of optimum moisture content.
   1. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.
   2. Remove and replace, or scarify and air-dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.10 COMPACTION OF BACKFILLS AND FILLS

A. Place backfill and fill materials in layers not more than 8 inches (200 millimeters) in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches (100 millimeters) in loose depth for material compacted by hand-operated tampers.

B. Compact soil to not less than the following percentages of 95 percent density according to ASTM D 698:
   1. Under pavements, compact each layer of backfill or fill material at 95 percent.
   2. Under walkways, scarify and recompact top 6 inches (150 millimeters) below subgrade and compact each layer of backfill or fill material at 92 percent.
   3. Under lawn or unpaved areas, scarify and recompact top 6 inches (150 millimeters) below subgrade and compact each layer of backfill or fill material at 85 percent.
   4. For gravel backfill, vibratory compaction is required.

3.11 GRADING

A. General: Uniformly grade areas to a smooth surface, free from irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
   1. Provide a smooth transition between adjacent existing grades and new grades.

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2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

3.12 SUBBASE AND BASE COURSES

A. Under pavements and walks, place subbase course on prepared subgrade and as follows:
   1. Place base course material over subbase.
   2. Compact subbase and base courses at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 1557.
   3. For gravel backfill, vibratory compaction is required.
   4. Shape subbase and base to required crown elevations and cross-slope grades.
   5. When thickness of compacted subbase or base course is 6 inches (150 millimeters) or less, place materials in a single layer.
   6. When thickness of compacted subbase or base course exceeds 6 inches (150 millimeters), place materials in equal layers, with no layer more than 6 inches (150 millimeters) thick or less than 3 inches (75 millimeters) thick when compacted.

3.13 FIELD QUALITY CONTROL

A. Testing Agency: Contractor will engage a qualified independent geotechnical engineering testing agency to perform field quality-control testing. Contractor to pay for testing services. One copy of the test reports shall be sent to the Owner.

B. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earthwork only after test results for previously completed work comply with requirements.

C. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable. Tests will be performed at the following locations and frequencies:
   1. Trench Backfill: At each compacted initial and final backfill layer, at least one test for each 150 feet (46 meters) or less of trench length, but no fewer than two tests.

D. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil to depth required; recompact and retest until specified compaction is obtained.

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3.14 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.
   1. Scarify or remove and replace soil material to depth as directed by Owner; reshape and recompact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
   1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to the greatest extent possible.

3.15 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Promptly remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris from site unless written permission from property owner allows otherwise.
B. Obtain permission from applicable regulatory agency for disposal of debris to waste disposal site.

END OF SECTION

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PART 1 – GENERAL

1.1 PERFORMANCE REQUIREMENTS

A. Dewatering Performance: Design, furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to control ground-water flow into excavations and permit construction to proceed on dry, stable subgrades.

1.2 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with water disposal requirements of authorities having jurisdiction.

PART 2 – PRODUCTS (Not Used)

PART 3 – EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by dewatering operations.
   1. Prevent surface water and subsurface or ground water from entering excavations, from ponding on prepared subgrades, and from flooding site and surrounding area.
   2. Protect subgrades and foundation soils from softening and damage by rain or water accumulation.

3.2 INSTALLATION

A. Install dewatering system utilizing wells, well points, or similar methods complete with pump equipment, standby power and pumps, filter material gradation, valves, appurtenances, water disposal, and surface-water controls.

B. Before excavating below ground-water level, place system into operation to lower water to specified levels. Operate system continuously until structures such as drains and sewers have been constructed and fill materials have been placed, or until dewatering is no longer required.

C. Provide an adequate system to lower and control ground water to permit excavation, construction of structures, and placement of fill materials on dry subgrades. Install sufficient

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dewatering equipment to drain water-bearing strata above and below bottom of foundations, drains, sewers, and other excavations.

D. Do not permit open-sump pumping that leads to loss of fines, soil piping, subgrade softening, and slope instability.

E. Reduce hydrostatic head in water-bearing strata below subgrade elevations of foundations, drains, sewers, and other excavations.

F. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water in a manner that avoids inconvenience to others. Provide sumps, sedimentation tanks, and other flow- control devices as required by authorities having jurisdiction.

G. Provide standby equipment on-site, installed and available for immediate operation, to maintain dewatering on continuous basis if any part of system becomes inadequate or fails. If dewatering requirements are not satisfied due to inadequacy or failure of dewatering system, restore damaged structures and foundation soils at no additional expense to Owner.
   1. Remove dewatering system from Project site on completion of dewatering. Plug or fill well holes with sand or cut off and cap wells a minimum of 36 inches (900 millimeters) below overlying construction.

H. Damages: Promptly repair damages to adjacent facilities caused by dewatering operations.

END OF SECTION

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PART 1 – GENERAL

1.1 PERFORMANCE REQUIREMENTS

A. Design, furnish, install, monitor, and maintain excavation support and protection system in compliance with current OSHA standards that are capable of: supporting excavation sidewalls, resisting soil and hydrostatic pressure, and supporting superimposed and construction loads.
   1. Provide professional engineering services to assume engineering responsibility, including preparation of Shop Drawings and a comprehensive engineering analysis by a qualified professional engineer.

1.2 SUBMITTALS

A. Shop Drawings for Information: Prepared by or under the supervision of a qualified professional engineer for excavation support and protection systems.

1.3 PROJECT CONDITIONS

A. Survey adjacent structures and improvements within 50 feet of project limits, employing a qualified professional engineer or land surveyor; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.
   1. During installation of excavation support and protection systems, regularly resurvey benchmarks, maintaining an accurate log of surveyed elevations and positions for comparison with original elevations and positions. Promptly notify Owner if changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.

PART 2 – PRODUCTS (Not Used)

PART 3 – EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards that could develop during excavation support and protection system operations.

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B. Install excavation support and protection systems to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.

C. Monitor excavation support and protection systems daily during excavation progress and for as long as excavation remains open. Promptly correct bulges, breakage, or other evidence of movement to ensure that excavation support and protection systems remain stable.

D. Promptly repair damages to adjacent facilities caused by installing excavation support and protection systems.

3.2 REMOVAL AND REPAIRS

A. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and bear soil and hydrostatic pressures. Remove in stages to avoid disturbing underlying soils or damaging structures, pavements, facilities, and utilities.

END OF SECTION

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PART 1 – GENERAL

1.1 SUBMITTALS

A. Product Data: For each product indicated.

B. Shop Drawings: Show locations, components, materials, dimensions, sizes, weights, finishes of components, installation and operational clearances, gate swings, and details of post anchorage and attachment and bracing.

1.2 QUALITY ASSURANCE

A. Fencing and all accessories shall be produced by a single manufacturer.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Each length of fabric shall be tightly rolled and firmly tied.

B. Each shipment of fabric shall be identified as to the material, color (as applicable), mesh size, height and length of fabric in each roll, ASTM designation, and name or mark of the manufacturer.

C. Store materials in a clean, dry area.

D. Handle materials in accordance with the manufacturer's instructions.

PART 2 – PRODUCTS

2.1 CHAIN LINK FENCE FABRIC

A. The fabric shall consist of one-piece fabric widths for fences up to 8-0" in height.

B. Steel Chain-Link Fence Fabric: Comply with Chain Link Fence Manufacturers Institute's "Product Manual."
   1. Diamond Mesh and Wire Size: 2-inch (50 millimeters) mesh, 0.192-inch (4.88 millimeters) diameter (6 gage).
   2. Zinc-Coated Fabric: ASTM A 392, with zinc coating applied to steel wire mesh fabric after weaving with Class 1, 1.2-oz./sq. ft. (366-g/sq. m) minimum coating weight.

C. Fabric Selvage: Twisted at top selvage and knuckled at bottom.

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D. Fabric Height: 8 feet.

2.2 HEAVY DUTY FENCE FRAMING

A. Round Steel Pipe: Standard weight, Schedule 40, galvanized steel pipe complying with ASTM F 1083. ASTM F 1043, Material Design Group IA, external and internal coating Type A, consisting of not less than 1.8-oz./sq. ft. (0.55-kg/sq. m) zinc; and line, end, corner, and pull posts and rails and braces as required for heavy duty fence.

B. Rails and Braces: Top, Intermediate, and Bottom Rails shall be not less than 18 feet in length with swedged end or fitted with couplings for connecting the lengths into a continuous run. Couplings shall allow for expansion and contraction, be not less than 6 inches long, and have minimum wall thickness of 0.070 inches. Open seam outside sleeves shall be permitted only with a minimum wall thickness of 0.100 inches.
   1. Post Brace Rails: Provide brace rail with truss rod assembly for each gate, end, and pull post. Provide two brace rails extending in opposing directions, each with truss rod assembly, for each corner post and for pull posts. Provide rail ends and clamps for attaching rails to posts.
   2. Means shall be provided for attaching rails to each gate, corner, pull, and end post.
   3. Tension wire is required at top of fence if top rail is omitted.

C. Barbed Wire Supporting Arms: Shall be at an angle of approximately 45 degrees or vertical, as required, and shall be fitted with clips or other means for attaching 3 strands of barbed wire. With 45 degree arms, the top wire shall be approximately 12 inches horizontally from the fence line and the other wires spaced uniformly between the top of the fence fabric and the outside strand. Arms shall be capable of supporting a weight of 250 pounds applied at the outer strand of barbed wire.

D. Barbed Wire: Commercial quality steel, 12-1/2 gage line wire, two strand twisted line wire with 4 point, 14 gage barbs at 5 inch spacing. Coating shall consist of a minimum of 0.80 ounces of zinc per square foot of wire surface conforming to ASTM A121 or a minimum of 0.30 ounces of aluminum per square foot of wire surface conforming to ASTM A585.

E. Components Dimensions and Weights:
   1. Pipe Weight:

Nominal Pipe O.D.	Pipe Weight (lbs/ft) Group IA
1-5/8 inch	2.27
2 inches	2.72
2-1/2 inch	3.65

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3 inches	5.79
3-1/2 inch	7.58
4 inches	9.11

2. Fence Post Size:

	Group IA	
Fabric Height	**Line Post Nominal O.D.**	**Terminal Post Nominal**
3 to 5 feet	2 inches	2-1/2 inches
6 to 8 feet	2-1/2 inches	3 inches
10 to 12 feet	3 inches	4 inches

3. Gate Post:

Group IA and IC Post O.D.	Single Gate Width	Double Gate Width
3 inches	Up to 6 feet	Up to 12 feet
4 inches	7 feet to 12 feet	13 feet to 25 feet

2.3 TIES AND CLIPS

A. Ties and/or clips of adequate strength shall be provided for attaching the fence fabric securely to all line posts at intervals not exceeding 15 inches; and not exceeding 24 inches when attaching fabric to rails or tension wire.
   1. Stretcher Bar Bands: Heavy pressed steel spaced not over 15 inches on center to secure stretcher bars to tubular end, corner pull, and gate post.
   2. Wire Ties: For tying fabric to line posts, use 11 gauge steel wire clips for C-section posts and a minimum 9 gauge aluminum wire ties for tubular posts, spaced 14 inches on center. For tying fabric to rails and braces, use 9 gauge aluminum wire ties spaced 24 inches on center. For tying fabric to tension wire, use 11 gauge hog rings spaced 24 inches on center.

2.4 TENSION BARS

A. Not less than 3/16 inch by 3/4 inch and not less than 2 inches shorter than the normal height of the fence fabric with which they are to be used. One tension bar shall be provided for each end and gate post, and two for each corner and pull post.

2.5 TERMINAL POST BANDS OR CLIPS

A. Provided for attaching the fence fabric and stretcher bars to all terminal posts at intervals not exceeding 15 inches.

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1. Galvanized steel or aluminum alloy per ASTM F-626.
2. Formed From Flat or Beveled Steel:
   a. Minimum thickness of 0.078 inch after galvanizing and minimum width of 3/4 inch for 4 inch O.D. or less posts.
   b. Minimum thickness of 0.108 inch after galvanizing and minimum width of 7/8 inch for posts larger than 4 inches O.D.
3. Attachment bolts shall be 5/16 inch galvanized carriage bolts.

2.6 TENSION WIRE AND FITTINGS

A. Metallic-Coated Steel Tension Wire: 7 gage, 0.177-inch-(4.5-mm-) diameter, Marcelled tension wire complying with ASTM A824. Coating shall conform to ASTM A824 Type I, aluminum coated, 0.40 oz/ft^2 or Type II zinc coated Class 2, 1.20 oz/ft^2.

B. Fittings: Provide fittings for a complete fence installation, including special fittings for corners. Comply with ASTM F 626.

2.7 POST TOPS

A. Post Tops: Pressed steel or malleable iron (designed as a weather tight closure cap for tubular posts). Where top rail is used, provide tops to permit the passage of the top rail.

2.8 GATES

A. Swing gates shall conform to ASTM F900.
   1. Materials: The base materials of the gate frame shall be round tubular members welded at all corners or assembled with corner fittings. Gates assembled with corner fittings shall have adjustable truss rods 5/16 inch minimum diameter on panels 5 feet wide or wider. Truss rods shall be the same base metal and finish as the gate frames.
      a. The interior bracing, when needed shall be the same metal and shape tubular material and finish as the gate frame, but need not be the same size. Gates leaves shall have vertical interior bracing at maximum intervals of 8 feet and shall have a horizontal interior member if the fabric height is 8 feet or more.
      b. Zinc-coated steel frames shall be in accordance with ASTM Specifications F1043 or F1083, or a combination thereof, and shall match that selected for any adjoining fence framework. Welded joints shall be coated in accordance with Practice A780, employing a zinc-rich paint.
      c. Gate fabric shall be the same type as used in fence construction. The fabric shall be attached securely to the gate frame at intervals not exceeding 15 inches.

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d. Barbed Wire Top: The end members of the gate frame shall be extended 1 foot in height to accommodate three strands of barbed wire. Clips necessary for securing wire shall be provided.

2. Dimensions, Mass, and Permissible Variations:
   a. Size of the gate opening shall be measured from the inside face to inside face of gate posts.
   b. Gate frame shall be designed for the width and built so that the outer members shall not sag in excess of the lesser of 1 percent of the gate leaf width or 2 inches.
3. Gate Accessories: All gate accessories shall be of the materials as specified for the fence.
   a. Gate Hinges: Hinges shall be structurally capable of supporting the gate leaf and allow the gate to open and close without binding. The hinges shall be so designed to permit the gate to swing a full 180 degrees.
   b. Single Gate Latch: Gate latch shall be capable of retaining the gate in a closed position and shall have provision for a padlock.
   c. Double Gate Latch: Gate latch shall be a drop rod or plunger bar arranged to engage the gate stop. Locking devices shall be constructed so that the center drop rod or plunger bar cannot be raised when the gate is locked. The latching devices shall have provision for a padlock.
   d. Gate Stops: Gate stops shall be provided for all double gates.
   e. Keepers shall be provided for each gate leaf over 5 feet.
   f. Gates 5 feet and under shall have a self-closing mechanism.

2.9 CAST-IN-PLACE CONCRETE

A. General: Comply with ACI 301 for cast-in-place concrete; materials consisting of portland cement complying with ASTM C 150, aggregates complying with ASTM C 33, and potable water.
   1. Concrete Mixes: Normal-weight concrete air entrained with not less than 3000-psi (20.7-MPa) compressive strength (28 days), 3-inch(75-mm) slump, and 1-inch (25- mm) maximum size aggregate.

PART 3 – EXECUTION

3.1 INSTALLATION

A. General: Install chain-link fencing to comply with ASTM F 567 and more stringent requirements indicated. Do not begin installation before final grading is completed, unless otherwise permitted by the Owner. Install all fencing to the limits shown on the drawings.

B. Post Excavation: Drill or hand-excavate holes for posts to diameters, depths, and spacings indicated, in firm, undisturbed or compacted soil.

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C. Post Setting:
   1. Concrete Footings: Place concrete around posts and vibrate or tamp for consolidation. Trowel smooth the top of each footing at a 20 degrees angle from the post to the surrounding ground to shed water away from the post. The post shall extend to the full depth of the footing. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during placement and finishing operations until concrete is sufficiently cured. Set the following post types in concrete footings and protect portion of posts aboveground from concrete splatter:
      a. Terminal.
      b. Line.
      c. Gate.
   2. Set all posts with a vertical tolerance of less than 1 inches in 10 feet as measured with a plumb bob.

D. Terminal Posts: Locate terminal end, corner, and gate posts per ASTM F 567 and terminal pull posts at changes in horizontal or vertical alignment greater than 20 degrees.
   1. Only one end or corner post shall be installed at the junction of different heights of fence and shall be consistent with the largest post required at the junction.

E. Line Posts: Space line posts uniformly at 10 feet (3.05 meters) on center.

F. Intermediate Rails: Install in one piece at post-height center span, spanning between posts, using fittings, special offset fittings, and accessories.

G. Top Rails: Install, spanning between posts, using fittings and accessories.

H. All fences shall have a bottom tension wire attached to the fabric and posts.

I. Chain-Link Fabric: Apply fabric to outside of enclosing framework.

J. Tie Wires: Attach wire to chain-link fabric per ASTM F 626. Tie fabric to line posts at maximum interval of 12 inches (304 mm) o.c. and to braces at maximum interval of 24 inches (609 mm) o.c.

K. Assemble gate frames by welding or fittings and rivets for rigid connections. Install fabric with stretcher bars at vertical edges, and tie at top and bottom edges. Attach stretcher bars to gate frame at not more than 15 inches on center. Attach hardware with rivets or by other means that will provide security against removal or breakage.

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L. Gate Installation: Install gates level, plumb, and secure for full opening without interference. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust gate to operate smoothly, easily, and quietly throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

M. All corner, terminal and gate posts for fence 6 feet and higher shall have a mid-rail and 3/8 round adjustable truss rod to the next post.

END OF SECTION

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PART 1 – GENERAL

1.1 SUMMARY

A. This work shall be performed in all disturbed areas not receiving such site improvements as buildings, roads, walks, sod, planting, etc., and shall include, but not necessarily be limited to, all seed bed preparation; the supplying and placing of soil additives, seed, and mulch wherever directed by the Owner; and maintenance.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Grass Seed: Contractor's blend (including Kentucky 31 Fescue and annual rye) furnished in new bags or bags that are sound and not mended; no "below standard" seed accepted.

B. Fertilizer: Commercially manufactured; Grade 10-10-10; furnished in standard containers that are clearly marked with the name, weight, and guaranteed analysis of the contents and that ensure proper protection in transportation and handling; and in compliance with all local, state, and federal fertilizer laws.

C. Agricultural Limestone: Containing a minimum of 85 percent calcium carbonate and magnesium carbonate combined, 85 percent of which passes a No. 10 mesh sieve.

D. Mulch: Stalks of rye, oats, wheat, or other approved grain crops properly cured prior to baling, air dried, and reasonably free of noxious weeds and weed seeds or other material detrimental to plant growth.

PART 3 – EXECUTION

3.1 SEEDING

A. Perform all seeding and related work as a continuous operation. Sow seed as soon as the seed bed has been prepared and perform subsequent work in a continuous manner.

B. Before beginning seeding operations in any area, complete the placing of topsoil and final grading, and have the work approved by the Owner.

C. Scarify, disk, harrow, rake, or otherwise work each area to be seeded until the soil has been loosened and pulverized to a depth of not less than 2 inches. Perform this work only when the soil is in a tillable and workable condition.

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D. Apply fertilizer and agricultural limestone uniformly over the seed bed, and lightly harrow, rake, or otherwise incorporate them into the soil for a depth of approximately 1 inch at the following rates:
   1. Fertilizer: 40 pounds per 1,000 square feet
   2. Agricultural Limestone: 80 pounds per 1,000 square feet

E. Sow seed uniformly with a rotary seeder, wheelbarrow seeder, or hydraulic equipment or by other satisfactory means.

F. The seeding rate shall be 5 pounds per 1,000 square feet for Kentucky 31 Fescue (Festuca Elatior).

G. Perform no seeding during windy weather or when the ground surface is frozen, wet, or otherwise un-tillable.

H. When seeding with mulch is specified, spread the mulch material evenly over the seeded areas immediately following the seeding operation.

I. Mulch Rate: 2 bales (100 pound minimum) per 1,000 square feet, depth = 2 inches min.

J. The mulch rate may be varied by the Owner, depending on the texture and condition of the mulch material and the characteristics of the area seeded. Cover all portions of the seeded areas with a uniform layer of mulch so that approximately 25 percent of the ground is visible.

K. Mulch shall be anchored by a tackifier or crimping.

L. No equipment, material storage, construction traffic, etc., will be permitted on newly seeded ground.

M. Dispose of all surplus materials as directed by the Owner.

3.2 INSPECTIONS

A. The Owner shall inspect the seeding within 14 days after planting and determine if the seeds are germinating and 60 days to determine if the coverage is acceptable.

3.3 HIGH-VELOCITY CLEANING

A. Secure an acceptable growth of grass in all areas designated for seeding.

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B. An area is considered acceptable if it is represented by a minimum of 100 seedlings per square foot of the permanent species of grass representative of the seed mixture. If an acceptable growth is not obtained on the first planting, reseeding and re-mulching will be required.

C. If the planting is less than 50 percent successful, rework the ground, re-fertilize, reseed and re- mulch.

END OF SECTION

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PART 1 – GENERAL

1.1 EASEMENTS

A. Water, Wastewater and/or Reclaimed Water Mains: When required, permanent exclusive easements must be provided with a minimum width of 20 feet. Easement width requirements are as follow:
   1. 0'-12' depth requires 20' easement.
   2. 13'-20' depth requires 30' easement.
   3. Depths greater than 20' require wider easements; these widths to be approved by the WMD.

   A minimum 10-foot wide temporary construction easement on each side of the permanent easement must also be provided. No trees shall be planted within the permanent easements. No permanent structures shall be constructed within the permanent easement. Structures immediately adjacent to proposed or existing easements must be designed and signed by a licensed structural Engineer.

B. Easements for water, wastewater and/or reclaimed water line extensions may be provided in either of two ways.
   1. Easement Document on forms provided by the City of Franklin Engineering Department, which must include legal description of the easement(s), legal Owners name, map and parcel, and must be signed by the Owner; and then notarized and recorded.

   2. Record with Subdivision Plat - If this method of recording easements is chosen, a preliminary plat of the subdivision must be provided at the time of plans submittal, which clearly defines the easements to be recorded.

C. All easements for work on property not owned by the Developer or Owner must be obtained and recorded before construction can begin. In new subdivisions, the letter of intent and preliminary plat showing the easements will be sufficient to start construction. However, the Final Plat must be recorded and delivered prior to final inspection of the new facilities by the WMD.

D. For developments which require either a water booster station or a sanitary sewer pump station, a parcel of land shall be deeded to the City of Franklin. Plats with descriptions and deeds shall be provided for all pumping stations and access roads to pumping stations.

1.2 ABANDONING UNACCEPTED INFRASTRUTURE

A. In the event that water, wastewater or reclaimed water infrastructure is constructed but is never accepted by the WMD for a period of twelve (12) months or more, the infrastructure shall be considered abandoned and require re-televising, re-testing, development of a

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punchlist of any deficiencies and correction of all deficiencies prior to final acceptance, release of performance bonds and allowing any service connections.

END OF SECTION

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PART 1 - GENERAL

1.1 SUMMARY

A. Restoration of existing sanitary sewers by installation of a resin impregnated flexible felt tube into the existing sewer line (from manhole to manhole) utilizing a vertical inversion standpipe and hydrostatic head and curing by circulating hot water or other approved means to produce a hard, impermeable pipe. Reference ASTM F1216, or most recent version for liner thickness calculations.

B. The liner shall be cured into a hard, impermeable pipe of the desired thickness, providing a structurally sound, smooth interior, and tight-fitting liner within the existing pipe. The lined pipe shall provide a hydraulic flow equal to or greater than the sewer when it was originally constructed. The liner installation shall be completed in such a way to prevent resin migration into service laterals.

1.2 DEFINITIONS/STANDARDS

A. Codes, Specifications and Standards:
   1. Codes, specifications, and standards referred to by number or title shall form a part of this specification to the extent required by the references thereto. Latest revisions shall apply, unless otherwise shown or specified.
   2. All pipe materials incorporated in the project shall be approved by the Owner for the application to be used.

B. American Society for Testing and Materials (ASTM) Standards:
   1. D638 – Standard Test Method for Tensile Properties of Plastics.
   2. D790 – Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
   3. D5813 - Standard Specification for Cured-In-Place Thermosetting Resin Sewer Piping Systems.
   4. D2122 – Standard Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings.
   5. D2837 – Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products.
   6. F1216 – Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube.
   7. F1743 - Standard Practice for the Rehabilitation of Existing Pipelines and Conduits by Pulled-in-Place Installation of Cured-in-Place Thermosetting Resin Pipe.

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1.3 SUBMITTALS

A. Submit the following:
   1. Manufacturer's Certificate of Compliance certifying compliance with the applicable specifications and standards including certified copies of factory test reports.
   2. Manufacturer's installation instructions and procedures.
   3. Contractor's procedures and materials for service renewal including time and duration of sewer service unavailability.
   4. Data, measurements, assumptions and calculations for sizing liners.
   5. Field measurements (diameter, depth, ovality) at upstream and downstream manholes.
   6. Sampling procedures and locations for obtaining representative samples of the finished liner.
   7. Product data for expanding hydrophilic rubber joint seal.

B. A final certificate of compliance with this specification shall be provided by the manufacturer for all lining material furnished. Tests for compliance by an independent laboratory shall be made according to the applicable ASTM specification and the manufacturer's quality control program.

C. Furnish an extended warranty for liner materials from the Contractor and liner manufacturer for a total of 5 years from date of acceptance.

1.4 QUALITY ASSURANCE

A. The Contractor shall be familiar with the sewer segments under consideration for lining prior to work. The Contractor shall certify in writing as to the applicability of the proposed liner process to each section to be lined.

B. Patents: Contractor shall warrant and indemnify Owner against all claims for patent infringement and any loss thereof.

C. Products must be approved by the State regulatory agency for the application to be used.

1.5 DELIVERY, STORAGE AND HANDLING

A. The Contractor shall be responsible for the delivery, storage, and handling of products. No products shall be shipped to the job site without the approval of the Resident Project Representative and/or Owner.

B. Products shall be stored in accordance with Manufacturer's recommendations. Promptly remove damaged products from the job site.

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PART 2 - PRODUCTS

2.1 GENERAL

A. The finished pipe liner in place shall be fabricated from materials which when complete are chemically resistant to and will withstand internal exposure to domestic sewage having a pH range of 5 to 11 and temperatures up to 150°F.

B. Liner and materials shall be approved by the WMD prior to its installation.

C. Take all necessary field measurements of the existing pipe (including diameter, ovality and length) prior to manufacturing liners.

D. The minimum length shall be deemed by the WMD to effectively span the distance from the inlet to the outlet of the respective manholes unless otherwise specified. The Contractor shall verify the lengths in the field before manufacturing.

E. The Contractor performing the CIPP lining work shall be fully qualified, experienced and equipped to complete this work expeditiously and in a satisfactory manner and shall be certified and/or licensed as an installer by the CIPP lining manufacturer. The Contractor shall have successfully installed a minimum of 250,000 feet of the proposed CIPP liner during the last three (3) years. The full-time, on-site superintendent/foreman that will supervise the CIPP lining installation under this Contract shall have successfully installed a minimum of 100,000 feet of the proposed CIPP liner during the last two (2) years.

2.2 CURED-IN-PLACE LINER

A. Unless specified otherwise, the liner shall be structurally designed for continuous loading conditions; a minimum service life of 50 years; fully deteriorated host pipe/direct bury condition; prism loading; soil loading of 120 PCF; factor of safety of 2.0; 2 percent ovality; maximum deflection of 5 percent; soil modulus of 1000 psi; lining enhancement factor of 7 maximum; H-20 live loading; 50 percent long-term modulus reduction factor; and hydrostatic load at 27.4 percent of depth to invert; and no bonding to the original pipe wall.

B. All cured-in-place lining products shall comply with ASTM F1216 with minimum finished liner thickness 6mm or greater if specified by design calculations and required by Owner (except for services).
   1. Calculations which determine wall thickness requirements of the liner shall be submitted to the Owner prior to installation. Calculations shall be prepared and sealed by a

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Tennessee registered Professional Engineer with a minimum of two (2) years CIPP design experience.

C. CIPP liner materials must have passed independent approved third-party laboratory testing, not excluding long-term (10,000 hour) structural behavior testing, and must have been successfully installed to repair failing host pipes in the United States (U.S.) for at least five (5) years. In addition to, Engineer may require that Contractor and manufacturer demonstrate that proposed CIPP liner materials meet or exceed the specifications herein and submit evidence for Engineer approval prior to installation of the proposed CIPP liner material systems.

D. The flexible tube shall be fabricated to a size that when installed will neatly fit (minimum 99.75 percent) the internal circumference of the existing sanitary sewer lines (including services as evidenced by indentations). Allowance shall be made for circumferential stretching during insertion so that the final cured product is snug against the wall of the host pipe.

E. Unless otherwise specified, the Contractor shall furnish a general purpose, unsaturated, polyester or thermosetting vinyl ester resin and catalyst system compatible with the reconstruction inversion process that provides cured physical strengths specified herein.

F. The liner shall not be made of a dark or non-reflective material that would inhibit proper closed circuit TV inspection.

G. Pre-approved manufacturers of cured-in-place pipe (CIPP) are:
   1. Insituform® CIPP, Insituform Technologies, Inc., 17988 Edison Avenue, Chesterfield, MO, 63005, phone (800) 234-2992.
   2. InLiner™, Inliner Technologies, Inc., 1468 West Hospital Road, Paoli, IN, 47454, phone (812) 723-0704.
   3. SAK Liner™, SAK Construction, LLC., 864 Hoff Road, O'Fallon, MO, 63366, phone (636) 385-1000.
   4. Approved equal.

2.3 EXPANDING HYDROPHILIC RUBBER JOINT SEAL

A. The rubber joint seal shall be an extended hydrophilic rubber compounded from chloroprene (Neoprene) rubber and a hydrophilic resin, which expands upon contact with water.

B. The rubber joint seal shall be bonded with adhesive on one face to hold it in place during assembly.

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C. On contact with water, the rubber shall swell up to 8 times its original volume if necessary and mold itself to completely fill any gaps and exert pressure evenly to ensure the seal. High compression or bolt up forces shall not be necessary to affect a complete and watertight seal.

D. The Contractor may propose alternative sealing materials or products in lieu of a hydrophilic rubber joint seal. This is provided the alternative will result in a positive seal between the liner and the existing host sewer pipe to ensure no groundwater tracking through the annulus space into a manhole. Any alternative must be approved by the Owner prior to installation.

2.4 RESIN

A. The resin system shall be a corrosion resistant isophthalic polyester or vinyl ester system including all required catalysts, initiators that when cured within the tube create a composite that satisfies the requirements of ASTM F1216, ASTM D5813 and ASTM F1743, the physical properties herein, and those which are to be utilized in the submitted and approved design of the CIPP for this Work.

B. The resin for this Work shall be equal or superior to, at the discretion of the Engineer, Vipel® L704 series resin as manufactured by AOC of Collierville, Tennessee. Any resin used shall produce a CIPP that will comply with the structural and chemical resistance requirements of this specification.

PART 3 - EXECUTION

3.1 PREPARATION

A. The following installation procedures shall be adhered to unless otherwise approved by the the Owner:
   1. The Contractor shall carry out his operations in strict accordance with all OSHA, TOSHA and manufacturer's safety requirements. Particular attention is drawn to those safety requirements involving entering confined spaces.
   2. It shall be the responsibility of the Contractor to remove all internal debris and clean the existing sewer line prior to installation of the liner. Cleaning and disposal of material shall be properly conducted.
      a. The Contractor shall ensure no solids are passed downstream to the next pipe section during the cleaning process.
   3. Inspection of existing sewer lines shall be performed by experienced personnel trained in locating breaks, obstacles and service connections by closed circuit television. The interior of the line shall be carefully inspected to determine the location of any conditions that may prevent proper installation of the liner pipe into the lines, and such

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conditions shall be noted so they can be corrected. A CD-ROM or DVD and suitable log shall be kept for later reference by the Owner as specified in Division 33 Section "Sewer Television Inspection". The television inspection shall be performed in the presence of the Resident Project Representative and/or Owner. All obstructions which prevent the passage of the television camera shall be immediately reported to the Engineer by Contractor referencing the location and nature of the obstruction.

4. The Contractor shall provide for the flow of sewage around the section or sections of pipe designated for lining as specified in Division 33 Section "Sewer Flow Control".
5. The Contractor shall clear the line of obstructions such as solids, dropped joints, protruding service connections or collapsed pipe that will prevent the insertion of the liner pipe, as noted on the Drawings and TV Logs attached. If inspection reveals an obstruction that cannot be removed by conventional sewer cleaning equipment, the Contractor shall notify Owner and immediately stop working. The Owner will make the decision on how to make a point repair excavation to uncover and remove or repair the obstruction prior to lining. All materials removed from the sewer line shall be loaded directly on a truck and hauled to an approved disposal site.
    a. Point repairs shall be conducted in accordance with sewer line excavation requirements.
6. Hydrophilic rubber joint seals shall be installed around the liner at all manhole connections for all lining products.
7. Ground water temperatures and ambient temperatures shall not be excessive for the product installation procedures.

B. Where practicable, liners can be installed in continuous runs through manholes where there are two or more continuous sewer segments, especially to connect several short segments with a continuous lining. Cut out lining in manholes for access unless otherwise specified by the Owner.

3.2 INSTALLATION

A. Cured-in-Place Liner:
    1. Liner installation shall be in accordance with ASTM F-1216.
    2. Install hydrophilic rubber joint seal around all liners at all manhole inlet and outlet connections.
    3. Seal the area where the line enters or leaves each manhole. Finish the inside of the manhole with a quick set cement grout to raise the invert to the grade of the liner pipe. Also use this grout to dress up around the end of the liner. This space may be sealed with a mechanical seal, chemical seal, or combination of both. The chosen method must be approved by the Owner.

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4. If the pipe liner fails to make a tight seal due to broken or misaligned pipe at the manhole wall or other reason, the Contractor shall apply a seal at that point. The seal shall be approved by the Owner.
5. When using wet inversion, the temperature of water discharged to sewer system from processing liners shall not exceed 150°F maximum or level allowed by State or local standards.
6. After the liner has been installed, all active, existing services shall be temporarily reinstated to 95 percent of the original opening. This shall be done without excavation in pavement areas, and in the case of non-man-entry pipes, from the interior of the pipeline by means of a 360° television camera and a cutting device that re-establishes the service connection. When a remote cutting device is used, and a cleanout is available, then a mini-camera down the service shall also be used to assist the operator in cutting or trimming.
7. At all points where the liner pipe has been excavated and exposed (e.g., in access shafts, service connections, etc.), prepare for the placement of a crushed stone backfill by removing all debris and creating a void below and around the pipe. The width of this void shall not exceed 4/3 of the liner's outside diameter plus 15 inches, or 4/3 of the service lines outside diameter plus 15 inches. Use a minimum of 6 inches of 1/2 inch to 3/4 inch crushed stone to provide bedding for the liner and service line. Then place a backfill of crushed stone to a height of 12 inches above the liner and service line. Provide the rest of the backfill from 12 inches above the pipe to grade as specified in Division 31 Section "Earthwork." Replace pavement removed during excavation in accordance with the requirements of Division 32 Section "Pavement Repair" as applicable.
8. The Contractor shall designate a location where the reconstruction tube will be vacuum impregnated prior to installation. The Contractor shall allow the Owner and/or Engineer to inspect the materials and "wet out" procedure. A catalyst system compatible with the resin and reconstruction tube shall be used. Sufficient excess resin will be provided to insure a mechanical bond with the host pipe after curing.
9. The wet out reconstruction tube shall be inserted through an existing manhole or other approved access by means of an inversion process and the application of a hydrostatic head sufficient to fully extend it to the next designated manhole or termination point. The reconstruction tube shall be inserted into the vertical inversion standpipe with the impermeable plastic membrane side out. At the lower end of the inversion standpipe, the reconstruction tube shall be turned inside out and attached to the standpipe so that a leak-proof seal is created. The inversion head will be adjusted to be of sufficient height to cause the impregnated tube to invert from manhole to manhole and hold the tube tight to the pipe wall, produce dimples at side connections and flared ends at the manholes. The use of a lubricant is recommended. Care shall be taken during the elevated curing temperature so as not to overstress the felt fiber.

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10. After inversion is completed the Contractor shall supply a suitable heat source and water recirculation equipment. The equipment shall be capable of delivering hot water throughout the section by means of a pre-strung hose to uniformly raise the water temperature above the temperature required to affect a cure of the resin. This temperature shall be determined by the resin/catalyst system employed.
11. The heat source shall be fitted with suitable monitors to gauge the temperature of the incoming and outgoing water supply. Another such gauge shall be placed between the impregnated reconstruction tube and the pipe invert at the remote manhole to determine the temperatures during cure. Water temperature in the line during the cure period shall be recommended by the resin manufacturer.
12. Initial cure shall be deemed to be completed when inspection of the exposed portions of cured pipe appear to be hard and sound and the remote temperature sensor indicates that the temperature is of a magnitude to realize an exothermic. The cure period shall be of a duration recommended by the resin manufacturer, as modified for the cured-in-place inversion process, during which time the recirculation of the water and cycling of the heat exchanger to maintain the temperature continues.
13. The Contractor shall cool the hardened pipe to a temperature below 100°F before relieving the static head in the inversion standpipe. Cool-down may be accomplished by the introduction of cool water into the inversion standpipe to replace water being drained from a small hole made in the downstream end discharging to the sewer. Care shall be taken in release of the static head so that a vacuum will not be developed that could damage the newly installed pipe. In no case shall water above 100°F be introduced into the sewer.

B. Service Lateral Renewal:
   1. Cured-in-Place Liner:
      a. After the new pipe has been cured in place, the Contractor shall reconnect the existing active service connections. This shall generally be done without excavation, and in the case of non-man-entry pipes, from the interior of the pipeline by means of a 360° television camera and a cutting device that reestablishes the service connection. Services shall be re-established to 100 percent of original capacity.
      b. The Contractor shall be responsible for determination of active services and their connection to the liner. The Owner shall be responsible for confirmation of Contractor's active listing. Damages or fines resulting from failure to reconnect any active service(s) shall be Contractor's responsibility.

3.3 POST INSTALLATION

A. Cured-in-Place Lining:

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1. Where liners of any type are installed in two or more continuous manhole segments, the liner invert through the intermediate manholes shall be left intact. Unless otherwise specified by the Owner, final finishing of the installation in those intermediate manholes shall require removal of the top of the exposed liner and neat trimming of the liner edge where it touches the lip of the manhole bench.
2. Portions of any piece of liner material removed during installation shall be available for inspection and retention by the Owner.
3. Reinstate openings for all drop assemblies after relining mainline sewer. All outside drop assemblies shall be lined, unless existing conditions prohibit lining the full length of the drop assembly. The vertical pipe shall be lined, at a minimum. Drop assemblies inside of manholes are not required to be relined, unless directed by the Owner.
4. Each segment lined shall be TV inspected as soon as practical after processing to ensure complete curing or reforming. The lined segment shall also be flushed with water or reclaimed water to ensure there are no sags. Segments not fully conforming to these Specifications must be immediately brought to the Owner's attention with a proposed method of correction. The method of correction shall be acceptable to the Owner.
5. After defects are corrected, the sewer shall be video recorded again.
6. Television inspection shall be completed before the Work will be accepted.

3.4 TESTING

A. See testing for Division 33 Sanitary Sewer Section 33 3113. Testing may be required at Owner's discretion.

B. After completing lining and service renewals, every liner shall be TV inspected with a 360° integral light head camera as soon as practical to verify proper installation. The rate of travel shall not exceed 30 feet per minute. At each service, the camera shall come to a complete stop and the service shall be panned. The footage meter count shall be clearly visible. A log for each segment shall be provided indicating the service location and actual address or parcel of each service renewed.

C. The Owner may have an independent testing lab analyze finished liner samples taken from manhole cutoffs, service coupons, etc. Samples shall be furnished directly to the Owner within 24 hours (or less) after installation.
   1. A minimum of 2 samples shall be taken of the first segment installed.
   2. A minimum of 2 samples shall be taken for each 1,200 LF of liner material installed or for each manufacturing lot, if less.
   3. A minimum of 6 samples per project shall be taken for each type of liner furnished.
   4. Tests in accordance with ASTM standards for Tensile Properties, Flexural Modulus and wall thickness shall be conducted.

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5. The Contractor shall determine sampling location and procedures to ensure representative samples are obtained from the finished liner, subject to approval by the Owner.
6. The Contractor shall furnish removable sizing sleeves to collect liner samples which accurately replicate the host pipe diameter.

3.5 COMPLETION

A. It is the intent of these specifications that the completed liner with all appurtenances shall be essentially equivalent in final quality and appearance to new sewer installation.

B. The finished liner shall be continuous over the entire segment between manholes and homogenous throughout.

C. The finished liner shall be fully rounded and as free as commercially practicable from visible defects, including but not limited to damage, deflection, holes, delaminating, ridges, cracks, uncured resin, foreign inclusions or other objectionable defects.

D. There shall be no visible infiltration through the liner, around the liner at manhole connections, at service connections, in services, or in cleanouts. Contractor shall repair any visible leaks, regardless of the results of leakage testing.

E. Where a defect in the liner requires removal of a section of the liner, in the Owner's opinion, the Contractor shall make all repairs as required by the Owner and shall install a segmental liner, compatible with the liner, to accomplish a continuous finished liner.

F. If an unacceptable crest or sag is determined by the Owner to exist in any portion of the sewer after the completion of the construction, the Contractor shall make the necessary repairs to the sewer to eliminate the problem. If necessary, the Contractor shall excavate the area and restore a uniform slope to the sewer line.

3.6 CLEAN-UP AND RESTORATION

A. The Contractor shall not allow the site of the Work to become littered with trash and waste material but shall maintain the site in a neat and orderly condition throughout the construction period.

B. On or before Final acceptance, the Contractor shall clean and remove from the site of the Work all surplus and discarded materials, temporary structures, stumps and portions of trees, and debris of any kind. He shall leave the site of Work in a neat and orderly condition, similar or equal to that prior to construction.

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C. Upon completion of cleanup and backfill operations and before final acceptance by the Owner, the Contractor shall replace and/or restore any trees, shrubbery, fences, driveways, sidewalks, culverts, bridges, houses or buildings and all water, sewer, gas, telephone and electrical lines thereto, and all other private and public property along or adjacent to the Work that may have been disturbed by construction operations.

D. All private and public property along or adjacent to the Work disturbed by construction operations shall be restored to a condition similar or equal to that existing prior to construction.

Before final acceptance by the Owner, the Contractor shall replace and/or restore any water, sewer, drain, and gas lines and appurtenances; electrical, telephone, telegraph conduits and wires, both underground and aboveground, and appurtenances; traffic signals, fire and police alarm systems and appurtenances; sidewalks, curbs, gutter, drainage ditches and pavements and all other public utility facilities and appurtenances along or adjacent to the Work that may have been disturbed by construction operations.

E. Any repairs required because of unsatisfactory backfill operations shall be at the expense of the Contractor.

3.7 PATENTS

A. The Contractor shall warrant and save harmless the Owner and Engineer against all claims for patent infringement and any loss resulting there from.

3.8 PRIVATE SERVICE LINE SHUTDOWN

A. When it is necessary to shutdown a private sewer service line while work is in progress and before the service lines are reconnected, the residents are to be notified by the Contractor at least one week prior to the shutdown. No sewer or water service is to remain shutdown for more than a period of eight (8) hours unless the Contractor provides substitute services for the residents. Commercial sewer services shall be maintained at all times that the business is open. No sewage from the services or main line shall be allowed to be discharged on the ground or in waterways. Holding pits or tanks are not allowed unless permitted by TDEC.

END OF SECTION

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PART 1 - GENERAL

1.1 SUMMARY

A. The Contractor's portion of sanitary sewer manhole rehabilitation shall include:

1. Rehabilitation of the manhole structure, including manhole chimney, corbel/cone, wall, penetration and base, by sealing with light weight structural reinforced concrete, to improve the structural condition and eliminate infiltration/inflow and improve the surface for a poly urea\urethane resin lining application.
2. Replacement of manhole frames and covers for grade adjustment, frame alignment, poor condition, or for inflow elimination.
3. The inspection and testing of the various types of work to meet compliance.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General:

1. The materials used shall be designed, manufactured and intended for sewer manhole rehabilitation and the specific application in which they are used. The materials shall have a proven history of performance in sewer manhole rehabilitation. The materials shall be delivered to the job site in original unopened packages and clearly labeled with the manufacturer's identification and printed instructions. All materials shall be stored and handled in accordance with recommendations of the manufacturer and the governing agencies. All materials shall be mixed and applied in accordance with the manufacturer's written instructions.

B. Stopping active leaks in concrete and before lining masonry manholes:

1. A premixed fast-setting, volume-stable waterproof cement plug consisting of hydraulic cement, graded silica aggregates, special plasticizing and accelerating agents. It shall not contain chlorides, gypsum, plasters, iron particles, aluminum powder or gas- forming agents, or promote corrosion of steel it may come in contact with. Set time shall be approximately 1 minute. Ten-minute compressive strength shall be approximately 500 psi.
2. A siliconate-based liquid accelerator, field mixed with neat Portland cement. The set time shall be approximately 1 minute.
3. The elastomeric polyurethane resin-soaked method, using dry twisted jute oakum, or resin-rod with polyurethane resin (water activated).

C. Urethane Resin Liner

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1. The urethane resin-based material shall be used to form the sprayed on/ structural enhanced monolithic liner covering all interior surfaces of the manhole including benches and inverts. The finished liner shall conform to the minimum requirements listed below.
    a. Compressive Strength: ASTM D-695 — 14,000 psi
    b. Tensile Strength: ASTM D-638 — 7,000 psi
    c. Shrinkage: ASTM D-2566 — 1/2 of 1 percent
    d. Flexural Strength: ASTM D-790 — 13,000 psi
    e. Bond: — Shall exceed tensile strength of substrate
    f. Flexural Modulus: ASTM D-790 — 735,000 psi
    g. Density: — 81 + PCF
2. The finished manholes shall be corrosion-resistant to: Hydrogen Sulfide; 20 percent Sulfuric Acid; 17 percent Nitric Acid; 5 percent Sodium Hydroxide, as well as other common ingredients of the sanitary sewage environment.
3. The wall of the urethane liner will be designed to withstand the hydraulic load generated by the groundwater table. The long term fifty (50) year value of the flexural modulus of the urethane will be an integral part of the engineering equation used to design the wall thickness of the liner.
    a. For this reason, the long term fifty (50) year value of the flexural modulus of the urethane will be verified by third party independent testing and submitted with the design calculations for each individual structure.
    b. The urethane liner shall have a minimum wall thickness of 250 mils. Liner shall be Spray well or equal.

PART 3 - EXECUTION

3.1 REHABILITATION OF MANHOLE STRUCTURE

A. Procedures:
1. Safety: The Contractor shall perform all work in strict accordance with all applicable OSHA standards. Particular attention is drawn to those safety requirements regarding confined space entry and respiratory protection from airborne particulate materials during cleaning and product mixing and application.
2. Cleaning: All concrete and masonry surfaces to be rehabilitated shall be clean. All grease, oil, laitance, coatings, loose bricks, mortar, unsound concrete and other foreign materials shall be completely removed. Water blasting utilizing proper nozzles shall be the primary method of cleaning; however, other methods such as wet or dry sandblasting, acid wash, concrete cleaners, degreasers or mechanical means may be required to properly clean the surface. All surfaces on which these other methods are used shall be thoroughly rinsed, scrubbed, and neutralized to remove cleaning agents and their reactant products. Debris resulting from cleaning shall be removed from the manhole and not allowed to be carried downstream.

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3. Stopping Infiltration: After surface preparation and prior to the application of mortars and coatings, infiltration shall either be stopped by plugging or chemical grout sealing.
4. Patching: All large holes or voids around steps, joints or pipes, all spalled areas and all holes caused by missing or cracked brick shall be patched and all missing mortar re-pointed using a non-shrink patching mortar. All cracked or disintegrated material shall be removed from the area to be patched or re-pointed, exposing a sound subbase. All cracks not subject to movement and greater than 1/16 inch in width shall be routed out to a minimum width and depth of 1/2 inch and patched with non-shrink patching mortar.
5. Flow Control: The Contractor shall be responsible for plugging or diverting the flow of sewage as needed for repair and lining of manhole inverts and benches. Sewer flow shall be maintained in accordance with Division 33 Section "Sewer Flow Control."
6. Remove all loose grout and rubble from existing channel. Rebuild channel if required by reshaping, repairing slope of shelves or benches. Work shall include aligning inflow and outflow ports in such a manner as to prevent the deposition of solids at the transition point. All inverts shall follow the grades of the pipe entering the manhole. Changes in direction of the sewer and entering branch or branches shall have a true curve of as large a radius as the size of the manhole will permit, but will be shaped to allow easy entrance of maintenance equipment including buckets, T.V. camera, etc.
7. Manhole Steps: Existing manhole steps shall be cut and removed prior to lining if they are deteriorated and/or not serviceable as determined by the Owner.
8. Each lining system shall be installed in accordance with the manufacturer's recommendations to withstand groundwater pressures. For manholes greater than 12 feet in depth, the lining shall withstand the pressures associated with a groundwater depth equal to the manhole depth. Linings for all other manholes shall withstand the pressures associated with groundwater depth of 12 feet. Measure groundwater depth from manhole bench to top of ground surface.
9. The manufacturer's recommended lining thickness shall be based on the ability to withstand groundwater pressure.
10. Application of lining products shall be factory certified applicators.

3.2 URETHANE RESIN LINER

A. Application Temperature: No application of liner shall be made unless temperatures inside the manhole is 50°F or higher.

B. Bench/Invert Repair:
   1. Manhole bench should always be sprayed, but depending on availability and future plans, some judgment consideration will have to be made regarding the invert. Important issue here is the necessity to insure a monolithic system is achieved.
   2. After blocking flow through the manhole and thorough cleaning/ preparatory work has been achieved, the sprayed-on urethane shall be applied to the invert; bench and wall areas in the same manner as specified for the liner application below. The spray shall be applied such that the entire manhole is a structurally enhanced monolithic liner. The

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invert and bench liner thickness shall be the same as that required at the bottom of the manhole walls as determined by the manufacturer's standard engineering calculations for groundwater pressure.

3. The finished invert surfaces shall be smooth, free of ridges and will be sloped in the direction of flow. Special care shall be used to insure a smooth transition between the new manhole invert and intersecting pipeline inverts such that flow will not be impaired.
4. The flow through the manhole shall be re-established as soon as practicable and following the liner manufacturer's recommendation for appropriate curing.

C. Liner Application: The urethane shall be manually sprayed onto all surfaces by a trained technician who is experienced in the application of a spray applied urethane resin and has been certified by the manufacturer. Appropriate personal protection equipment shall be utilized.

D. Curing: A minimum of 30 minutes curing time after the completion of spraying shall be allowed before subjecting the manhole to active flow. A minimum of 3 hours curing time or until all sprayed materials have returned to the ambient temperature of the manhole interior shall be allowed before performing the vacuum method test on the manhole. In extremely cool weather, the manhole shall be protected while curing is in progress to maintain temperatures of 50°F or higher.

3.3 RESET AND RESEAL MANHOLE FRAME AND COVER, REINSTALLATION OR REPLACEMENT

A. The Contractor shall remove the existing manhole frame and cover and, if they are not being reused, dispose of them as directed by the Owner. It shall be the responsibility of the Contractor, at no additional cost to the Owner, to repair any damage to the chimney or corbel caused by the removal of the existing manhole frame.

B. If the manhole frame is to be raised, new precast concrete grade rings or wedge adjustment rings shall be installed to enable the frame and cover to meet the new grade. The wedge adjustment ring shall be the Pro-Ring 40 Series Grade Ring by Cretex. The manhole cover may also be raised to meet the grade by installing an approved steel or iron manhole adjusting ring in the top of the existing manhole frame.

C. The manhole frame for the cover shall be set on the manhole sidewall in a full cement mortar bed, at the required elevation. Where manholes are constructed in paved areas or fill slopes, the surface of the frame and cover shall be tilted so as to conform to the exact slope, crown and grade of the existing pavement or area adjacent thereto.

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D. Existing frames and covers that are to be reused shall be thoroughly cleaned before reinstallation. The Contractor shall then install the new or reused frames so that the top of the covers are at the required grade in a manner described in paragraph “D” above. An external frame-sidewall seal shall be installed. A flexible seal shall be installed at the manhole frame- sidewall interface. The seal shall be an external corrugated elastomeric sleeve shall be installed with external bands after setting frame. Field measurements or accurate information, as detailed in the seal manufacturer's recommended procedures, shall be determined to obtain the proper size and shape of the seal.

E. The contact surfaces for the sleeve shall be circular, clean, reasonably smooth, and free of loose material and excessive voids. If the masonry surface is rough or irregular and will not provide an effective seal, it shall be smoothed with mortar. A bed of butyl rubber caulk shall be applied to the sealing surface of the sleeve to fill minor irregularities in the masonry surface. After the sleeve has been placed in proper position, the bands are positioned and individually tightened or expanded as required to provide a watertight seal. Detailed installation instructions shall be in accordance with the manufacturer's instructions.

F. Any new manhole frame and cover replacement shall result in a minimum 24 inches diameter clear opening to the manhole.

3.4 MANHOLE REHABILITATION ACCEPTANCE

A. After the manhole rehabilitation work has been completed, the manhole shall be visually inspected by the Contractor in the presence of the Resident Project Representative and the Work shall be found satisfactory to the Resident Project Representative. Internal manhole frame-chimney seals shall be inspected to ensure that the sleeve is tight against the manhole surfaces, that no voids (leakage points) exist under the sleeve and that the bands and locking nuts are tight. In addition, at the Owner's request, the Contractor may be required within two years to visually inspect the manholes that were rehabilitated. Any work that has become defective shall be redone by the Contractor.

B. Vacuum Testing:

1. When the manhole rehabilitation method called for results in sealing, patching or lining the entire inside of a manhole, vacuum testing will be required. This will include stopping active leaks, patching and filling non-leaking holes and cracks, polymer and epoxy coating systems, poured-in-place concrete manhole liners and prefabricated manhole liners.
2. The Vacuum Testing Method Shall Be Conducted as Follows: All incoming and outgoing sewer and service lines shall be plugged, the plugs restrained and the vacuum tester head placed on the manhole frame and sealed. A vacuum of 10 inches Hg shall then be drawn on the manhole and the time measured for the vacuum to drop to 9 inches Hg.

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This time shall not be less than 40, 50, or 60 seconds for manhole diameters of 48, 60, and 72 inches respectively. For manholes deeper than 20 feet, the test times shall be increased by 2 seconds per foot of additional manhole depth.

3. If the manhole or structure fails the vacuum test, the Contractor shall perform additional repairs and repeat the test procedures until satisfactory results are obtained.
4. After the manhole rehabilitation work has been completed, the manhole shall be visually inspected by the Contractor in the presence of the Resident Project Representative and the work shall be accepted if found satisfactory to the Resident Project Representative. The finished surface shall be free of blisters, “runs” or “sags” or other indications of uneven lining thickness. No evidence of visible leaks shall be allowed. In addition, at the Owner’s request, the Contractor may be required within two years to visually inspect the manholes that were rehabilitated. Any work that has become defective within the two year period shall be redone by the Contractor at no additional expense to the Owner.

END OF SECTION

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PART 1 – GENERAL

1.1 DEFINITIONS

A. Methods of trenchless installation:

1. Bore and Jack (auger boring): A trenchless method that utilizes a rotating cutting head and augers to excavate material along a predetermined alignment. The excavation, generally 6 inches ahead of the casing pipe being jacked simultaneously, occurs by an auger placed within the encasement. The spoil material is removed through the open end of the casing pipe. Pipe diameter range: 12 inches through 48 inches; maximum distance: 300 feet.

2. Directional Drilling: A trenchless method that consists of a multi-stage process to excavate and install a pipeline. A pilot bore is drilled along the predetermined alignment. Drilling fluid is usually injected to minimize friction and prevent collapse of the bore hole. Typically, a radio signal from a transmitter located in the drill bit head indicates depth and alignment. The initial pilot bore can be adjusted by means of hydraulics until it reaches the termination point. The pilot bore is then replaced by a reaming device and pulled back through the initial bore alignment. The pipe material is attached to the reaming device and is pulled into the ground during the back reaming process. Pipe diameter range: 4 inches through 72 inches; maximum distance: 2,000 feet.

3. Microtunneling: A trenchless method similar to the bore and jack method with the exception that it is remotely controlled. The guidance system provides control of the steering head. Stability to the excavation face is provided by applying mechanical or fluid pressure to counterbalance earth and hydrostatic pressures. Pipe diameter range: 12 inches through 180 inches; maximum distance: unlimited.

4. Pipe Ramming: A trenchless method using a pneumatic ramming tool to push a casing pipe through subsurface material, usually soil. The process effectively swallows the subsurface material into the interior of an open-ended casing pipe and is later removed by pneumatic or auger means. Pipe diameter range: 4 inches through 80 inches; maximum distance: 200 feet.

5. Tunneling: A trenchless method requiring hand mining or drilling equipment, such as a tunnel boring machine (TBM), to excavate a predetermined alignment. Liner plates are installed as support for the open area. Tunnel diameter range: 48 inches through 192 inches, maximum distance: unlimited.

6. Pipe Bursting: A trenchless method used to replace and upsize existing utilities. The method requires that the utility be temporarily abandoned to conduct work. A cutting

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head is pulled through the existing pipeline effectively displacing the fragments of the pipeline into the surrounding soil while simultaneously pulling a new pipeline into place behind it. Pipe diameter range: 4 inches through 54 inches, maximum distance: pressure pipe – fitting to fitting, gravity pipe – structure to structure.

B. Carrier Pipe: utility pipe in excess of 2 inch in diameter.

C. Service Pipes: utility pipe ranging in diameter from ¾-inch to 2 inches.

1.3 SUBMITTALS

A. Product Data:
   1. Carrier pipe
   2. Casing pipe
   3. Casing spacers
   4. End seals
   5. Liner plates
   6. Tunnel liner grout
   7. Casing and tunnel pipe filler material
   8. Backfill for abandoned casings and tunnels
   9. Utility identification sign

B. The Contractor shall prepare a schedule for the Work and submit it to the Owner for approval. The schedule shall include all major tasks to be performed including the following:
   1. Equipment mobilization and setup
   2. Pipe assembly
   3. Pilot hole drilling (directional drilling)
   4. Pre-reaming (directional drilling)
   5. Pre-testing and pigging pipe before installation
   6. Pipe pulling (directional drilling)
   7. Testing and pigging pipe after reinstallation
   8. Restoration and demobilization

1.4 QUALITY ASSURANCE

A. The Contractor shall have a representative who is thoroughly knowledgeable of the equipment, boring, and jurisdictional Agency procedures present at the job site during the entire installation and available to address immediate concerns and emergency operations.

B. Provide a record of the advancement of the casing or carrier pipe. The log shall indicate the distance traveled and depth below existing grade over the entire length at 5-foot intervals.

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C. Conduct survey of finished work to ensure alignment of casing or carrier pipe is within specified tolerances.

D. Provide compaction testing of backfills and embankment, if required, as part of the field quality control for the carrier pipe being constructed. Assure that at least one compaction test site occurs at each pit.

E. Do not remove failed casing, liner plate, or carrier pipe from bore or tunnel alignment. Upon unsuccessful installation of casing or carrier pipe, backfill pipe or tunnel per the requirements of Part 2.

F. Provide three copies of complete record drawings for each utility pipeline crossing. Drawings shall include plan view and profile view.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipe, casing, and accessories to jobsite in accordance with manufacturer's recommendations.

B. Accessory items shall be in manufacturer's original, unopened packaging. Store and protect materials in accordance with manufacturer's recommendations.

PART 2 – PRODUCTS

2.1 CARRIER PIPE

A. The carrier pipe within the casing pipe shall be restrained joint and used to convey water, sewage, or other medium.

B. Refer to Division 33 Section Sanitary Sewer (Gravity) and Sewage Force Main for acceptable materials. Refer to project Drawings for material type and identification.

2.2 SERVICE PIPE

A. The service pipe within the casing pipe shall be used to convey water, sewage, or other medium.

B. Refer to Division 33 Section "Sanitary Sewer (Gravity)" for service pipe materials. Refer to the Drawings for material type identification.

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2.3 CASING PIPE FOR UTILITY PIPELINES

A. The casing pipe or encasement shall be used for structural integrity of the installation and protection of the carrier pipe. In all instances the casing pipe shall have a minimum nominal diameter 4 inches larger than the greatest outside diameter of the carrier pipe, including the pipe bells. Casing pipe is required under local roadways, state roadways, and railways and meet the requirements of TDOT's Design Guidance and the American Railway Engineering and Maintenance of Way Association's Specifications for Pipelines Conveying Flammable and Non-Flammable Substances, current edition.

B. The casing pipe material shall be as noted on the Drawings and as approved by the Agency having jurisdiction over the area being crossed.

C. The casing pipe shall be new, welded or seamless steel pipe per ASTM A139, Grade B; ASTM A252, Grade 2; or ASTM A53, Grade B. The steel casing pipe shall have a minimum yield strength of 35,000 psi and shall have a minimum wall thickness as shown in the following table:

TABLE OF MINIMUM THICKNESS FOR STEEL CASING		
Casing Pipe Nominal Diameter (in)	**Under Highway Wall Thickness (in)**	**Under Railroad Wall Thickness (in)**
6 through 12	0.250	0.250
14	0.250	0.281
16	0.250	0.281
18	0.250	0.312
20	0.312	0.344
24	0.312	0.406
30	0.375	0.469
36	0.500	0.532
42	0.500	0.625
48	0.625	0.688
54	0.625	0.781
60	0.625	0.844
66	0.625	0.938
72	0.750	1.000

D. When the steel casing pipe is installed without the benefit of a protective coating, the wall thickness should be increased to the nearest standard size, which is a minimum of 0.063 inches greater than the thickness indicated in the Table.

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E. For directional drilling applications, and as approved by WMD, the casing pipe may utilize new, welded, or seamless high density polyethylene (HDPE) type DR 11 per ASTM D3350-02.

2.4 CASING PIPE FOR UTILITY SERVICES

A. The casing pipe shall be used for structural integrity of the installation and protection of the service pipe.

B. Utility service casing pipe material shall be new Schedule 40 PVC unless otherwise indicated on the Drawings.

2.5 CASING SPACERS

A. Casing spacers/isolators shall be installed on any carrier pipe passing through a casing pipe or tunnel. They are designed to support and protect the carrier pipe, and electrically isolate the carrier pipe from the casing pipe. Casing spacers are not required when HDPE carrier pipe is used in directional drilling applications that utilize HDPE casing pipe. Casing spacers are not required for service pipe installations.

B. Spacing: Number of spacers and distance between spacers are determined by type of pipe used. Recommended spacing for steel carrier pipe is 6 feet to 8 feet, recommended spacing for PVC pipe is 3 spacers per joint.

C. Band: shall be constructed of minimum 14 gauge 304 stainless, two segment. For carrier pipes 42 inch diameter and larger, bands shall be three or more segments and 12 gauge carbon steel.

D. Risers: shall be constructed of minimum 10 gauge high grade 304 stainless steel. Risers shall be sized to position the carrier pipe in the casing, support all loads and provide proper contact for the isolation function.

E. Liner: the casing spacers/isolators shall have a flexible PVC liner of 0.09 inch thickness with a durometer "A" 85-90 hardness and a minimum 58,000 volt dielectric strength.

F. Runners: the runners shall be of high pressure molded glass reinforced polymer with a minimum compressive strength of 18,000 psi, 2 inch in width and a minimum of 7 inches long. Polyethylene runners are not acceptable. The runners shall be attached to the band or riser by welded stainless steel studs and lock nuts which shall be recessed far below the wearing surface on the runner. The recess shall be filled with a corrosion inhibiting filler.

G. Hardware: the band sections shall be bolted together with 304 stainless steel studs, nuts and washers. Hardware shall be 5/16-inch for pipes up to 42-inch diameter and 3/8-inch for

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carrier pipes 42-inch and larger.

2.6 END SEALS

A. End seals shall be used to effectively seal the casing pipe to the carrier pipe at each end of the casing pipe prior to backfilling.

B. Material: shall be made of 1/8-inch thick synthetic rubber and use stainless steel bands and clamps to secure each end to the casing and carrier pipes.

2.7 LINER PLATES

A. The tunnel liner plate shall be of structural quality, hot-rolled, carbon-steel sheets or plates in conformance with ASTM A1011. The steel liner plate shall have a minimum thickness of 12 gage.

B. The tunnel liner plate submittal should specify either smooth or corrugated, number of flanges, exterior coating, and width of plate.

2.8 TUNNEL LINER GROUT

A. Cement grout shall consist of a uniform mixture of 1:6 (cement:sand). Completely fill all voids using a pumping system. The compressive strength at 28 days shall be 100 psi, minimum.

2.9 CASING AND TUNNEL PIPE FILLER

A. The space between the casing pipe and the carrier pipe should not be filled completely to avoid transfer of earth and live leads from the casing to the carrier pipe.

B. Material: fill sand, flowable mortar, or controlled low strength material. Refer to tables for approximate quantities.

C. Compressive strength of flowable mortar at 28 days: 100 psi to 200 psi.

TABLE OF QUANTITIES FOR FLOWABLE MORTAR	
Material Type	**Quantity per Cubic Yard**
Cement	100 lbs
Fly ash	300 lbs
Fine aggregate	2,600 lbs

D. Compressive strength of controlled low strength material at 28 days: 50 psi.

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TABLE OF QUANTITIES FOR CONTROLLED LOW STRENGTH	
Material Type	**Quantity per Cubic Yard**
Cement	50 lbs
Fly ash	250 lbs
Fine aggregate	2,910 lbs

2.10 BACKFILL FOR ABANDONED CASINGS AND TUNNELS

A. The space between the casing pipe and carrier pipe should be filled completely to avoid settlement of casing due to earth and live loads.

B. Material: 3,000 psi minimum Portland cement concrete, flowable mortar, or controlled low strength material. Refer to tables above for approximately quantities.

C. Compressive strength at 28 days: 100 psi to 200 psi – refer to the above tables.

D. Compressive strength at 28 days: 50 psi – refer to the above tables.

2.11 UTILITY IDENTIFICATION SIGN

A. Provide a utility identification sigh for each end of a casing pipe or tunnel. Provide additional signs as shown on the Drawings.

B. Post: The post shall be constructed of composite material and have dimensions of 66-inches high by 4 inches wide. The marker post shall be pigmented throughout based upon the utility type.
   1. Water – blue
   2. Sanitary sewer – green
   3. Reclaimed – purple

C. Sign: The post shall have a sign affixed to it. The sign shall be constructed of powder coated steel. The overall dimensions of the sign shall be 6-inches by 6-inches. The following information shall be engraved upon the sign:

   Warning: Utility Water/Sanitary sewer/Reclaimed Crossing
   Contact: City of Franklin Water Management Department
   Phone: 615-794-4554

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D. The marker and sign shall be guaranteed in quality for 15 years against deterioration and discoloring.

PART 3 – EXECUTION

3.1 SCOPE OF WORK

A. The Contractor shall select a method of trenchless installation which is appropriate for anticipated subsurface conditions; will allow the pipe to be installed to the desired line and grade as specified; and will prevent heaving or settlement of the ground surface or damage to nearby facilities.

B. All borings and tunnels shall be accomplished by one of the specified and approved trenchless installation methods; and shall meet the size, line, and grade shown on the Drawings.

C. All trenchless installation work shall be done in accordance with Agencies having jurisdictional authority over the utility being crossed. Contractor shall notify the jurisdictional agency a minimum of three business days prior to the start of trenchless activities.

D. Contractor shall protect all existing utilities and facilities in the work area.

E. Upon successful installation of casing or carrier pipe based on tolerances stated herein, backfill said pipe or tunnel per the requirements of Part 2 of this Section.

F. Verify suitability of excavated materials for reuse as backfill per Section 31 0000. Remove and stockpile topsoil for subsequent reuse. Do not mix topsoil with other excavated materials. Remove rock, rubbish, debris, and unsuitable materials. Excavate the minimum size pits necessary to safely and properly perform the work.

G. Comply with requirements of Division 31 Sections “Dewatering” and “Excavation Support and Protection” as necessary.

H. Clean up all affected sites and restore all areas to pre-construction or better condition.

3.2 ACCEPTABLE TRENCHLESS INSTALLATION METHODS

A. Bore and Jack (Auger Boring):
   1. Excavate a suitable sized pit to accommodate the equipment. Provide adequate walkway and workspace on each side of the auger and jacking equipment. The Contractor shall furnish and install trench shoring or bracing in compliance with OSHA standards.

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2. Provide continuous pressure to the face of the excavation to balance groundwater and earth pressures.
3. The carrier pipe shall be furnished by the Contractor. Jack the steel casing pipe into place as the boring proceeds. Ensure that the end of casing is true. Completely weld sections of pipe to provide watertight joints.
4. Upon acceptance of the casing, install the carrier pipe in the casing by jacking it through the casing. If necessary to achieve proper line and grade on the carrier pipe, use blocking material to offset any minor variations in the alignment of the casing. Otherwise, casing spacers shall be used for all pressure main installations. Spacers shall be installed 1 foot from each end of each pipe joint and at the midpoint of each pipe joint. The carrier pipe shall be restrained by the spacer within the casing.
5. Both ends of casing pipe shall be sealed with synthetic rubber end seals with stainless steel band and clamps.
6. Tolerances:
    a. Bore accuracy shall be within ±1% (both horizontally and vertically) of the total borehole length.
    b. The borehole shall follow the design centerline of the pipe profile and alignment described on the Drawings. At no point in the bore will the combined radii in the plan and profile exceed the allowable minimum radius of the pipeline manufacturer.

B. Directional Drilling:
1. Drilling until shall be equipped with an electrical strike safety package and shall be tested upon setup of the job.
2. Drill a pilot bore with the designed tolerances for radius requirements. The pilot bore shall be monitored using instrumentation which will accurately locate the pilot bore positions in the X, Y, and Z axes relative to the ground surface.
3. The enlargement of the hole to accommodate the carrier pipe shall be accomplished by the ream and pull back method:
    a. Prereaming: Prereaming operating shall be conducted at the discretion of horizontal drilling Contractor. All provisions of this specification relating to simultaneous reaming and pulling back operations shall also pertain to prereaming operations.
    b. Pulling Loads: Contractor shall be responsible for determining safe pulling loads required for proper installation. Such loads shall be minimized as required to prevent failure of the pipeline during installation.
    c. Torsional Stress: A properly sized and fully operational swivel will be installed between the reaming assembly at the end of the drill pipe, and the pipeline to restrict torsional stress from being transmitted to the pipeline.
    d. Pull Section Support: The pull section shall be supported as it proceeds during pull back so that it moves freely, and the pipe material is not damaged.
4. Tolerances:
    a. A smoothly drilled pilot hole shall follow the design centerline of the pipe profile and alignment described on the Drawings. At no point in the bore will the combined radii in the plan and profile exceed the allowable minimum radius of the pipeline manufacturer.

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b. The course of the pilot hole must stay within the given right-of-way at all points along the drilled route. Contractor shall provide and use a separate steering system employing a ground survey grid system, such as "Tru-Tracker".
c. The Contractor shall have accurate working gauges which register the tensile force being used to pull the pipeline back through the reamed borehole. It is the Contractor's responsibility to prepare the reamed out hole such that pulling back operations do not exceed the tensile strength of the pipe. The Contractor shall provide estimated calculations for the pulling loads and allowable loads before pull back operations begin. If during the pipeline pulling process this force exceeds 75 percent of this allowable load for the pipeline, the project inspector must be notified immediately. Logs must be kept intact referencing all forces exerted on the pipeline during pullback.
d. The Contractor shall provide adequate supports along the stringing area to protect the pipe and allow free movement of the pipeline during pullback.
e. During pullback operations, Contractor shall monitor roller operation and use sidebooms, if required, to assist movement of the pipe. Situations which could cause damage to the pipe material shall be corrected immediately. Damaged pipe shall be repaired to the satisfaction of the Owner or replaced by the Contractor before pulling operations resume.

C. Microtunneling:
1. Excavate suitable sized pits to accommodate the tunneling equipment at entrance and exit of proposed microtunnel bore. The Contractor shall furnish and install trench shoring or bracing in compliance with OSHA standards.
2. Excavate the tunnel using a steerable, laser guided tunnel boring machine remotely controlled and monitored from the surface by the operator at all times. Functions of the system to be monitored at the remote console shall include rate of advance, length of conduit installed, thrust force, deviation from line and grade, roll, inclination, and valve positions.
3. Excavation of tunnel shall take place within the tunneling shield. Personnel should not enter the excavation. The tunnel shield shall be full faced with the capability of supporting the face both during excavation and during shutdown. When soil conditions dictate, the tunnel shield must be capable of removing cobbles and boulders. The excavation system shall be fully capable of excavating all material that it will encounter.
4. The jacking system, including any intermediate jacks used, shall be capable of continuously monitoring the jacking pressure, the rate of advancement and the distance jacked. The equipment shall have the capability of limiting the jacking force applied to the pipe/tunnel shield so as not to exceed the maximum compressive loads allowed for the pipe. A lubrication system shall be provided that injects an approved lubricant at the rear of the tunneling shield to lower the friction developed on the exterior of the pipe during jacking.
5. The spoil can be removed from inside the pipe or casing by auger, compressed air, or water jetting.
6. Tolerances:
   a. Microtunnel accuracy should be within ± 1 inch (both horizontally and vertically).
   b. The borehole shall follow the design centerline of the pipe profile and alignment

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described on the Drawings. At no point in the bore will the combined radii in the plan and profile exceed the allowable minimum radius of the pipeline manufacturer.

D. Pipe Ramming:
   1. Excavate suitable sized pits to accommodate equipment at entrance and exit of proposed tunnel bore. The Contractor shall furnish and install trench shoring or bracing in compliance with OSHA standards.
   2. Set guide rails to line and grade of proposed bore. The first section of pipe or casing shall be equipped with a steel band around the leading edge to over excavate the bore and reduce friction on successive sections.
   3. Install steel pipe casing using a pneumatic tool hammer to push the pipe or casing into the ground. The leading edge of the pipe shall be left open for most applications, allowing the soil to enter the pipe or casing. The leading edge can be closed for pipe casing diameters of 4 inches or less.
   4. Remove spoil from inside of pipe casing by auger, compressed air, or water jetting.
   5. Tolerances:
      a. Pipe ramming bore accuracy should be within ±5% (both horizontally and vertically) of total bore length.
      b. The bore shall follow the design centerline of the pipe profile and alignment described on the Drawings. At no point in the bore will the combined radii in the plan and profile exceed the allowable minimum radius of the pipeline manufacturer.

E. Tunneling:
   1. Excavate suitable sized pits/shafts to accommodate the equipment at entrance and exit of proposed tunnel bore. The Contractor shall furnish and install trench shoring or bracing in compliance with OSHA standards.
   2. Excavate a utility tunnel using a tunnel boring machine (TBM) and conventional methods. Excavation of tunnel shall take place within tunneling shield. Tunneling shield shall be of steel construction and sufficient length to install one complete ring of liner plates before it is advanced for the installation of the next ring of liner plates.
   3. Liner plate must be constructed in-place in the tail section of the tunneling shield. Liner plate shall have tapped grout holes of minimum 2 inch diameter, spaced at approximately 3 feet along the circumference of the tunnel. The grout holes shall be spaced 4 feet longitudinally along the tunnel course.
   4. Inject grout through liner plate grout holes. Grout holes shall be plugged when grouting is completed.
   5. Install utility carrier pipeline after tunnel is complete and fill remaining annular space completely with filler. Carrier pipe must be able to withstand potential earth loads transferred to the pipe after the annular space is filled with filler.
   6. Tolerances:
      a. Tunnel accuracy shall be within ±1.0 feet horizontally and ±0.1 feet vertically.
      b. The borehole shall follow the design centerline of the pipe profile and alignment described on the Drawings. At no point in the bore will the combined radii in the plan and profile exceed the allowable minimum radius of the pipeline manufacturer.

F. Pipe Bursting:

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1. Pipe Bursting shall be conducted using Horizontal Directional Drill (HDD)/Impactor, pneumatic, hydraulic or static pipe bursting systems. The pipe bursting unit shall be designed and manufactured to force its way through the existing line by fragmenting the pipe and compressing the broken pieces into the surrounding soil as its progresses. The bursting unit shall generate sufficient force to burst and compact the existing pipeline. See manufacturer specifications for what size unit should be used in what diameter of pipe, as well as parameters of what size unit for percentage of upsize allowed.
2. The HDD or winch should be fitted with a direct reading load gauge to measure the pullback force or winching load. The Contractor shall provide a system of guide pulleys and bracing at the exit pit to minimize cable contact with the existing line between launch and exit pits. The winch cable, burst head, and polyethylene pipe cannot come into contact with the supports of the trench shoring in the insertion pit.
3. All buried utilities adjacent to the pipe bursting operation shall be reviewed and where necessary be excavated to relieve transient loading during the insertion operation. If any utilities are within 24 inches of the pipe to be burst, the Contractor shall excavate a pit at the location to check clearance. The amount of clearance will be affected by the soil type, the amount of up-sizing and the location of the existing utility in relation to the line being burst. If adequate separation does not exist between the existing line and the subject utility, the Contractor shall employ substitute means to rehabilitate the existing line.
4. Any concrete encasements and/or PVC point repairs shall be excavated and broken out prior to the bursting operation to allow the steady and free passage of the pipe bursting head. All in-line valves and fittings shall be removed prior to the bursting operation.
5. The new polyethylene pipe shall be inserted immediately behind the bursting head in accordance with the manufacturer's recommended procedures. The bursting equipment shall be specifically designed and manufactured for the type of insertion process being used. The insertion pit shall be long enough to avoid imposing a bending radius of less than 35 times the outside diameter of the pipe liner during installation.
6. The polyethylene pipe shall be assembled and joined at the site using the butt-fusion method to provide a leak proof joint. Threaded or solvent-cement joints and connections are not permitted. All equipment and procedures used shall be in strict compliance with the manufacturer's recommendations. Fusing shall be accomplished by personnel certified as fusion technicians by a manufacturer of polyethylene pipe and/or fusing equipment. In cases where the insertion pit is not a manhole, the liner pipe may be joined by use of a stainless steel full encirclement clamp or the installation of a new manhole. Details of the recommended lengths of such clamps to afford adequate pullout protection are summarized as follows:

Inner Diameter of Liner Pipe (inches)	Minimum Width of Clamp (inches)
8.0	15
12.0	20
15.0	30

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18.0	30

7. Any annular space between the existing pipe and the liner shall be filled with cement grout in accordance with Paragraph 2.6. Precautions shall be taken to prevent collapse of the liner with grouting pressure. Either place the grout under very low pressure, or hydrostatically pressurize the liner pipe during the grouting process to resist collapse.
8. At all points where the polyethylene pipe is exposed (such as at insertion shafts, at service connection fittings, or other points where the existing pipe must be removed), the polyethylene pipe shall be encased in a cement-stabilized sand or high density material to prevent deflection due to earth loading or subsidence. Material should be in accordance with the cement grout described in Paragraph 2.6.
9. After installation of the polyethylene liner pipe, a minimum of 6-inches of the liner pipe shall be left to protrude from the wall of the entrance and exit pits prior to relaxation. A minimum 48 hour relaxation period (longer if recommended by the manufacturer) shall be required to allow the pipe to stabilize. After the relaxation period, the protruding ends of the pipe shall be neatly trimmed back to fit the structure or match up to other equipment and materials. Allow a slight flaring of the material so that the liner will not pull away from the opening and retract into the original pipe.
10. Pressure test the polyethylene pipe in accordance with the contract document Section applicable for the pipeline intent.
11. Service connections to the polyethylene pipe shall be accomplished by the sidewall fusion method in accordance with the manufacturer's instructions. Refer to Division 33 Section “Sanitary sewer (Gravity)” for service connection materials.
12. Dimension Ratios: The minimum wall thickness of the polyethylene pipe shall meet the following:

Depth of Cover (feet)	Minimum SDR
0 – 16	21
> 16	17

3.3 MANAGEMENT OF CUTTINGS AND FLUIDS

A. The approved methods of trenchless installation are to be conducted in a manner to eliminate the discharge of water, drilling mud, and cuttings to the creeks or land areas involved during the construction process. Contractor shall immediately contain and clean-up any inadvertent returns. Contractor shall also provide equipment and procedures to maximize the recirculation or reuse of drilling mud to minimize waste disposal.

B. Disposal of drilling and cutting fluids shall be responsibility of the Contractor and shall be conducted in compliance with all relative environmental regulations, easement and work space agreements, and permit requirements.

C. Water supply is the Contractor’s responsibility, whether purchased locally, or hauled in.

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D. Drilling and cutting fluids must be free of all additives that will adversely affect the environment.

E. Adequate dewatering of all excavations and tunnels is the Contractor's responsibility unless otherwise stated.
   1. Take measures to prevent surface water from entering excavation.
   2. Pump surface water and groundwater from excavation or tunnel, of necessary.
   3. Discharge water may not be discharged to adjacent property without written permission from the property owner.
   4. Excavation discharge water should not interfere with vehicular traffic and must be directed away from adjacent electrical facilities.
   5. Sanitary sewers are not an acceptable option for disposal of discharge water.
   6. Erosion control measures should be taken to protect the discharge location(s), if applicable.
   7. Adjacent structures should be monitored for subsidence as a result of dewatering, if applicable.

3.4 CLEANUP, REPAIRS, AND RESTORATION

A. The Contractor is responsible for leaving all areas affected by his construction activities in a condition equal to or better than the condition before construction.

B. All carrier pipe beyond the end of casing pipe as well as in entry and exit pits shall be bedded and backfilled in accordance with Division 31 Section "Earthwork".

C. The Contractor shall restore area around entry and exit pits within 1 day of work completion. Fill to previous existing ground elevation and grade any areas where settlement occurs due to subsidence.

D. Install a utility identification sign above ground at each end of the casing or tunnel. If the utility has been installed without a casing or tunnel, install utility identification signs as shown on the Drawings.

END OF SECTION

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PART 1 - GENERAL

1.1 SUBMITTALS

A. Product Data:
   1. Tapping Saddles
   2. Corporation Valves
   3. Service Pipes
   4. Line Setters
   5. Water Meters
   6. Meter Boxes

PART 2 - PRODUCTS

2.1 TAPPING SADDLE

A. Tapping saddles shall have double straps or a double wide band and shall be suitable for use with the various pipes at the installation point (i.e. will not cause electrolysis). For ¾-inch to 2-inch services use a tapping saddle.
   1. Manufacturer / Model:
      a. Smith-Blair Double Bale Model 313,
      b. Mueller BR2B,
      c. Ford Meter Box Style 202B,
      d. Approved equal.

2.2 CORPORATION VALVE

Corporation valve shall be designed and manufactured to conform to AWWA C800-84 and ASTM B-62 which cover thread dimensions, metal alloy (red brass: 85-5-5-5), and pressure rating. Inlet threads shall be AWWA Taper Thread CC. The outlet shall be suitable for the service piping required. Corporation valve shall be connected into the water line/main with a tapping saddle. Corporation valve shall be ball valve type suitable for pressures up to 300 psi.

1. Manufacturer / Model:
   a. Ford Meter Box F1000 for ¾-inch and 1-inch
   b. Ford Meter Box FB1000 for 1 ½-inch and 2-inch
   c. Mueller B-20046N
   d. Approved equal.

2.3 SERVICE PIPE

A. Service pipe and fittings, sizes 3/4-inch through 3- inch, shall be of the following material(s):
   1. HDPE:
      a. Pipe produced from PE4710 Virgin HDPE resins in accordance with ASTM D2737.
   2. Polyethylene tubing as approved by WMD

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3. Approved equal

2.4 WATER METER

A. Water meters 2-inch and below shall be provided by WMD. Water meters ¾" and 1" shall be Sensus iPERL.

B. Water meters larger than 2-inch shall be provided by the contractor and as approved by WMD. Meters larger than 2 inches may be installed by the WMD but at the Contractor's expense.

C. Water meters 1 1/2-inch and larger shall be cold water turbine type meeting all requirements of ANSI/AWWA C701 or C702 as determined by the WMD. Meter registers shall be straight reading in U.S. gallons and be equipped with a device to afford capability for accurately testing the meter in accordance with AWWA Standards. The meters shall be equipped with a removable corrosion resistant strainer screen between the outer case and measuring chamber. At a minimum, meters shall be rated to withstand a pressure of 150 psi. All meters shall be equipped with Radio Read Technology (SmartPoint 520M).

D. Manufacturer / Model:
   1. Sensus Omni Turbo

2.6 METER BOX

A. Meter boxes shall be rectangular, open bottom with service pipe notches constructed of high density polyethylene. Meter boxes shall be sized based on the meter size and other appurtenances to be included within the box. The meter box lid shall be purple.
   1. Manufacturer / Model:

Meter Size	Meter Box	Meter Lid
¾"	Sigma-Raven RMB132418-SW*	Sigma RMB – purple lid*
1"	Sigma-Raven RMB132418-SW*	Sigma RMB – purple lid*
1 ½"	Sigma-Raven RMB173018-SW*	Sigma LC 1730T-D - purple*
2"	Sigma-Raven RMB173018-SW*	Sigma LC 1730T-D - purple*

*Or approved equal

2.7 LINESETTER

A. Meters shall be installed with a linesetter manufactured in compliance with ANSI/AWWA C800 (latest revision). The linesetter shall have lead free solder joints and factory air tested under water at 85 PSIG. The line setter shall include a check valve lockwing ball style meter valve.

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B. Manfacturer/Model:
   1. McDonald 720 Series Meter Setter
   2. Approved equal

PART 3 - EXECUTION

3.1 PREPARATION

A. No taps shall be made without approval by the Owner.

B. Existing service assemblies and meter boxes shall be replaced by new equipment unless otherwise directed by the Drawings or Owner.

3.2 INSTALLATION

A. In general, install the meter box as near the property line as possible within the public right-of- way. Set plumb approximately 1 inch above the existing or proposed grade and so that the surface drainage will not enter it. Fill from the existing or proposed grade to the top of the meter box at a slope of 1:12. When the cut or fill slopes extend beyond the public right-of-way, install the meter box at the top or toe of slope, as applicable.

B. Where existing water service is proposed to be interrupted by the abandonment/ retirement of an existing water line, Contractor shall reconnect service pipe to the new water line unless otherwise directed by the Drawings or Owner. Service assembly renewal shall be done after successful leakage and bacteriological testing of the new water line has been completed.

C. Service pipe proposed to be installed under paved roads shall be done utilizing trenchless installation methods, unless otherwise directed by the Drawings or Owner. If rock is encountered, the governing roadway Agency should be contacted regarding open cutting the road to install the service pipe. Backfill and pavement repair requirements of the governing roadway Agency shall be followed. In some cases, the proposed service pipe crossing may need to be relocated. Minimum service pipe cover shall be the 36 inches under roadways.

D. Service pipe proposed to be installed parallel to a roadway shall have a minimum pipe cover of 30 inches.

E. Service pipe shall be installed at a minimum depth of 24 inches from the corporation valve to the meter box.

F. After the service pipe and line setter are installed, turn water on service pipe between meter setter and main, blowing any accumulated trash out of the service pipe.

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G. The service pipe shall not be tight from corporation valve to curb valve.

H. Line setter shall be installed in the bottom of the meter box so that the meter is centered and level in the meter box.

END OF SECTION

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PART 1 – GENERAL

1.1 DEFINITIONS/STANDARDS

A. The following are industry abbreviations for metal and plastic materials:
   1. PVC – polyvinyl chloride plastic
   2. DIP – ductile iron pipe

B. Buried piping shall be of the bell and spigot type.

C. Non-buried piping shall have flanged ends, unless otherwise noted on the Drawings.

1.2 SUBMITTALS

A. Product Data:
   1. Ductile Iron Pipe
   2. Ductile Iron Fittings
   3. Polyvinyl chloride Pipe
   4. Polyvinyl chloride Fittings
   5. Insert a Tee
   6. Pipe insulation and accessories
   7. Mechanical joint restraint devices
   8. Flanged coupling adapters
   9. Flexible expansion joint
   10. Line markers
   11. Utility warning tape
   12. Detection wire

1.3 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of piping and specialties and are based on the specific system indicated.

B. Comply with regulatory requirements of local, state and federal agencies having jurisdiction.

C. Piping material shall bear label, stamp, or other markings of specified testing agency.

D. Comply with ASTM specifications for materials.

E. The pipe manufacturer must furnish the Owner a notarized certificate stating that the pipe furnished has been manufactured and tested in accordance with the applicable standards and include date of manufacture.

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F. Polyvinyl chloride (PVC) pipe shall have proper markings which include manufacturer's name or trademark, nominal pipe size and size base, pressure rating for water at 73.4 degrees Fahrenheit, PVC cell classification or material code, dimension ratio or standard dimension ratio, AWWA or ASTM designation, and pressure class with which the pipe complies.

G. Customer Inspection:
   1. The Owner, Engineer, and/or Resident Project Representative shall be entitled to inspect pipes and witness the pipe manufacturing.
   2. Manufacturer's Notification to Customer: Should the Owner request to see specific pipes during any phase of the manufacturing process, the Manufacturer must provide the Owner with adequate advance notice of when and where the production of those pipes will take place.

H. Gaskets shall be suitable for service conditions and loads indicated. Conflicts with products listed shall be brought to the Owner's attention before proceeding with ordering materials.

I. Joint lubricant shall be suitable for service conditions and pipe material and as recommended by the pipe manufacturer.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.

B. Storage and Handling:
   1. Protect stored piping from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing inside.
   2. Store plastic piping protected from direct sunlight.
   3. Support to prevent sagging and bending.
   4. Protect flanges, fittings, and specialties from moisture and dirt.

1.5 GENERAL REQUIREMENTS

A. All pipe material for sewer lines shall be approved by the WMD.

B. Shop drawings and manufacturer certification are required for all products specified in this section.

C. Refer to other sections for items affecting gravity sewers. Coordinate this work with that specified by other sections for timely execution.

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D. Each type of gravity pipe and fittings (PVC, DIP, etc.) supplied under this section shall be provided by the same manufacturer, respectively.

E. The minimum pipe size for gravity sanitary sewer mains is 8 inches.

F. Sewers shall be laid with a positive, uniform slope between manholes.

G. The following minimum slopes shall be provided based on diameter of the pipe:

Diameter (inches)	Minimum slope (ft) (per 100 feet)**
8	0.4
10	0.28
12	0.22
15	0.15
16	0.14
18	0.12
21	0.10
24	0.08
27	0.067
30	0.058
36	0.046
42	0.037
48	0.031

**These slopes are based on using Manning's formula with an "n" value of 0.013 and providing a mean velocity of not less than 2 feet per second at the estimated peak flow.

H. Slopes for pipe sizes larger than 48 inches shall be determined on a case-by-case basis and approved by the WMD.

I. A minimum slope of 0.2 percent drop across the bottom of the manhole must be provided to maintain cleaning and the hydraulic gradient. Lesser slopes may be approved on a case by case basis by the WMD.

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J. Sewers on 18 percent slope or greater shall be anchored securely with concrete anchors with the following minimum spacing:

1. Not over 36 feet center to center on grades 18 percent and up to 25 percent
2. Not over 24 feet center to center on grades 25 percent and up to 35 percent
3. Not over 16 feet center to center on grades 35 percent and over

K. Where sanitary sewers are installed in new fill, a compaction letter sealed by a Geotechnical Engineer registered in the State of Tennessee shall be submitted to the Owner prior to installation of said utilities. An acceptable compaction letter shall state that field density testing indicates the fill has been compacted to at least 95% of the maximum dry density according to the Standard Proctor.

L. Sanitary sewer lines located near bodies of water shall not "float". Buoyancy calculations shall be submitted to ensure that the sanitary sewer line will not float. If the sanitary sewer line floats, it shall be anchored.

M. Generally, the following locations should be utilized for location of new sanitary sewer mains unless field conditions such as other utilities, etc., make it impractical to do so:

1. New sanitary sewer mains to be in the center of the roadway where practical unless otherwise approved by the WMD and shall not be located under sidewalks or curb and gutter.
2. Where roadway construction is not feasible, the sanitary sewer main shall be located in easements unless otherwise approved by the WMD.

N. No sanitary sewer main shall be located in a detention basin, water quality pond or other drainage structure. Sanitary sewer pipe and manholes shall not be located in or underneath the dam or dike of the detention basin nor located anywhere within ten feet horizontally of the projected maximum highwater line of the water in the detention basin.

O. Joining two different material types of pipe between manholes will not be permitted.

P. Vertical separation between utilities shall be a minimum of 18 inches. Horizontal separation between utilities shall be a minimum of 10 feet unless otherwise approved by WMD. The WMD may require larger vertical or horizontal separations based on site conditions and the ability to operate and maintain the constructed systems.

Q. In general, pipe materials based on line size and depth of cover are as follows:

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Diameter (inches)	Depth	Pipe Material
≤ 15	≤12’	PVC
≤ 15	>12’	DIP
No lines deeper than 15’ without WMD approval.		

R. All changes in pipe diameters shall be at manholes.

S. The minimum cover for sanitary sewer shall be 3 feet measured at the crown of the pipe. Sanitary sewer within roadway or other traffic areas with less than 4 feet of cover measured at the crown of the pipe shall be ductile iron.

1.6 LATERALS

A. The minimum pipe diameter for a sanitary sewer lateral is 6 inches.

B. Laterals shall generally be located 10' from the water lateral and on the downstream side and/or out of the way of driveways, landscaping, headwalls, etc.

C. Cleanouts shall be located at the property line in a box as approved by the WMD per the Standard Details. If the sanitary sewer main is located on the property to be served, the cleanout shall be located at the edge of the sanitary sewer easement in a box as approved by the WMD.

D. The minimum slope for a sanitary sewer lateral is two (2) percent.

E. The minimum cover for a sanitary sewer lateral is eighteen (18) inches.

F. The sanitary sewer lateral and main shall be the same pipe material.

PART 2 - GENERAL

2.1 DUCTILE IRON PIPE

A. Ductile iron pipe for sanitary sewer use shall have TNEMEC Perma Shield PL Series 431 ceramic epoxy lining or approved equal.

B. Ductile iron pipe shall conform to the requirements of ANSI 21.151/AWWA C151 latest revision for ductile iron pipe centrifugally cast in metal or sand-lined molds. It shall be made

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and tested in accordance with ASTM A536, latest revision. The pipe shall be able to withstand a hydrostatic pressure of 500 psi.

C. The design thickness shall be that specified by ANSI A21.50/AWWA C150 latest revision except that all pipe with a diameter of 16 inches or less shall be thickness Class 50 and all pipe with a diameter 18 inches or greater shall be thickness Class 52 unless determined otherwise by the Owner or Engineer.

D. Coatings and Lining: Pipe shall be lined with TNEMEC Perma Shield PL Series 431 ceramic epoxy lining, a modified polyamine epoxy containing at least 20% by volume of ceramic microspheres for increased abrasion resistance. The outside coating shall be an asphaltic coating approximately 1 mil thick in accordance with ANSI A21.51/AWWA C151. At any point where the TNEMEC Perma Shield PL Series 431 ceramic epoxy lining is damaged or compromised, the coating shall be repaired per TNEMEC standards.

E. The bell of each pipe shall have a tapered annular opening and a cast or machined retaining groove for the gasket. The gasket shall have a flared design so that maximum deflection will be provided. The plain spigot end of the pipe shall be beveled in order to simplify its entry into and centering within the bell and compression of the gasket.

F. Gaskets:
   1. Gaskets shall be Styrene Butadiene Copolymer (SBR) or Ethylene Propylene Diene Monomer (EPDM) in accordance with ANSI A21.11/AWWA C111, latest revision made in the form of a solid ring to exact dimensions.
      a. Push-on Joint Gaskets: The design of the gasket groove in the bell of the pipe and the design, hardness, and other properties of the gasket itself shall be such that the joint is liquid tight for all pressures from a vacuum to a maximum rating of 350 psi of internal liquid pressures. Gaskets for pipe with an operating pressure greater than 160 psi shall be restrained joint gaskets.
         1) Manufacturer / Model:

            a) American Ductile Iron Pipe “Fastite,”
            b) U.S. Pipe “Tyton,”
            c) McWane “Tyton” or
            c) Approved equal.

      b. Push-on Restrained Joint Gaskets: Restrained pipe and fittings are as shown on the Drawings. Retainer glands and similar devices will not be allowed unless otherwise noted or shown on the Drawings or approved by the Owner. Push-on joint restraint shall be incorporated in the design of the pipe bell and gasket. The restraint shall be provided by the wedging action developed between pairs of hardened high-strength, stainless steel elements spaced around the gasket. The push-on restrained joint shall be rated for 250 psi working pressure.
         1) Manufacturer / Model:

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a) American Ductile Iron Pipe "Fast-Grip" (for pipe sizes 24-inch and less),
b) U.S. Pipe "Field Lok" Gaskets (for pipe sizes 24-inch and less),
c) American Ductile Iron Pipe "Flex-Ring" (for pipe sizes 30 and 36 inch),
d) American Ductile Iron Pipe "Lok-Ring" (for pipe sizes greater than 46 inches),
e) U.S. Pipe "TR Flex" (for pipe sizes 24-inch and larger), or
f) McWane "TR Flex" (for pipe sizes 4-inch and larger), or
g) Approved equal.

2. Lubricant: Lubricant shall be furnished with each order to provide for the proper installation of the pipe supplied with said order. This lubricant shall be nontoxic, impart no taste or smell to the water, and have no harmful effect on the rubber gasket. It shall have a consistency that will allow it to be easily applied to the pipe in either hot or cold weather and that will enable it to adhere to either wet or dry pipe.

G. Welded-on Outlets:

1. Welded-on outlets shall be limited to branch outlets having a nominal diameter less than 70 percent of the nominal diameter of the main line pipe or 30-inch whichever is smaller as shown in the following table.

Main Line	**Branch Outlet**
Nominal Diameter	**Nominal Diameter**
10 inch	6 inch
12 inch	8 inch
14 inch	8 inch
16 inch	10 inch
18 inch	12 inch
20 inch	14 inch
24 inch	16 inch
30 inch	20 inch
36 inch	24 inch

2. Parent pipe and branch outlet candidate pipe shall be centrifugally cast ductile iron designed in accordance with ANSI A21.50/AWWA C150 and manufactured in accordance with ANSI A21.51/AWWA C151. Minimum classes shall be: for sizes 4- inch through 12-inch, Pressure Class 350; for sizes larger than 12-inch, Pressure Class 250.
3. Welded-on outlets may be provided as a radial tee outlet, tangential outlet, or lateral outlet fabricated at a specific angle to the main line pipe in 1 degree

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increments between 45 degrees and 90 degrees from the axis of the main line pipe as shown on the Drawings.

4. All welded-on outlets shall be rated for a working pressure of 250 psi and must have a minimum safety factor of 2.0 based on proof of design hydrostatic test results.
5. The joints on welded-on branch shall meet, where applicable, the requirements of ANSI A21.11/AWWA C111 and/or ANSI A21.15/AWWA C115. The joint materials (glands, gaskets, and studs) shall be furnished where applicable.
6. Weldment for welded-on outlets shall be based on the method described in Section VIII of the ASME Unfired Pressure Vessel Code. Reinforcing welds shall be placed using Ni-Rod 55 cored wire or Ni-Rod 55 electrodes manufactured by INCO Alloys (or an electrode with equivalent performance properties). Carbon steel electrodes are not acceptable.
7. Prior to the application of any coating or lining in the outlet area, all weldments for branch outlets to be supplied on this project shall be subjected to an air pressure test of at least 15 psi. Air leakage is not acceptable. Any leakage shall be detected by applying an appropriate soapy water solution to the entire exterior surface of the weldment and adjoining pipe edges or by immersing the entire area in a vessel of water and visually inspecting the weld surface for the presence of air bubbles. Any weldment that shows signs of visible leakage shall be repaired and retested in accordance with the manufacturer's written procedures.
8. Welded-on outlets shall be fabricated by the pipe manufacturer at the same facility where the pipe is produced. The pipe manufacturer shall have a minimum of 5 years of experience in the fabrication and testing of outlets of similar size and configuration.
9. The manufacturer shall have a fully documented welding quality assurance system and maintain resident quality assurance records based on ANSI/AWS D11.2, the Guide for Welding Iron Castings. The manufacturer shall maintain appropriate welding procedure specifications (WPS), procedure qualification (PQR), and welder performance qualification test (WPQR) records as well as appropriate air test logs documenting air leakage tests.

H. Manufacturer:
   1. American Cast Iron Pipe Company,
   2. Griffin Pipe Products,
   3. McWane,
   4. U.S. Pipe, or
   5. Approved equal.

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2.2 DUCTILE IRON FITTINGS

A. Standard and special fittings shall be pressure Class 350 ductile iron. All fittings shall conform to the specifications of ANSI A21.10/AWWA C110 (Full Body) or ANSI A21.53/AWWA C153 (Compact), latest revisions.

B. All buried fittings shall be push-on or mechanical joint. Non-buried fittings shall be flanged unless otherwise shown on Drawings or directed by the Owner. Where flanged pipe is shown, no substitution of a Uni-Flange type joint will be used without prior approval of the Owner. Where push-on joint fittings are used, the fittings must be rodded to an anchor (i.e. dead-man, valve, etc.), have a mechanical joint fitting restraining device, or push-on restrained joint gasket.

C. Coatings and Lining: Fittings shall be lined with TNEMEC Perma Shield PL Series 431 ceramic epoxy lining. This is an amine cured novolac epoxy containing at least 20% by volume of ceramic quartz pigment. The outside coating shall be an asphaltic coating approximately 1 mil thick in accordance with ANSI A21.51/AWWA C151.

D. Manufacturer:
   1. Tyler/Union
   2. American Cast Iron Pipe Company
   3. U.S. Pipe and Foundry
   4. McWane
   5. Approved equal

2.3 POLYVINYL CHLORIDE PLASTIC (PVC) PIPE

A. All PVC pipe shall be SDR 26. PVC plastic pipe shall conform to the latest edition of ASTM Specification D3034 for 4" through 15" diameter pipe, ASTM Specification F679 for 18" through 48" diameter pipe, AWWA C900, and/or AWWA C905, as appropriate; Standard Dimension Ratios (SDR); Maximum Length – 20 feet. PVC Pipe, 3 inches and smaller shall conform to the latest edition of ASTM D 1785 Schedule 80 with solvent weld joints.

B. Joints shall be integral bell and spigot type joints conforming to ASTM D-3139. Elastomeric gasket shall conform to the requirements of ASTM F-477. Gaskets shall be part of a complete pipe section and purchased as such.

C. PVC pipe shall have the pipe stiffness rating of 115 psi.

D. Manufacturer:
   1. Hawk Plastics Corporation,
   2. Vulcan Plastic Corporation,
   3. North American Pipe Corporation, or
   4. Approved equal

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2.4 POLYVINYL CHLORIDE PLASTIC (PVC) FITTINGS

A. PVC fittings shall be constructed of the same plastic material and have the same minimum pressure rating as the pipe being connected. The fittings shall be the molded type or machined from extruded stock.

B. PVC fittings, adaptors, or appurtenances shall be furnished, as required, to connect the plastic pipe to ductile iron fittings and pipe.

C. PVC fittings 3-inch and smaller shall be Schedule 80 socket type in accordance with ASTM D 2467. All socket type connections shall be made with PVC solvent cement complying with ASTM D 2564. PVC solvent cement shall be furnished from the same supplier as the PVC pipe. Socket-threaded adapters shall be provided for connection to threaded appurtenances where required.

2.5 HIGH DENSITY POLYETHYLENE (HDPE) PIPE

A. HDPE pipe shall be manufactured from high density polyethylene pipe (HDPE) compound which conforms to ASTM D1248 and meets the requirements for Type III, Class B, Category 5, grade P34 and has a PPI rating of PE3408. The pipe produced from this resin shall have a minimum cell classification of 345434D or E as per ASTM D3350. Pipe shall be light in color to produce good quality televised inspection.

B. The HDPE pipe shall be ductile iron pipe size (DIPS) as per ASTM F714.

C. The outside diameter of the pipe shall be such that a standard dimension ratio (DR) of 17 results in the specified internal diameter of the proposed sewer.

D. The minimum length shall be that deemed necessary by the Contractor to effectively span the distance from the inlet to the outlet of the respective manholes with allowances for thermal expansion and contraction and for any creep that may occur as a result of installation. The Contractor shall verify the lengths in the field before installing the pipe.

E. Marking on polyethylene pipe shall include the following:
1. ASTM F714.
2. Cell Classification 345434 D or E.
3. Nominal size (for example, 10 inches), followed by DIPS.
4. DR 17.
5. Name of manufacturer.
6. Production code from which location and date of manufacturer can be identified.

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7. Pipe test category.

F. Tests for compliance shall be made according to the applicable ASTM specification. A certificate with this specification shall be provided by the manufacturer for all material furnished. The Owner reserves the right to witness inspection and test of the materials.

G. The pipe shall conform to the minimum structural standards for HDPE (Type III Resins) meeting ASTM D3350, as listed below.

	U.S. Standard	**Results**
Flexural Stress (Yield)	ASTM D-638	3,300 PSI
Flexural Stress (Break)	ASTM D-638	4,500 PSI
Flexural Modulus of Elasticity	ASTM D-790	145,000 PSI

H. The pipe shall have a green stripe to indicate sanitary sewer use.

2.6 HIGH DENSITY POLYETHYLENE (HDPE) FITTINGS

A. Butt Fusion Fittings: Shall be PE3408 HDPE, Cell Classification of 345464C as determined by ASTM D3350-02, and approved for AWWA use. Butt fusion fittings shall have a manufacturing standard of ASTM D3261. Molded and fabricated fittings shall have a pressure rating equal to the pipe unless otherwise specified in the drawings. Fabricated fittings are to be manufactured using Data Loggers. Temperature, fusion pressure, and a graphic representation of the fusion cycle shall be part of the quality control records. All fittings shall be suitable for use as pressure conduits, and per AWWA C906, have nominal burst values of three and one-half times the Working Pressure Rating (WPR) of the fitting.

B. Electrofusion Fittings: Shall be PE3408 HDPE, Cell Classification of 345464C as determined by ASTM 3350-02. Electrofusion fittings shall have a manufacturing standard of ASTM F1055. Fittings shall have a pressure rating equal to the pipe unless otherwise specified on the plans. All electrofusion fittings shall be suitable for use as pressure conduits, and per AWWA C906, have nominal burst values of three and one-half times the Working Pressure Rating (WPR) of the fitting. All electrofusion couplings and fittings must use a 3-pin fusion system.

C. Flanged and Mechanical Joint Adapters: Shall be PE 3408 HDPE, Cell Classification of 345464C as determined by ASTM D3350-02. Flanged and mechanical joint adapters shall have a manufacturing standard of ASTM D3261. Fittings shall have a pressure rating equal to the pipe.

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2.7 MECHANICAL JOINT RESTRAINT DEVICES

A. Ductile Iron Pipe Restraint Devices:
   1. Restrained devices for gravity sewer shall be used in cased pipes.
   2. Restraint devices for nominal pipe sizes 3 inch through 48 inch shall consist of multiple gripping wedges incorporated into a follower gland meeting the applicable requirements of ANSI/AWWA C110/A21.10. Restraint device shall have torque limiting twist-off nuts.
   3. Restraint devices shall have a working pressure rating of 350 psi for 3 through16 inch and 250 psi for 18 through 48 inch. Ratings are for water pressure and must include a minimum safety factor of 2 to 1 in all sizes.
   4. Gland body, wedges and wedge actuating components shall be cast from grade 65-45-12 ductile iron material in accordance with ASTM A536.
   5. Manufacturer / Model:
      a. EBAA Iron Inc. Megalug Series 1100, or
      b. Approved equal.

B. Polyvinyl Chloride Pipe Restraint Devices:
   1. Restraint devices shall consist of multiple gripping wedges incorporated into a follower gland meeting the applicable requirements of ANSI/AWWA C111/A21.11. Restraint device shall have torque limiting twist-off nuts.
   2. The devices shall have a working pressure rating equal to that of the pipe on which it is used. Ratings are for water pressure and must include a minimum safety factor of 2 to 1 in all sizes.
   3. Gland body, wedges and wedge actuating components shall be cast from grade 65-45-12 ductile iron material in accordance with ASTM A536.
      1. Manufacturer / Model:
         a. EBAA Iron, Inc. Megalug Series 2000PV, or
         b. Approved equal.

C. Plain End to Plain End Pipe Restraint Device:
   1. Joint restraint to prevent axial separation shall be incorporated into the design of the sleeve or coupling used to connect two plain ends of same or dissimilar materials, such as ductile iron pipe, steel pipe, PVC pipe (C900, C905, or ASTM D2241) and or high density polyethylene (HDPE) pipe.
   2. To prevent movement causing fittings to slide or rotate, internal pipe wall stiffeners must be used. The stiffeners must be sized to encompass the entire bearing length of the restraint devices.
   3. Restraint devices shall consist of multiple gripping wedges incorporated into a follower gland. Restraint device shall have torque limiting twist-off nuts.
   4. The coupling sleeve shall be coated internally with a minimum of 15mils of fusion bonded epoxy conforming to the applicable requirements of ANSI/AWWA C213.
   5. Ductile Iron components shall meet or exceed the requirements of ASTM A536.
   6. The restrained joining system shall meet the applicable requirements of AWWA C219,

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ANSI/AWWA C111/A21.11, and ASTM D2000.

7. Manufacturer / Model:
   a. EBAA Iron, Inc. Series 3800, or
   b. Approved equal.

2.8 FLANGED COUPLING ADAPTERS

A. Flanged coupling adapters shall be used to connect plain end pipe to flanged fittings, meters, valves, or equipment as shown on the Drawings shall be rated for 200 psi working pressure unless indicated otherwise.

B. Materials of Construction:

Body:	Steel	ASTM A53
Flange:		
3” thru 5” Pipe		ANSI 150 lb flat face
6” Pipe and above		AWWA C207 Class D, ANSI 150 lb drilling
Follower:		
3” thru 12” Pipe	Ductile Iron	ASTM A536
14” Pipe and above	Heavy Rolled Steel	AISI C1018
Gasket:		Grade 30
Bolts and Nuts:	304 Stainless Steel	
Interior Coating:	Fusion Bonded Epoxy	
Exterior Coating:	2 Coats of Rust Inhibiting Synthetic Resin or Asphaltum Enamel	

C. Manufacturer / Model
1. Smith-Blair Model 913 Steel Restrained Flanged Coupling Adapter with Optional Anchor Studs, or
2. Approved equal.

2.9 FLEXIBLE EXPANSION JOINT

A. Flexible expansion joints shall be cast from grade 65-45-12 ductile iron conforming to the material requirements of ASTM A536 and ANSI/AWWA C153/A21.53.

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B. Each flexible expansion joint shall be pressure tested at the factory against its own restraint to a minimum of 350 psi (250 psi for 30" diameter and larger.) A minimum 2:1 safety factor shall apply.

C. Each flexible expansion joint shall consist of an expansion joint designed and cast as an integral part of a ball and socket type flexible joint, having a minimum per ball deflection of: 20 degrees, 3 inch – 12 inch; 15 degrees, 14 inch – 36 inch; 12 degrees, 48 inch and 4-inches minimum expansion. Additional expansion sleeves shall be available and easily added or removed at the factory or in the field. Both standardized mechanical joint and flange end connections shall be available.

D. All internal surfaces (wetted parts) shall be lined with a minimum of 15 mils of fusion bonded epoxy conforming to the applicable requirements of ANSI/AWWA C213. Sealing gaskets shall be constructed of EPDM. The coating and gaskets shall meet ANSI/NSF-61.

E. All external surfaces shall be coated with a catalyzed coal tar epoxy conforming to the material requirements of AWWA C210. Appropriately sized polyethylene sleeves, meeting ANSI/AWWA C105/A21.5, shall be included for direct buried applications.

F. Manufacturer / Model:
   1. EBAA Iron, Inc. FLEX-TEND, or
   2. Approved equal.

2.10 COMPRESSION COUPLINGS

A. When dissimilar pipe materials like PVC and concrete pipe are joined, use compression couplings that are resistant to the corrosive action of soils and sewage and that will provide a permanent watertight joint. The compression couplings shall be of natural or synthetic rubber or rubber-like material and shall comply with the requirements and test methods specified in Table 2 of ASTM C425. The coupling shall meet the leak requirements specified in ASTM C425, and the bands for attaching the couplings to the dissimilar pipes shall be of stainless steel meeting ASTM A167 or A240. Each coupling shall bear the manufacturer's identifying mark and an indication of its size. Compression couplings will not be allowed in the new sewer laterals (main line) without prior permission from the Owner.

2.11 LINE MARKERS

A. Markers shall be single piece design, constructed of durable, UV resistant, composite material, and have a pointed end for ease of installation. The marker shall have a constant flat "T" cross-sectional design and be 3.75 inch in width and of such length to provide a minimum height above the ground surface of 44 inches and a minimum embedment depth of 18 inches. The marker shall resist displacement from wind and vehicle impact forces. The

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marker shall be free of burns, discoloration, cracks, bulges, or other objectionable marks. A line shall be stamped horizontally across the front of the marker to indicate proper burial depth.

B. The marker shall be pigmented throughout the entire cross-section so as to produce a uniform color which is an integral part of the material. The marker shall be colored green.

C. Line markers shall be labeled with the lettering "CAUTION SEWER LINE" with the Owner's name and telephone number written below the lettering.

D. Contractor shall provide line markers on each manhole for unpaved areas of gravity sewer, or as directed by the Owner at a cost incidental to the Contract.

E. Manufacturer / Model:
   a. Carsonite International, Early Branch, SC Model CUM 375 or
   b. Approved equal.

2.12 UTILITY WARNING TAPE

A. Detectable underground utility warning tape, which can be located from the surface by a pipe detector, shall have of a minimum thickness of 0.35 mils solid aluminum foil encased in a protective inert plastic jacket that is impervious to all known alkalis, acid, chemical reagents and solvents found in the soil. The tape shall have a minimum overall thickness of 5.0 mils and a minimum width of 3 inch (non-metallic piping) with a minimum unit weight of 2-1/2 pounds/ 1 inch x 1,000 foot. The tape shall be color coded green in accordance with APWA National Color Code and permanently imprinted "Caution Buried Sewer Line Below".

B. Manufacturer / Model:
   1. Allen Systems, "Detect Tape",
   2. Empire Level Mfg. Corp., "Magnatee", or
   3. Approved equal.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Refer to Division 31 Section "Earthwork" for excavating, trenching, and backfilling.

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3.2 EXCAVATION FOR GRAVITY SEWERS

A. Excavation for pipelines shall consist of the excavation necessary for the construction of sewer lines and their appurtenances (including manholes, collars, concrete saddles, and pipe protection) that are called for by the drawings. It shall include clearing and grubbing where necessary, backfilling and tamping pipe trenches and around structures, and disposing of waste materials, all of which shall conform to the applicable provisions set forth in these Specifications.

B. The Contractor may, if approved by Owner, use a motor powered trenching machine. Trenching excavation width shall be determined by Owner based upon the diameter of the pipe. Contractor shall be fully responsible for the location, preservation, and repair of existing utility service connections.

C. Unless the construction of lines by tunneling or boring is called for by the drawings or specifically authorized by the Owner, make excavation for pipelines in open cut and true to the lines and grades shown on the drawings or established by the Owner. Cut the banks of trenches between vertical parallel planes equidistant from the pipe centerline. The horizontal distance between the vertical planes (or, if sheeting is used, between the inside faces of that sheeting) shall vary with the size of the pipe to be installed, but shall not be more than the distance determined by the following formula: 4/3 (d) + 15 inches, where "d" represents the internal diameter of the pipe in inches. When approved in writing by the Owner, the banks of trenches from the ground surface down to a depth not closer than 1 foot above the top of the pipe may be excavated to non-vertical and nonparallel planes, provided the excavation below that depth is made with vertical and parallel sides equidistant from the pipe centerline in accordance with the formula given above. Any cut made in excess of the formula 4/3 (d) + 15 inches shall be at the expense of the Contractor and may be cause for the Owner to require that stronger pipe and/or a higher class of bedding be used at no cost to the Owner.

D. For all pipes provide a minimum 6 inches of No. 67 (TDOT) crushed stone for bedding.

E. Do not excavate pipe trenches more than 400 foot ahead of the pipe laying, and not more than four hundred (400) feet of open ditch shall be left behind the pipe laying, and perform all work so as to cause the least possible inconvenience to the public. Construct temporary bridges or crossing when and where the Owner deems necessary to maintain vehicular or pedestrian traffic.

F. In all cases where materials are deposited along open trenches, place them so that in the event of rain no damage will result to the work and/or to adjacent property.

G. Refer to the Section regarding excavation for sheeting, shoring and bracing requirements.

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H. Prior to excavating pipe trench for sewer mains and services outside of public R.O.W., an onsite meeting between Owner, Engineer, and Contractor is required to discuss proper methods of installation to preserve existing mature tree roots. The proposed alignment centerline and trench edge shall be marked prior to onsite meeting. An 8" layer of bark, wood chips, or arborist approved matting is required to limit soil compaction within the drip line. Cleanly cut roots prior to trench excavation. Trench spoil will not be allowed to be placed within the drip line and left for more than three days. The City's arborist shall be consulted prior to and during construction activities.

3.3 PIPE LAYING

A. Two weeks prior to the commencement of trench excavation, the Contractor shall prepare and submit to the Owner for review four (4) copies of detailed Cut Sheets showing the manhole numbers; the distance between manholes; the grade, size and type of line; the depth of cut; on minimum 50 foot centers including abrupt grade changes such as ditches and all manhole locations. All expense for the preparation of Cut Sheets shall be included in the unit price bid per foot of pipe.

1. Cut Sheets must be reviewed and approved by the Owner in writing before trenching operations may be permitted. It shall be the Contractor's responsibility to prepare Cut Sheets in advance of his anticipated trenching schedule.
2. Licensed surveyor or engineer shall prepare Cut Sheets.

B. On all projects, communicate with Owner or RPR a minimum of two days prior to pipe laying activity. For capital investment projects, pipe laying shall not occur without the presence of the Owner or RPR. If the Owner or RPR cannot be present, sufficient photo documentation shall be submitted (including date and time stamp) for approval. If conditions are found to have occurred other than the layout shown on the Drawings, Contractor shall bore all expenses to correct.

C. Before placing sewer pipe in position in the trench, carefully prepare the bottom and sides of the trench, and install any necessary bracing and sheeting as required in this Specification.

D. Wherever necessary to provide satisfactory bearing surface, place concrete cradles as shown on the drawings or as directed by the Owner. Cradles shall be of concrete and conform to the dimensions shown on the drawings. Concrete placed outside the dimensions shown shall be at the Contractor's or Developer's expense.

E. Use of lasers for pipe laying activity is required unless otherwise by the WMD. Set reference points for both line and grade at each manhole. Where grades are 0.6 percent or less, check the elevation of the beam each 100 foot with an offset point or engineer's level.

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F. If needed, tightly stretch a mason's line or wire above ground level, parallel to and directly above the axis of the pipe to be installed, supporting this line at intervals of no more than 50 foot for sewers being laid on a grade of 2 percent or more and of no more than 25 foot for grades of less than 2 percent. Determine the exact line and grade for each section of pipe by measuring down from this line to the invert of the pipe in place, and accurately place each pipe to the exact line and grade called for on the drawings. Furnish all labor and materials necessary for erecting batter-boards.

G. Do not allow water to run or stand in the trench while pipe laying is in progress or before the trench has been backfilled. Do not at any time excavate more trench than the available pumping facilities can dewater.

H. Correct trench bottoms found to be unsuitable for foundations after pipe laying operations have started, bringing them to exact line and grade with crushed stone as necessary.

I. Carefully inspect each piece of pipe and special fitting before it is placed, and lay no defective pipe in the trench. Pipe laying shall proceed upgrade, starting at the lower end of the grade and with the bells upgrade. When pipe laying is not in progress, keep the ends of the pipe tightly closed with an approved temporary plug.

J. Bell holes shall be large enough to allow ample room for the pipe joints to be properly made. Cut out bell holes no more than two joints ahead of pipe laying. Carefully grade bottom of the trench between bell holes so each pipe barrel rests on a solid foundation for its entire length. Lay each pipe joint so as to form a close concentric joint with adjoining pipe and to avoid sudden offsets or inequalities in the flow line.

K. No other type of joint may be used unless authorized in writing by the Owner.

L. For sanitary sewer laterals, install tee branches in sanitary sewer main to serve each parcel facing or abutting on the street or alley in which sewer is being laid at such other locations as may be designated by the Owner. If tee branches are not to be used immediately, close them with approved stoppers that are held in place to prevent infiltration and withstand all test requirements.

M. For all tees that are plugged and laid in rock, blast a minimum of six linear feet of ditch line in the direction and to the approximate grade of the future lateral as directed by the Owner, but do not excavate the material. This shall be done at no extra cost to the Owner. Furnish the Owner with a record of the exact location of each tee installed.

N. If the work consists of constructing a new sewer to replace an existing one, connect existing service lines to the new line.

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O. New service laterals shall conform to the standard drawings.

P. Jointing:

1. Clean ends of pipe, bell interior, and coupling components before jointing.
2. Apply joint lubricant to pipe ends, bell interior, and elastomeric seals of coupling. Use only lubricants approved by the pipe manufacturer.
3. Use suitable equipment and end protection to push or pull the pipes and/or couplings together. Do not exceed forces recommended by the pipe and coupling manufacturers.
4. Join pipes in straight alignment then, if allowed, defect the pipe to the required angle. Deflection shall not exceed 3 degrees unless otherwise noted or the manufacturers recommended deflection.

Q. As the work progresses, thoroughly clean the interior of the pipe in place. After each line of pipe has been laid, carefully inspect it, and remove all earth, trash, rags, and other foreign matter from its interior.

R. After the joints have been completed, they shall be inspected, tested, and accepted by the Owner or RPR before being covered. The pipe shall meet the test requirements for water-tightness; immediately repair any leak or defect discovered at any time after completion of the work. Any pipe that has been disturbed after joints were formed shall be taken up, the joints cleaned and remade, and the pipe re-laid at the Contractor's expense. Carefully protect all pipes in place from damage until backfilling operations are completed.

S. Do not begin the backfilling of trenches until the pipe in place has been inspected and approved by the Owner or RPR.

T. Line Separation:

1. Lay sewers at least 10 foot horizontally from any existing or proposed water main. If this is not practical, the sewer may be laid closer than 10 foot to a water main provided it is laid in a separate trench and the elevation of the top of the sewer is at least 18 inches below the bottom of the water main.
2. Where a sewer crosses under water mains, the top of the sewer shall be at least 18 inch below the bottom of the water main. If the elevation of the sewer cannot be varied to meet the above requirements, relocate the water main to provide this separation, or else reconstruct it with mechanical joint ductile iron pipe for a distance of 10 foot on each side of the sewer with a full joint of the water main centered over the sewer.
3. If it is impossible to obtain proper horizontal and vertical separation as stipulated above, construct both the water main and the sewer of mechanical joint ductile iron pipe, and pressure test each.

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a. Pipe shall be in accordance with paragraph 2.1 of this section with the exception that it be mechanical joint in lieu of bell and spigot.
b. Sewer pipe shall be tested in place for a minimum of 2 hours without leakage prior to backfilling.
c. The Owner must approve the construction method to be used whenever the minimum 10-feet horizontal separation and/or 18-inch vertical separation is not possible.

U. Make connections to all existing sewer lines as shown on the drawings or as directed by the Owner. Make service connections either by removing a section of the sewer from the existing line and inserting a wye or tee branch of the proper size or connect to the main by constructing a manhole or junction box.

V. Make connections to existing manholes or inlets by core drilling a hole in the wall of the existing structure, installing a Kor-N-Seal connector, inserting a length of sewer pipe into the hole. Shape or reshape the bottom of the manholes as necessary to fit the invert of the sewer pipe.

W. Joint dissimilar pipe by using suitable compression couplings of compatible materials. If compression couplings are not available, make jointing with a special fabricated coupling approved by the Owner.

X. Provide concrete protection or concrete cap as shown on the drawings for pipe sewers that, when completed, have less than 2.5 feet of covering in non-traffic areas and 4 feet of cover in traffic areas. Contractor may also use ductile iron pipe in areas with less than 4 feet of cover in lieu of the concrete cap.

Y. Carefully protect from damage all existing sewers, water lines, gas lines, sidewalks, curbs, gutters, pavements, electrical lines, and other utilities or structures in the vicinity of the work at all times. If it is necessary to repair, remove, and/or replace any such utility or structure in order to complete the work properly, do so in compliance with the provisions set forth in other section of these specifications or as required by the appropriate utility. Any such work shall be considered incidental to the construction of pipe sewers, and no additional payment will be allowed therefor.
1. Water service connections will be repaired or replaced by the Contractor at his expense as an incidental part of the work.
2. Service or house connections to existing sewers that are damaged or removed shall be repaired or replaced by the Contractor at his own expense as an incidental part of the work.

3.4 BACKFILLING

A. Begin backfilling after the line construction is completed, inspected, and approved by

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the Owner.

1. PVC and HDPE:
    a. On each side of the line, from the bottom of barrel to one foot above the top of the pipe, the backfill material shall consist of No. 67 (TDOT) stone. Place this backfill simultaneously on either side of the pipe in even layers that before compaction are no more than six inches deep. Thoroughly and completely tamp each layer into place before placing additional layers.
2. Ductile Iron Pipe:
    a. On each side of the line, from the bottom of barrel to the top of the pipe, the backfill material shall consist of No. 67 (TDOT) stone.
    b. From the top of the pipe to one foot above the crown the backfill material shall be selected backfill consisting of either fine, loose earth like sandy soil or loam or of granular material that is free from clods, organic matter, debris, stone, and/or other objectionable materials and that has a size of no more than two inches. Place this backfill simultaneously on either side of the pipe in even layers that before compaction are no more than six inches deep.
    c. Thoroughly and completely tamp each layer into place before placing additional layers.

B. From one foot above the pipe upward, the backfill material may contain broken stones that make up approximately 3/4 of the backfill's total volume, However, if this type of backfill is used, there must be enough spalls and earth materials to fill all voids completely. The maximum dimension of individual stones in such backfill shall not exceed six inches, and the backfill material shall be placed and spread in even layers not more than 12 inches deep. At locations beneath or closely adjacent to pavement or at locations of improvements subject to damage by displacement, the backfill shall be entirely No. 67 (TDOT) stone. Tamp and thoroughly compact the backfill in layers that, before compaction, are six inches deep. Contractor shall demonstrate that backfill material is compacted to 95 percent of optimum density as defined by ASTM D698 (Standard Proctor). In other areas, the backfill for the upper portion of the trenches may be placed without tamping but shall be compacted to a density equivalent to that of adjacent earth material as determined by laboratory tests. Use special care to prevent the operation of backfilling equipment from causing any damage to the pipe.

C. For all underground piping installations, install continuous underground detectable warning tape during backfilling of trench.
1. Installation of detectable tape shall be per manufacturer’s recommendations. Allow a minimum of 18-inches between the tape and the utility line. Allow a minimum of 12-inches between the tape and the ground surface.
2. Installation of non-detectable tape shall be per manufacturer’s recommendations and shall be as close to the grade as is practical for optimum

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protection. Allow a minimum of 24 inches between the tape and the utility line. Allow a minimum of 12 inches between the tape and the ground surface.

D. If earth material for backfill is, in the opinion of the Resident Project Representative, too dry to allow thorough compaction, add enough water so that the backfill can be properly compacted. Do not place earth material that the Resident Project Representative considers too wet or otherwise unsuitable. Refer to Section 31 0000 for practices for unsuitable backfill materials.

E. Wherever excavation has been made within easements across private property, the top one foot of backfill material shall consist of fine loose earth free from large clods, organic matter, debris, stone, and/or other objectionable materials. Topsoil shall be in accordance with the requirements of this Specification.

F. Wherever trenches have been cut across or along existing pavement, temporarily pave the backfill of such trenches by placing Class A, Grade D, crushed stone as the top 12 inches of the backfill. Maintain this temporary pavement either until the permanent pavement is restored or until the project is accepted by the Owner.

G. Conduct backfilling around manholes, inlets, outfalls, and/or structures in the same manner as specified above for pipelines except that even greater care is necessary to prevent damage to the utility structure.

H. Wherever pipes have diameters of 15 inches or less, do not use power operated tampers to tamp that portion of the backfill around the pipe within one foot above the pipe.

I. Perform backfilling so as not to disturb or injure any pipe and/or structure against which the backfill is being placed. If any pipe or structure is damaged and/or displaced during backfilling, open up the backfill and make whatever repairs are necessary.

J. Backfilling and clean-up operations shall closely follow pipe laying; failure to comply with this provision will result in the Owner requiring that the Contractor's other activities be suspended until backfilling and clean-up operations catch up with pipe laying.

K. Install line markers directly above pipeline alignment at intervals of 1,000 feet where indicated on the Drawings. Line markers shall be installed after final clean-up is completed.

3.5 TESTING OF GRAVITY SEWERS

A. Visual Tests:

1. Upon completion of the construction or earlier if the Owner deems advisable, the Resident Project Representative will make a visual inspection of the sewer

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and construction site. Immediately repair all leaks and defects found by such inspection.

2. In addition to general cleanup and leakage, the following standards shall be used to determine failure or defects of this project.
   a. Sewers shall be built so as to remain true to line and grade. The inclining grade of the bottom of the sewer after completion shall be such that, after flooding, the flood water drains off so that no remaining puddle of water is deeper than 1/2 inch on pipe 36 inch internal diameter or smaller and 3/4 inch on pipe larger than 36 inch internal diameter. Any section of pipe that does not comply with the specifications at any time previous to final acceptance of the work shall be replaced or re-laid at the Contractor's expense.
   b. The Contractor will be held strictly responsible that all parts of the work bear the load of the backfill. If cracks 1/100 inch or deflection past the manufacturer's standards develop in the pipe within one year from the date of final acceptance of the work, the Contractor will be required to replace, at his expense, all such cracked pipe. To this end, the Contractor is advised to purchase pipe under a guarantee from the manufacturer, guaranteeing proper service of sewer pipe under conditions established by the drawings, specifications, and local conditions at the site of the work.
   c. Upon visual inspection of observed defects, Owner may require an additional year of warranty to provide additional environmental conditions time to develop, if any, to determine if observed defects worsen based upon construction activities.

B. Air testing for sewers 24 inches and smaller: Perform low pressure air testing as follows:
   1. Furnish all equipment, facilities, and personnel necessary to conduct the test. The test shall be observed by the Resident Project Representative.
   2. Make the air test after all services have been installed and backfilling has been completed and compacted.
   3. Plug all tees and ends of sewer services with flexible joint plugs or caps securely fastened to withstand the internal test pressures. Such plugs or caps shall be readily removable, and their removal shall provide a socket suitable for making a flexible jointed lateral connection or extension.
   4. Prior to testing, check the pipe to see that it is clean. If not, clean via hydraulic cleaning equipment. It shall be the Contractor's responsibility to have the pipe cleaned.
   5. Immediately following this check or cleaning, test the pipe installation with low pressure air. Supply the air slowly to the plugged pipe installation until the internal air pressure reaches 5.0 psi. Allow at least three minutes for temperature stabilization. For pipes up to 24-inches in diameter, the City requires air testing at five pounds for five minutes with no allowable air loss.

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6. If the pipe installation fails to meet these requirements, the Contractor shall determine at his own expense the source or sources of leakage and repair or replace all defective materials or workmanship. The completed pipe installation shall meet the requirements of this test before being considered acceptable.
7. The recommended procedures for conducting acceptance tests are as follows:
   a. Clean pipe that is to be tested.
   b. Plug all pipe outlets with suitable test plugs, and brace each plug securely.
   c. Add air slowly to the portion of the pipe installation being tested until the internal air pressure is raised to 5.0 psi.
   e. After the above internal pressure is obtained, allow at least two minutes for air temperature to stabilize, adding only the amount of air required to maintain pressure.
   f. After two minutes, disconnect the air supply.
   g. When pressure decreases by leaking down or by bleeding down with a release valve, start the stopwatch, and determine the time in seconds that is required for the internal air pressure to reach 5.0 psi.
8. Plugs used to close the sewer pipe for the air test must be securely braced to prevent the unintentional release of a plug, which can become a high velocity projectile. Locate gages, air piping manifolds, and valves at the top of the ground. No one shall be permitted to enter a manhole where a plugged pipe is under pressure.

C. Joint Testing in Sewers larger than 24 inches

   1. Testing for sewers larger than 24 inches shall be completed in no more than two joints of pipe at a time at 5 psi for 5 minutes.

D. Repairs: Regardless of the outcome of any tests, repair any noticeable leak.

E. Submit written testing records to the Owner documenting the results of the tests for each section of sewer between manholes. The record shall show, at a minimum, sewer size, manhole numbers, sewer length, and duration of test and shall be certified by the Engineer for correctness.

3.6 VISUAL INSPECTION OF MISCELLANEOUS MATERIALS

A. All material used on this project will be visually inspected by the Resident Project Representative at the site for conformance to the required specifications. When reasonable doubt exists that said material meets the specifications, the Owner may require certified mill tests, samples, and/or tests by an independent laboratory or other suitable form of verification that the material meets the required specifications.

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3.7 DEFLECTION TESTING FOR PVC PIPE

A. Test deflection of the pipe by passing a 9-arm pin go/no-go mandrel sized to 95 percent of the pipe diameter of the actual pipe used with the pipe in place and covered. Make this acceptance test after backfill consolidation has occurred. The Contractor shall provide the mandrel and conduct test in presence of the Resident Project Representative.

B. Mandrel testing shall be performed after a minimum of two wet weather events. Or, at the discretion of the Owner, compaction of the backfill may occur in lieu of wet weather and will be as directed by Owner.

C. The mandrel shall clearly pass into the sanitary sewer line through the manhole; and shall not be assembled in the line.

3.8 POINT REPAIR

A. Point repair methods shall be on a case-by-case basis at the discretion of the WMD.

3.9 CLEANUP

A. After completing each section of the sewer line, remove all debris, construction materials, and equipment from the site of the work, grade and smooth over the surface on both sides of the line, and leave the entire right-of-way in a clean, neat, and serviceable condition.

END OF SECTION

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PART 1 – GENERAL

1.1 SUMMARY

A. Sanitary sewer flow control required to conduct the sanitary sewer line replacement and rehabilitation, television inspection (as applicable), sanitary sewer line testing, (as applicable), and sanitary sewer line sealing operations (as applicable) effectively. Flow control will be required for inspection or other maintenance operations, for all sanitary sewer line replacements, and when sanitary sewer line flow depth is greater than 25 percent.

1.2 PERFORMANCE REQUIREMENTS

A. It is essential to the operation of the existing sanitary sewerage system that there is no interruption in the flow of sewage throughout the duration of the Project. To this end, Contractor shall provide, maintain and operate all temporary facilities such as dams, plugs, pumping equipment (both primary and back-up units) as necessary to intercept the sewage flow before it reaches the point where it would interfere with their work, carry it past their work and return it to the existing sanitary sewer downstream of their work.

B. Discharge of sewage into the construction trench, or any other area, shall not be permitted.

1.3 SUBMITTALS

A. Informational Submittals:
   1. Flow Control Plan: Submit at least two weeks prior to controlling flows. Include, as a minimum, the following:
      a. Estimate of peak flow amount to be controlled
      b. Detailed procedures for handling peak estimated flow.
      c. Schedule.
      d. Drawing of plug, bypass pump, and pipeline locations.
      e. Listing of equipment.
         1. Bypass pump sizes, capacities, number of each size to be onsite, and power requirements including standby equipment.
         2. Bypass pipeline sizes and material types.
      f. Sanitary sewer user notification plan.
      g. Operation plan.
      h. Emergency procedures.
      i. Telemetry communication.

   2. Permits to locate and operate flow control system.

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PART 2 – GENERAL

2.1 FLOW CONTROL SYSTEM

A. Provide adequate capacity and size to handle existing flows plus additional flows that may occur during periods of rainstorm, by providing at least 125 percent of peak sanitary sewer flow estimate.

B. Plugs:
   1. Provide with taps for connection of pressure gauges and air hoses, and flow-through capability.
   2. Pipe Diameters 24 inches and Smaller: Use mechanical plugs with rubber gaskets or pneumatic plugs with rubber boots.
   3. Pipe Diameters Larger than 24 inches:
      a. Use inflatable bag stoppers made in two or more pieces.
      b. Manufacturer: Cherne Industries, or approved equal

C. High-Density Polyethylene (HDPE) or Ductile Iron Discharge Piping:
   1. Leak free.
   2. Pressure rating at least 1.5 times the operating pressure.
   3. HDPE Pressure Piping:
      a. In accordance with ASTM D3350.
      b. Joints: Butt-fusion welded.
   4. Ductile Iron:
      a. AWWA C151/A21.51, Centrifugally cast, Grade 60-42-10 iron.
      b. Joints: Rubber gasketed push-on in accordance with AWWA C111/21.11
      c. Fittings: In accordance with AWWA C110/A21.20.
   5. May reuse for subsequent flow bypass pumping system placements. Owner or Engineer, at their sole discretion, shall have right to reject sections deemed unserviceable.

D. Bypass Pumps:
   1. Fully automatic, self-priming units that do not require use of foot valves or vacuum pumps in priming system.
   2. Open impeller design with ability to pump minimum 3-inch diameter solids.
   3. Able to run dry for long periods of time to accommodate cyclical nature of flows.
   4. Engine: Equipped to minimize noise. Noise levels shall not exceed 86 dBA at a distance of 50 feet from the source.
   5. Standby Pump: One of each size to be onsite.
   6. Check valves are required on the discharge line for each pump.

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PART 3 – EXECUTION

3.1 GENERAL

A. Notify Owner at least 48 hours prior to implementing flow control system.

B. Operate and maintain flow control system 24 hours per day, 7 days per week, including holidays, as required, to control flow.

C. When depth of flow in a pipe section is above the maximum depth specified for television inspection (as specified in Division 33 Section “Sanitary Sewer Television Inspection”), joint testing (to manufacturer’s specifications or approved by WMD), or rehabilitation (as specified in Division 33 Section “Rehabilitation of Sanitary sewer Utilities”’), reduce flow by plugging, diverting, or pumping flow around Work area.

D. Except at pipe sags, depth of flow during television inspection and joint testing shall not exceed the requirements of Division 33 Section "Sanitary sewer Television Inspection".

E. Eliminate all flow from sanitary sewer manhole-to-manhole segments during spot repair, service connection rehabilitation, manhole construction, and sanitary sewer pipe replacement or lining within that segment.

F. If flow reaches peak estimated flow that flow control system was designed for, stop all Work that requires flow control, secure Work area, and restore flow in sanitary sewer until flow recedes.

G. After the Work is completed, return flow to replaced sanitary sewer and remove temporary equipment.

3.2 PLUGGING OR BLOCKING

A. Flow control may consist of blocking flow with mechanical or pneumatic plugs if only a small amount of flow needs to be controlled and adequate storage is available and not cause surcharging or other major disturbances upstream or downstream.

B. Use primary and secondary plugs for each flow control location.

C. When blocking flow is no longer needed for performance and acceptance of the Work, remove plugs in a manner that permits sewage flow to slowly return to normal.

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D. If bypass pumping, remove temporary plugs at end of each working day and restore normal flow, unless otherwise approved by WMD. If downstream work is not or cannot be completed during the workday provide, operate, and maintain bypass pumping system.

E. Use bypass pumping if the Work cannot be scheduled at a time when flow is low or completed during low flow period.

3.3 BYPASS PUMPING

A. The Contractor shall obtain approval and secure all permits for placement of temporary bypass pumping system and pipeline within TDOT right-of-way.

B. Flow bypass shall be done in such a manner that will not damage private or public property, or create a nuisance or public menace. Pumped sewage shall be in an enclosed pipe that is adequately protected from traffic, and shall be redirected into sanitary sewer system or alternatively into an enclosed tank for hauling offsite. Dumping or free flow of sewage on private or public property, gutters, streets, sidewalks, or into storm sanitary sewers is prohibited.

C. The Contractor shall submit to the Owner for approval a description of the bypass pumping methodology, pressure testing, flushing and bypass pumping plan before Contractor commences sewage bypass pumping.

D. The Contractor shall furnish, install, and maintain power, primary and standby pumps, appurtenances, and bypass piping required to maintain existing flows and services.

E. The Contractor shall equip pump engines with noise suppression devices to keep pump noise to a minimum and comply with applicable noise ordinances.

F. The Contractor shall be responsible for continuity of sanitary sewer service to each facility connected to the section of sanitary sewer main during the execution of the Work, and shall also bypass the main sanitary sewer flow around the pipe to be replaced, or into adjacent sanitary sewers, if available.

G. The pumps and the bypass lines shall be of adequate capacity and size to handle all flows, as described in 2.1A, without any major disturbances or sewage backup to private property.

H. The Contractor shall be solely responsible for clean-up, repair, property damage costs and claims resulting from failure of the diversion system.

I. The Contractor shall submit to the Owner specifications for all pumping equipment to be used on the job (including all sizing calculations) and a list of all backup pumping equipment to be held in reserve on the Site.

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3.4 SERVICE LATERAL DISCONNECTION

A. When it is necessary to work on a private service line before the service lines are disconnected, ensure that the building occupants are notified.

B. The Contractor will notify building occupants regarding service lateral disconnection by placing door hangers not less than 1 week prior to and within 24 hours prior to disconnection.

C. When a service lateral must be disconnected from the main for more than 1 work day, the lateral shall be positively drained or pumped a minimum of once every 24 hours. Monitor status of flow and storage. Pump lateral more frequently where flows exceed the storage capacity of the lateral or such temporary storage as may be provided by Contractor.

D. Temporarily restore services in uncompleted sections during nonwork hours.

E. Notify building occupants when work is complete and full uninterrupted service restored.

F. No service is to remain shutdown for more than a period of 8 hours, unless Contractor provides substitute services for the residents. If the service is to be shutdown for more than 8 hours and Contractor cannot provide substitute services, then Contractor shall be required to provide temporary living quarters (i.e., hotel) for the resident at no additional cost to Owner or the resident. Temporary living quarters shall be approved by Owner and coordinated through Owner.

3.5 FIELD QUALITY CONTROL AND MAINTENANCE

A. Test: Contractor shall perform leakage and pressure tests of the bypass pumping discharge piping using clean water prior to actual operation. Prior to operation, test each section of discharge piping with maximum pressure equal to 1.5 times the maximum operating pressure of system. Owner shall be given 24 hours notice prior to testing.

B. Inspection and Maintenance Service: Contractor shall ensure that the temporary pumping system is properly maintained and a responsible operator shall be on hand at all times when pumps are operating.

3.6 CLEANING

A. Before bypass pumping system is broken down, removed from the pump, and moved to next section or removed at the completion of the Work, discharge sewage remaining in bypass discharge pipeline and pumping equipment to working sanitary sewer and flush the pipeline.

B. Disturbed Areas: Upon completion of bypass pumping operation, clean disturbed areas and restore to condition, including pavement restoration, at least equal to that which existed prior to start of the Work.

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3.7 LIABILITY

A. Contractor shall be responsible for damages to private or public property that may result from his sanitary sewer flow control operations. Contractor shall be responsible for any violations of laws, regulations or permits and shall indemnify and hold Owner harmless for any and all damages, including but not limited to, fines and penalties that arise from such violations.

END OF SECTION

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PART 1 – GENERAL

1.1 SUMMARY

A. This section covers the cleaning of sanitary sewers to remove all debris, solids, sand, grease, grit, roots, etc. from the sanitary sewers and manholes to improve pipe flow, facilitate television inspection for sanitary sewer rehabilitation, for proper application of root control chemical, or as required for other specified rehabilitation.

B. The Work covered by this section includes furnishing all labor, equipment, and materials required to clean and inspect sanitary sewer lines as specified.

1.2 SUBMITTALS

A. Action Submittals: Catalog and manufacturer's data sheets for cleaning equipment.

B. Informational Submittals:
1. Sample of the finished picture from the picture capture system.
2. Equipment manufacturer's operational manual and guidelines.
3. Liquid waste manifest.

PART 2 – PRODUCTS

2.1 EQUIPMENT

A. Cleaning:
1. All high-velocity sanitary sewer cleaning equipment shall be constructed for ease and safety of operation. The equipment shall have a selection of two or more high-velocity nozzles. The nozzles shall be capable of producing a scouring action from 15 to 45 degrees in all size lines designated to be cleaned. Equipment shall also include a high-velocity gun for washing and scouring manhole walls and floors and produce at least a 2,000 psi pressure. The gun shall be capable of producing flows from a fine spray to a solid stream.

2. Sanitary sewer line cleaning equipment shall be a combination of high-velocity (hydro-cleaning) jet and vacuum systems, truck mounted for mobility and ease of operation. The hydro-cleaning equipment for sanitary sewer lines shall include a minimum of 1,000-gallon water storage tank, auxiliary engines and pumps, and include a minimum of 600 feet of 1 1/4 -inch ID high pressure hose on a power driven hose reel. Pump nozzle combinations shall be capable of producing water flow rates up to 120 gpm, and a minimum of 60 gpm at a working pressure up to 2,000 psi. The vacuum system shall be a

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positive displacement blower with a minimum of 4,200 cfm at 15-inches of mercury. The WMD must approve any variations to this pumping rate, in advance.

3. A working pressure gauge shall be used on the discharge of all high-pressure water pumps.

4. Contractor shall use in addition to conventional nozzles, a nozzle which directs the cleaning force to the bottom of the pipe for sanitary sewers 18-inch and larger.

B. Heavy Cleaning: Utilize high-pressure water jet truck or any other methods as approved by WMD for heavy cleaning.

PART 3 – EXECUTION

3.1 GENERAL

A. Prior to the start of any Work under this Project, Contractor shall make available to WMD and Engineer all equipment that is to be utilized in the execution of this Contract. The WMD will hold a preconstruction conference at which the sequence of work, methods, inspection, and monitoring requirements and debris disposal shall be discussed.

B. When sanitary sewer flow depth is greater than 33 percent, flow depth shall be decreased by plugging or bypass pumping. Plugs shall be designed to pass any desired portion of sanitary sewer flow. If bypass pumping is required, Contractor shall provide all necessary equipment, manpower, and expertise. Contractor shall be responsible for all damage to public or private property resulting from these operations.

C. Designated sanitary sewers and manholes shall be cleaned using mechanical hydraulically propelled or high-velocity sanitary sewer cleaning equipment. The cleaning process shall remove all grease, roots, sand, silt, solids, rags, debris, etc. from each sanitary sewer segment, including the manhole(s).

D. Selection of the cleaning equipment and the method for cleaning shall be based on the condition of the sanitary sewer mains at the time. Work commences and will be subject to WMD approval.

E. All cleaning equipment and devices shall be operated by experienced personnel.

F. Satisfactory precautions shall be taken to protect the sanitary sewer mains and manholes from damage that might be inflicted by the improper use of the cleaning process or

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equipment. Any damage done to a sanitary sewer by Contractor shall be repaired by the Contractor at no additional cost to the WMD and to the satisfaction of the WMD and Engineer.

G. Cleaning shall also include the initial manhole wall washing by high-pressure water jet.

H. Contractor, when instructed by the WMD, will be required to demonstrate the performance capabilities of the cleaning equipment proposed for use on the Project. If the results obtained by the proposed sanitary sewer cleaning equipment or attachments are not satisfactory, Contractor shall use different equipment/attachments, as required, to meet Specifications. More than one type of equipment/attachments may be required at a location.

I. When hydraulic or high-velocity cleaning equipment is used, a suitable sand trap, weir, dam, or suction, shall be constructed in the downstream manhole in such a manner that all the solids and debris are trapped for removal.

J. If sanitary sewer backs up into a lateral and enters a building or residence during cleaning, the Contractor shall notify the WMD and Engineer of the occurrence. It is the Contractor's responsibility to clean any backups that occur. If prior knowledge of backups is available, the Contractor shall take measures to prevent another backup from occurring (i.e. plugging the lateral, etc.) before cleaning.

3.2 HYDRAULIC CLEANING

A. Contractor shall tele vise the pipeline prior to performing any cleaning operations. If the pipeline is obstructed, the Contractor shall thoroughly clean the pipe of debris, grease, roots, sediment, broken pipe, or other obstructions that could retard the movement of the television camera. Precautions shall be taken to protect the sanitary sewer lines being cleaned from damage by the cleaning equipment.

B. Hydraulically propelled devices, which require a head of water to operate, shall utilize a collapsible dam. The dam shall be easily collapsible to prevent damage to the sanitary sewer, property, etc.

C. When using hydraulically propelled devises, precautions shall be taken to ensure that the water pressure created does not cause damage or flooding to public or private property.

D. Contractor shall not increase the hydraulic gradient of the sanitary sewers beyond the elevation that could cause overflow of sewage into area waterways or into structures.

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3.3 HIGH-VELOCITY CLEANING

A. Contractor shall operate the equipment so that the pressurized nozzle continues to move at all times.

B. The pressure nozzle shall be turned off or water pressure be reduced anytime the hose is held or delayed in order to prevent damage to the line. In heavy debris the step cleaning method should be used.

3.4 MECHANICAL CLEANING

A. Mechanical cleaning, in addition to normal cleaning when required by the WMD, shall be approved equipment and accessories driven by power winching devices.

B. All equipment and devices shall be operated by experienced operators in an effort to prevent pipe damage during the cleaning process.

C. Buckets, scrappers, scooters, porcupines, kites, heavy duty brushes, metal pigs, and other debris removing equipment/accessories shall be used as appropriate and necessary in the field, in conjunction with the approved power machine(s).

D. The use of cleaning devices such as rods, metal pigs, porcupines, root saws, snakes, scooters, sanitary sewer balls, kites, and other approved equipment, in conjunction with hand winching devices, or, gas, electric rod propelled devices, shall be considered normal cleaning equipment.

3.5 WATER USAGE

A. Any and all water from the WMD, or other utility district, used by the Contractor, shall be from a metered supply with an approved backflow device to protect the water supply. All metered water supply shall be paid to the Owner through the regular billing system. See Utility Billing for fee amounts.

B. Contractor shall be responsible for obtaining transient water meter(s) from the WMD or other utility districts, which shall be installed on the trucks or at fire hydrant(s). All related charges for the set-up shall be considered incidental to the cleaning of the existing sanitary sewer mains.

C. Contractor shall be responsible for preventing contamination of the potable water system. When drawing water from a public hydrant, Contractor shall use a backflow preventer or an 18-inch air gap.

D. No fire hydrant shall be obstructed or used when there is a fire in the area.

E. It shall be the Contractor's responsibility to obtain approval to use the WMD's, or other

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utility district's fire hydrants.

F. The WMD will install and remove all temporary fire hydrant meters with the COF water system.

3.6 REMOVAL AND DISPOSAL OF DEBRIS

A. All materials removed from the sanitary sewer lines during cleaning operations shall be trapped and removed from the system at the downstream manhole of the section being cleaned. All materials shall be disposed of in compliance with all applicable laws and regulations and in a manner approved by the Owner.

B. Passing of debris from upstream manhole sections to downstream manhole sections will not be allowed.

C. All debris from the manholes shall be loaded into an enclosed container that is permitted by WMD and the Tennessee Department of Environment and Conservation (TDEC) for liquid waste hauling.

D. All solids or semi-solids resulting from the cleaning operations shall be removed from the site at the end of each workday, and disposed of properly at the Contractor's expense.

E. Contractor shall not be allowed to accumulate debris, or liquid waste, sludge, etc. on the site.

F. Under no circumstances shall sewage or solids removed in the cleaning process be dumped onto streets or into ditches, catch basins, storm drains, sanitary sewer manholes, cleanouts, or dumpsters.

END OF SECTION

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PART 1 – GENERAL

1.1 SUMMARY

A. The Work covered by this section includes furnishing all labor, equipment, and materials required to clean and inspect the designated sanitary sewer lines specified.

B. Closed-circuit television inspection of sanitary sewers as follows:
   1. TV inspection on all lines proposed for rehabilitation under this Contract shall be performed were no videotape of the sanitary sewer is available from Owner
   2. TV inspection of line segments specified for chemical root removal, shall be required to confirm cleaning and location of service connections.
   3. Contractor shall use an industry standard Television Inspection Form.
   4. Digital videos, data, and photos shall be delivered to the Owner on DVD, CD-ROM or thumb drive.

1.2 SUBMITTALS

A. Action Submittals: Catalog and manufacturer's data sheets for television equipment.

B. Informational Submittals:
   1. References: Contact names and telephone numbers.
   2. List of staff and equipment to be used on project.
   3. Crew chief qualifications.
   4. Traffic control plan.
   5. Initial first days CCTV digital videos and inspection logs within 24 hours of start of CCTV inspection.
   6. Certification that staff to be used for the Work is properly trained in confined space entry and hazardous atmospheres.
   7. Chemical root removal – MSDS to be approved by WMD.
   8. Emergency plan, including bypass pumping if necessary, to be reviewed and approved by WMD.
   9. Final report.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Contractor: Performed work successfully for at least three other projects, within last 5 years, with pipe lengths and pipe diameters similar to this project.
   2. Crew Chief: Minimum of 5 years experience on projects similar to this project and experienced using proposed equipment for this project.

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1.4 NOTIFICATIONS

A. Notify Owner:

1. A minimum of 5 days prior to the anticipated commencement of inspections in any one area and 24 hours in advance of actual start.
2. When obstruction, restricting flow in pipeline, is discovered.
3. If depth of flow in pipeline exceeds 33 percent of pipe diameter.
4. If conditions for CCTV inspection are found to be unsafe or impractical.
5. Pipe configuration in field is different than shown on maps. Notification shall include diagram clearly indicating location of structure in relation to immediately adjacent structures.
6. In the event that the CCTV equipment fails, immediately notify the WMD prior to any equipment recovery.

B. The Contractor will notify building occupants regarding Sewer Television Inspection in the area by placing door hangers and/or signage not less than 72 hours prior to commencing work.

PART 2 – EXECUTION

2.1 PREPARATION

A. Contractor shall televise the pipeline prior to performing any cleaning operations. If the pipeline is obstructed, the Contractor shall thoroughly clean the pipelines of debris, grease, roots, sediment, broken pipe, or other obstructions that could retard the movement of the television camera. Precautions shall be taken to protect the sanitary sewer lines being cleaned from damage by the cleaning equipment.

B. Immediately after cleaning, the sanitary sewer line section shall be visually inspected by means of closed-circuit television to determine the condition of the line and to locate existing service connections. The inspection will be done one manhole section at a time and the flow in the section being inspected will be suitably controlled as specified. (See Division 33 Section "Sanitary sewer Flow Control").
   1. Contractor shall not be allowed to float the camera unless permitted by Owner.

C. All internal pipe damage shall be photographed in color by Contractor utilizing picture capture equipment, and shall be clearly labeled as to date, each number, footage, and type of defect. The photographs shall be the property of Owner.

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2.2 TELEVISION INSPECTION

A. The camera shall be moved through the line in either direction at a moderate rate, stopping when necessary to permit proper documentation of the sanitary sewer line section condition. In no case will the television camera be pulled at a speed greater than 30 feet per minute. Manual winches, power winches, TV cable, and powered rewinds or other devices that do not obstruct the camera view or interfere with proper documentation of the sanitary sewer conditions shall be used to move the camera through the sanitary sewer line. Contractor is required to provide running water within the pipe during TV inspections.

B. When manually operated winches are used to pull the television camera through the line, telephones or other suitable means of communication shall be set up between the two manholes of the section being inspected to ensure good communications between members of the crew.

C. The importance of accurate distance measurements is emphasized. Measurement for location of defects shall be above ground by means of a meter device. Marking on the cable, or the like, which would require interpolation for depth of manhole, will not be allowed. Accuracy of the distance meter shall be checked by use of a walking meter, roll-a-tape, or other suitable device; accuracy shall be satisfactory to Owner.

D. The camera height shall be adjusted such that the camera lens is always centered in the pipe being televised.

E. Lighting system shall be adequate for quality pictures. A reflector in front of the camera may be required to enhance lighting in black pipe.

2.3 PASSAGE OF TV CAMERA

A. It is the intent of the Scope of Work to inspect the full length of sanitary sewer between each manhole, but there may be occasions during the TV inspection of a sanitary sewer line section, when the camera will be unable to pass an obstruction even though flow is continuing. If, during the inspection operation, the television camera will not pass through the entire manhole section, the Contractor shall set up his equipment so that the inspection can be performed from the opposite manhole. No additional payment shall be made for reverse set-ups required due to an obstruction.
   1. When the camera is being pulled from the “other end” and a second repair location is encountered away from the first repair/obstruction location, Owner shall be notified and allowed to review the TV DVD at the Site in a timely manner. Obtain Owner’s permission to make the two point repairs. No downtime shall be allowed.

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a. If the repairs are allowed and completed, Contractor shall again proceed to re-televise the sanitary sewer line section.

2. Owner makes no guarantee that all of the sanitary sewer mains proposed to be TV inspected after the cleaning, are clear for the passage of the camera set-up. The equipment, tools and method(s) used for securing the passage of the camera are to be at the discretion of Contractor, with the approval of Owner. The decision to repair or not to repair a location shall always be made by Owner.

B. TV videos shall be submitted in one continuous section from manhole to manhole, and not in broken pieces, unless specifically approved by Owner.

C. Roots shall be removed in the sections where root intrusion is a problem. Special precautions should be exercised during the cleaning operation to assure complete removal of visible roots from the joint area. Any visible roots that may impact rehabilitation efforts shall be removed. Procedures may include the use of mechanical devises such as rodding machines, expanding root cutters and porcupines, and hydraulic procedures such as high-pressure jet cleaners.

D. To aid in the removal of roots and at the option of Contractor, sanitary sewer sections that have root intrusion may be treated with an Owner-approved herbicide. For approved applicable herbicide MSDS shall be submitted to WMD. The application of the herbicide to the roots shall be done in strict accordance with the manufacturer's recommendations and specifications in such a manner to preclude any damage to the surrounding vegetation. Contractor shall replace any damaged vegetation so designated by Owner or Engineer, at no additional cost to Owner. All safety precautions as recommended by the manufacturer shall be strictly adhered to concerning handling and application of the herbicide.

E. Contractor, after cleaning a section of pipe, shall utilize the television camera to inspect the main. No line shall be considered cleaned until Owner approves.

F. For Owner funded projects: The television camera shall travel through the lines using its own power. The pictures taken of the entire inside periphery of the pipe shall be clear and visible. Picture quality and definition shall be to the satisfaction of Owner, and if unsatisfactory, the equipment shall be removed and no payment made for the unsatisfactory inspection.

G. At all service laterals the camera shall be stopped and panned to such an angle that an internal view of the service lateral is available to determine if the lateral is active, dead or plugged. Where other pipe deficiencies are noted, the camera shall be stopped to observe the condition, record information and take photographs. Any service lateral or deficiency observed in the sanitary sewer line shall be photographed and described on the photograph.

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2.4 DOCUMENTATION

A. Contractor shall submit in electronic format digital videos, photos, and evaluation reports, to Owner.

B. The digital video shall be recorded at Standard Play and each digital video segment information entered in the software as required under Article Basic Module (1) – Survey/Logging Report.

C. If digital videos are of such poor quality that Owner is unable to evaluate the condition of the sanitary sewer main, locate the sanitary sewer service connections, or verify the cleaning Contractor shall be required to re-televise the sanitary sewer and provide a new digital videos of good quality, at no additional cost to Owner.

2.5 BASIC MODULE (1) – SURVEY/LOGGING REPORT

A. The software's core module shall be capable of providing complete survey reports and be PACP (Pipeline Assessment and Certification Program) certified by NASSCO. The software shall be the latest version of PipeLogix.

B. There shall be PACP Complaint codes pre-programmed and grouped by PACP Groups.

C. The software shall be capable of customization with the ability to modify or add to the pipeline condition and group them for ease of use.

D. The footage reading from the camera equipment shall be automatically entered into the Survey Log through RS232 cable and shall directly correspond to the noted defect location throughout the pipe graphic and tabular reports generated.

E. The inspection and reporting software program shall be menu-driven and shall have a complete on-screen help file.

F. Drop-down boxes shall be utilized to quickly reference common information such as defects, pipe materials, survey purpose, locations, pipe usage, etc.

G. The browser screen shall allow quick viewing of:
   1. Sequential survey/segment as setup number (automatic input by software).
   2. User-selected categories.
   3. Up-stream and down-stream manhole numbers.
   4. Street name.
   5. Pipe segment details.

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6. Drainage basin number.

H. All relevant pipe segment information shall be entered prior to the actual survey. The below listed minimum pipe details must be supplied in the software for proper system management. The graphic and tabular survey reports generated shall include the following information:
   1. Pipe diameter.
   2. Starting manhole number. (per COF numbering)
   3. Ending manhole number. (per COF numbering)
   4. Starting manhole depth.
   5. Ending manhole depth.
   6. Direction of survey.
   7. Pre-clean (y/n).
   8. Total surveyed length.
   9. Pipe material.
   10. Pipe section length.
   11. Pipe shape.
   12. Road name.
   13. Address or place name.
   14. Work Order number.
   15. Video CD number.
   16. Engineering drawing number.
   17. Purpose of survey.
   18. Estimate Pipe age (year of construction, if known).
   19. Inspection of survey date.
   20. Depth of water in starting manhole.

I. PipeLogix software (latest version) shall maintain a database of underground pipe and manhole assets. The database(s) shall have structure similar to the one referencing pipe usage (i.e., sanitary storm drainage, etc.) sections (i.e., projects, areas, or quadrants). Surveys shall include a method of pipe segment numbering and a chronological survey set-up numbering system.

J. PipeLogix's basic module database shall have the means to sort in ascending and descending order according to date, pipe segment, reference number, road name, manhole number(s), observed footage, pipe materials, pipe diameters, work order numbers, etc. A filtering system shall also be made available.

K. The basic module software shall have search capabilities in order to find information about past surveys located in the database(s).

L. A summary paragraph shall be made available for a conclusive pipe segment assessment.

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M. The graphical reports shall print in color for quick glance referencing of the defect category. The color-coding scheme shall allow for quick reference as to the quality of service, structural, hydraulic, and constructional defects within a particular survey.

N. A scoring system incorporated in the software will assist the user/management personnel in making proper assessment of pipe conditions. Scoring is to be based upon defect severity entered by the operator.

O. An inspection "health check" feature shall be incorporated to insure that the information has been correctly entered. The health check allows for verification of essential information to complete a survey. This feature can be implemented individually or on a total selection basis.

P. A Site sketch feature shall also be supplied so that a drawing or sketch shall indicate special details or locations about a particular set-up Site.

Q. The software shall also have the capability to import and export survey results in a variety of industry standard formats.

2.6 BASIC MODULE (1) – SUMMARY REPORTING

A. Summary reports compiling data from multiple inspections shall be available. Such reports shall indicate individual survey results in tabular from and list (sort) surveys based on a user-defined description field.

B. Defect report shall be programmable to list specific defects observed with corresponding footage, starting and ending manhole number, structural pipe defects (i.e., cracks, offsets, defective laterals, collapsed pipe, etc.) and service-oriented defects (i.e., roots, grease, obstructions, infiltration, etc.).

C. A drainage schedule report shall include starting and ending manhole numbers, depths, pipe material, total survey length, and pipe diameter.

D. The grading scores report shall summarize the manhole numbers, pipe material, pipe diameter, and the grade scores for each survey with totals.

E. Service and structural aspect scoring reports are to list the pipe segment, reference number, total observed length, number of defects, and total score with reference to the condition of the total pipe, average of the pipe, total defects, and average of defects.

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F. Section summary reports are to be made available so that all surveys within a section are listed showing purpose of inspection, date, work order numbers, manholes, road names, and total lengths.

G. All software shall be compatible with Owner's current system.

2.7 EVALUATION REPORTS

A. Each video shall be accompanied by a TV inspection report, which shall be a written/narrated log of all pipe defects, sags, service connection locations and conditions, etc., recorded on a footage basis. Report shall be provided in an electronic (computer usable) format that is transferable to a Microsoft Access database.

B. The pipe defects shall include separate codes for the following: Radial Cracks, Longitudinal Cracks, Misaligned Joints, Broken Joints, Root Intrusion, Laterals, and Infiltration. The size/length of the defect shall be reported. The beginning of all sags of the pipe, the length that is underwater as well as where the camera pulls out of the sag shall be reported. The clock position of each service connection and the condition shall be reported. The condition of each service connection will include the distance protruding when appropriate and the type. All other information required for analysis such as degrees of deterioration, deformation or collapsed pipe shall be reported. All reports and/or submittals shall adhere to Pipeline Assessment Certification Program (PACP) Standards.

C. This log shall also identify the section being televised, flow and camera direction, type of pipe, pipe condition, weather conditions, type of surface cover, or any other information required by Owner.

D. Owner may provide Contractor a log form that utilizes codes for the above-mentioned defects.

E. At the end of the project, Contractor shall provide a summary listing of all videos provided under this project.

END OF SECTION

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PART 1 – GENERAL

1.1 SUBMITTALS

A. Product Data

1. Prior to fabrication, pump station manufacturer shall submit electronic copies of submittal data for review and approval.
2. Submittal shall include shop drawings, electrical ladder logic drawings, and support data as follows: Catalog cut sheets reflecting characteristics for major items of equipment, materials of construction, major dimensions, motor and v-belt drive data, pump characteristic curves showing the design duty point capacity (GPM), head (FT), net positive suction head required (NPSHr), and hydraulic brake horsepower (BHP). Electrical components used in the motor branch and liquid level control shall be fully described.
3. Shop drawings shall provide layout of mechanical equipment and anchor bolt locations for station. Pipe penetrations and station access clearances shall be dimensioned relative to the station centerline. The electrical ladder logic drawings shall illustrate motor branch and liquid level control circuits to extent necessary to validate function and integration of circuits to form a complete working system.

B. Operations and Maintenance Manuals

1. Operation shall be in accordance with written instructions provided by the pump station manufacturer. Comprehensive instructions supplied at time of shipment shall enable personnel to properly operate and maintain all equipment supplied. Content and instructions shall assume operating personnel are familiar with pumps, motors, piping and valves, but lack experience on exact equipment supplied.
2. Documentation shall be specific to the pump station supplied and collated in functional sections. Each section shall combine to form a complete system manual covering all aspects of equipment supplied by the station manufacturer. Support data for any equipment supplied by others, even if mounted or included in overall station design, shall be provided by those supplying the equipment. Instructions shall include the following as a minimum:
    a. Functional description of each major component, complete with operating instructions.
    b. Instructions for operating pumps and pump controls in all modes of operation.
    c. Calibration and adjustment of equipment for initial start-up, replacement of level control components, or as required for routine maintenance.
    d. Support data for commercially available components not produced by the station manufacturer, but supplied in accordance with specifications, shall be supported by literature from the prime manufacturer and incorporated as appendices.

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e. Electrical schematic diagram of the pump station circuits shall be in accordance with NFPA 79. Schematics shall illustrate, to the extent of authorized repair, pump motor branch, control and alarm system circuits including interconnections. Wire numbers and legend symbols shall be shown. Schematic diagrams for individual components, not normally repairable by the station operator, need not be included. Details for such parts shall not be substituted for an overall system schematic. Partial schematics, block diagrams, and simplified schematics shall not be provided in lieu of an overall system diagram.

f. Mechanical layout drawing of the pump station and components, prepared in accordance with good commercial practice, shall provide installation dimensions and location of all pumps, motors, valves and piping.

3. Operation and maintenance instructions which rely on vendor cut-sheets and literature which include general configurations, or require operating personnel to selectively read portions of the manual shall not be acceptable. Operation and maintenance instructions must be specific to equipment supplied in accordance with these specifications.

1.2 QUALITY ASSURANCE

A. The manufacturer of the pump station shall have a minimum of five years' experience in the design and manufacture of factory-built automatic pump stations of similar size and shall guarantee the structure and all equipment to be free from defects in materials and workmanship for a period up to two years from the date of start-up, not to exceed 30 months from the date of shipment.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of pumping stations and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Hydraulic Institute Compliance: Comply with Hydraulic Institute 1.1-1.5 for sewage and sump pumps.

E. NEMA Compliance: Comply with NEMA MG 1 for electric motors.

F. UL Compliance: Comply with UL 778 for sewage and sump pumps.

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G. The pumps and pump station manufacturer must be ISO 9001:2000 revision certified, with scope of registration including design control and service after sales activities.

H. Upon request from the Owner, the pump station manufacturer shall prove financial stability and ability to produce the station within the specified delivery schedules. Evidence of facilities, equipment and expertise shall demonstrate the manufacturer's commitment to long term customer service and product support.

I. In order to unify responsibility for proper operation, it is the intent of these Specifications that all system components be furnished by a single supplier (unitary source) and that source shall be the pump manufacturer. The pumps must be of standard catalog design, totally warranted by the manufacturer. Under no circumstances will a system consisting of parts compiled and assembled by a manufacturer's representative or distributor be accepted.

J. Manufacturer must show proof of original product design and testing. Products violating intellectual property regulations shall not be allowed, as they may violate international law and expose the user to unintended liabilities. "Reverse-engineered" products fabricated to substantially duplicate the design of original product shall not be allowed, as they may contain substantial differences in tolerances and material applications addressed in the original design, which may contribute to product failure.

K. The term "pump manufacturer" or "pump station manufacturer" shall be defined as the entity which designs, machines, assembles, hydraulically tests and warranties the final product.

L. Pump Performance Certifications:
   1. All internal passages, impeller vanes, and recirculation ports shall pass a 3-inch spherical solid. Smaller internal passages that create a maintenance nuisance or interfere with priming and pump performance shall not be permitted. Upon request from the Owner, manufacturer's certified drawings showing size and location of the recirculation port(s) shall be submitted for approval.
   2. Reprime Performance:
      a. Consideration shall be given to the sanitary sewage service anticipated, in which debris is expected to lodge between the suction check valve and its seat, resulting in the loss of the pump suction leg, and siphoning of liquid from the pump casing to the approximate center line of the impeller. Such occurrence shall be considered normal, and the pump must be capable of automatic, unattended operation with an air release line installed.
      b. During unattended operation, the pump shall retain adequate liquid in the casing to insure automatic repriming while operating at its rated speed in a completely

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open system. The need for a suction check valve or external priming device shall not be required.

c. Pump must be capable of repriming 25 vertical feet at the specified speed and impeller diameter. Reprime lift is defined as the static height of the pump suction above the liquid, while operating with only one-half of the liquid remaining in the pump casing. The pump must reprime and deliver full capacity within five minutes after the pump is energized in the reprime condition. Reprime performance must be confirmed with the following test set-up:
    1) A check valve to be installed downstream from the pump discharge flange. The check valve size shall be equal (or greater than) the pump discharge diameter.
    2) A length of air release pipe shall be installed between pump and the discharge check valve. This line shall be open to the atmosphere at all times duplicating the air displacement rate anticipated at a typical pump station fitted with an air release valve.
    3) The pump suction check valve shall be removed. No restrictions in the pump or suction piping will prevent the siphon drop of the suction leg. Suction pipe configuration for reprime test shall incorporate a 2 feet minimum horizontal run, a 90^{o} elbow and vertical run at the specified lift. Pipe size shall be equal to the pump suction diameter.
    4) Impeller clearances shall be set as recommended in the pump service manual.
    5) Repeatability of performance shall be demonstrated by testing five consecutive reprime cycles. Full pump capacity (flow) shall be achieved within five minutes during each cycle.
    6) Liquid to be used for reprime test shall be water.

3. Upon request from the Owner, certified reprime performance test results, prepared by the manufacturer, and certified by a registered professional engineer, shall be submitted for approval prior to shipment.

M. Factory System Test:
1. All internal components including the pumps, motors, valves, piping and controls will be tested as a complete working system at the manufacturer's facility. Tests shall be conducted in accordance with Hydraulic Institute Standards at the specified head, capacity, rated speed and horsepower. Factory operational test shall simulate actual performance anticipated for the complete station.
2. Upon request from the Owner, the operational test may be witnessed by the Owner, and/or representatives of his choice, at the manufacturer's facility.

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N. The manufacturer's technical representative shall inspect the completed installation, correct or supervise the correction of any defect or malfunction, and instruct operating personnel in the proper operation and maintenance of the equipment as described in Part 3 of this Section.

1.3 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
   1. Notify Owner not less than two days in advance of proposed utility interruptions.

1.4 WARRANTY

A. Warranties and guarantees of suppliers of various components in lieu of a single source responsibility by the pump station manufacturer will not be accepted. The pump station manufacturer shall be solely responsible for the guarantee of the station and all components. In the event a component fails to perform as specified or is proven defective in service during the guarantee period, the pump station manufacturer shall provide a replacement part without cost to the Owner. He shall further provide, without cost, such labor as may be required to replace, repair or modify major components such as pumps, pump motors and sewage piping manifold.

1.5 MANUFACTURED EQUIPMENT EVALUATION

A. The specifications and drawings detail approved manufacturer's equipment and represent the minimum standard of quality for both equipment and materials of construction. The Contractor shall prepare his bid based on this equipment for the purpose of determining the low bid without consideration of possible substitute.

B. Substitution of other makes may be considered if the equipment proposed for substitution is superior or equal in quality and efficiency to the standards of quality named in the specifications and is demonstrated to the satisfaction of the Owner.

C. Contractors wishing to offer a deduct for substitute equipment shall include the following submittal information. This submittal shall include all necessary information for the proper determination of the acceptability of the proposed substitution and shall not necessarily be limited to the following:
   1. Complete description of the equipment, system, process or function, including a list of system components and features, drawings, catalog information and cuts, manufacturer's specifications, including materials descriptions.

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2. Performance data and curves, and horsepower requirements.
3. Outside utility requirements, such as water, power, air, etc.
4. Functional description of any internal instrumentation and controls supplied including list of parameters monitored, controlled or alarmed.
5. Addresses and phone numbers of nearest service centers and a listing of the manufacturer's or representative's services available at these locations, including addresses and phone numbers of the nearest parts warehouses capable of providing full parts replacement and/or repair services.
6. A list of five similar in size installations in the states where similar equipment by the manufacturer is currently in similar service; include contact name, telephone number, mailing address of the municipality or installation; engineer, owner, and installing contractor. If five installations do not exist, the list shall include all that do exist, if any.
7. Detailed information on site, architectural, structural, mechanical, plumbing, electrical and control, and all other changes or modifications to the design and construction work necessary to adapt the equipment or systems to the arrangement shown and/or functions described on the drawings and in the technical specifications. This shall include plan view and section sketches illustrating any additional space requirements necessary to provide the minimum adequate clear space within and around the equipment for operation and maintenance, as shown on the drawings and specified.
8. All differences between the specifications and the proposed substitute equipment shall be clearly stated in writing under a heading of "differences".
9. Other specific submittal requirements listed in the detailed equipment and material specifications.

D. Approval of the substitution to bid as an alternate shall in no way relieve the Contractor from submitting the specified shop drawings for approval or complying fully with all provisions of the specifications and drawings. If substituted equipment is accepted, the Contractor shall, at his own expense, make any changes in the structures, piping, electrical, etc. necessary to accommodate the equipment. If engineering is required due to substitution of alternate equipment, the Contractor shall pay for all engineering changes. To receive final consideration, copies of the manufacturer's quotations for the equipment may be required to document the savings to the satisfaction of the Owner. It is the intent that the Owner shall receive the full benefit of the savings in cost of the equipment and the Contractor's bid price shall be reduced by an amount equal to the savings. In all technical and other evaluations, the decision of the Owner is final.

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PART 2 – PRODUCTS

2.1 SYSTEM DESCRIPTION

A. The sanitary sewer pumping system provided as required by this Specification shall be a complete, stand alone, pumping system with an enclosure suitable for above- ground outdoor installation, and shall include an emergency "quick connect" coupling, as specified by the Owner.

B. In addition to the station enclosure, principle items of equipment shall include two (or three) horizontal, self priming, centrifugal sewage pumps, V-belt drives, motors, internal piping, valves, motor control panel, automatic liquid level control system, and internal wiring.

C. Emergency supplemental power shall be provided as directed by the Owner.

2.2 MANUFACTURERS

A. Approved Manufacturers
   1. Gorman-Rupp Company.
   2. ABS.
   3. Flygt.
   4. Approved equal.

B. Terminology used may include reference to that manufacturer's performance and product. Such reference shall be construed only as establishing quality of materials and workmanship to be used under this Section. It shall not in any way, be construed as limiting competition.

2.3 DESIGN REQUIREMENTS

A. Operating Conditions
   1. Ambient Air Temperature:
      a. Maximum 105°F
      b. Minimum 10°F
   2. Outdoor Continuous Service
   3. Altitude 600 ft msl

B. Electrical Service: Electrical service provided at the pump station site shall be 480V, 3 phase, 60 cycle, 4 wire service as provided by the local electric utility. Voltage tolerance shall be plus or minus 10 percent. Phase-to-phase unbalance shall not exceed 1% average voltage as set forth in NEMA Standard MG-1. Control voltage shall not exceed 132 volts.

C. All electrical control panels and valves shall be above ground.

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D. All stations shall be located within a site prepared, landscaped, fenced area and provided with a permanent asphalt drive, or approved equal, accessible at all times. The site must provide adequate area for the WMD personnel to maneuver onsite.

E. The access road to the pump station shall be a minimum of twelve (12) feet wide.

F. The slope of the drive shall not exceed twelve (12) percent.

G. Provisions shall include sufficient right-of-way for overhead power and telephone service.

H. All stations shall have a water supply for maintenance.

I. Exterior security lights shall be installed at every station.

J. All pumping stations shall have back up air compressors.

K. The station's operational components shall be located at an elevation that is not subject to the 100-year flood or shall otherwise be adequately protected against the 100-year flood damage. The top (floor) of the pumping station shall be a minimum of 6 inches above the finished grade of the site around the station. Where the wet well is at a depth greater than the water table elevation, special provisions shall be made to ensure water tight construction of the wet well. Any connections to the pump station should be made at an elevation higher than the maximum water table elevation, where possible.

L. In general, lift stations shall have an approved backflow preventer. Details of this installation shall be approved prior to installation. The backflow preventer shall be installed such that it is protected from freezing and in a manner to allow for proper drainage and testing.

M. Provide a diagram detailing how to bypass the pumps. This diagram shall be displayed within the station enclosure so that it can be easily located.

2.4 SERVICE AND CAPACITY

A. Sanitary sewer pumping systems must be designed to handle raw, unscreened, domestic sanitary sewage and shall provide unattended, alternating duplex pump operation.

2.5 STATION ENCLOSURE

A. The station enclosure shall provide sufficient inside area for maintenance personnel to perform normal operation and maintenance inside, sheltered, and free from foul weather. The enclosure shall consist of a base to support the pumps and a cover. Minimum dimensions of the enclosure shall be eight feet by twelve feet and nine feet in height.

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B. The station enclosure shall be manufactured of molded fiberglass reinforced orthophthalic polyester resins with a minimum of 30% fiberglass, and a maximum of 70% resin. Glass fibers shall have a minimum average length of 1¼ inches. Resin fillers or extenders shall not be used. Major design considerations shall be given to structural stability, corrosion resistance, and water-tight properties. The polyester laminates shall provide a balance of mechanical, chemical, and electrical properties to insure long maintenance free life. They must be impervious to micro-organisms, mildew, mold, fungus, corrosive liquids, and gases which can reasonably be expected to be present in the environment surrounding the wet well. Wood core type enclosures shall not be considered acceptable and shall be basis for equipment rejection. See manufacturer's requirements for enclosure warranty in these specifications.

C. All interior surfaces of the housing shall be gel coated with a polyester resin. It shall be of suitable thickness and formulated to provide:
   1. Maintenance-free service
   2. Abrasion resistance
   3. Protection from sewage, greases, oils, gasoline, and other common chemicals.
   4. Color fastness
   5. Gloss retention

D. Interior surfaces of the enclosure cover shall be white for maximum light reflectivity. The base shall be of a darker color to de-emphasize the presence of dirt, grease, etc. Colors used for both portions shall result in a pleasing looking structure.

E. The pump station shall be furnished with 1" thick foam insulation which shall be applied to the walls, door, and roof to achieve an R-6 insulation factor. A gasketed seal around the door shall also be included.

F. The outside of the enclosure shall be coated with a suitable pigmented resin compound to insure long, maintenance-free life. The fiberglass enclosure shall be a regular product of the pump station manufacturer.

G. Station base shall be constructed of pre-cast, reinforced concrete encapsulated in a fiberglass mold. The design shall resist deformation of the structure during shipping, lifting, or handling. Base shall incorporate drainage provisions, and an opening sized to permit installation of piping and service connections to the wet well. After installation, the opening shall serve as a grout dam to be utilized by the Contractor. The base shall incorporate anchor bolt recesses for securing the complete station to a concrete pad (supplied by the Contractor) in accordance with the project plans.

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H. Holes through the base shall be provided for suction and discharge lines, air release lines, and level control line. Holes for the suction and discharge lines shall be provided with a grout dam incorporated in a grout retention cavity which the Contractor shall fill at installation with suitable grout to seal each pipe-to-base joint against the entrance of hazardous gases from the wet well.

I. Station base shall incorporate a suitable flange designed for securing the pump station to the concrete pad in accordance with the station plans.

J. The enclosure cover shall be provided with a hinged fiberglass reinforced access door. Minimum dimensions of the door shall be 36 inches wide by 78 inches high for access by maintenance personnel to station interior. Door shall be a minimum 1 7/8 inch thick and shall be hinged with a minimum of two heavy duty stainless steel hinges to the enclosure cover. Door shall be furnished with a padlockable handle connected to a latching mechanism. Latch shall engage door casing or maximum security against vandalism. All mounting hardware for door casing and door must be concealed or of such type as to prevent vandalism with ordinary tools.

K. Removable panels shall be supplied on two sides of the enclosure for additional access to equipment. Location and size shall permit access for routine maintenance functions such as pump and motor inspection, drive belt adjustment, and pump clean-out. Non-hinged panels shall be secured with stainless steel tamper-proof hardware.

L. A duplex ground fault indicating utility receptacle providing 115 volts, single phase, 60 hertz shall be mounted inside the pump station. Receptacle shall be NEMA 5-15r configuration, heavy duty, specification grade and fitted with a weatherproof cover. The receptacle shall be protected by normal duty circuit breaker.

M. A shuttered exhaust fan with a minimum capacity of 500 CFM to change the air in the enclosure once every minute, shall be mounted in the end wall approximately opposite the hinged door opening. An air intake vent shall be mounted in the hinged door assembly. Both intake and exhaust opening shall be equipped with a screen and cowl suitably designed to prevent the entrance of rain, snow, rocks, and other foreign material. The thermostatically controlled exhaust fan shall energize automatically at approximately 70 degrees F, and turned off at 55 degrees F. Fan circuit shall be protected by a normal duty circuit breaker.

N. Two enclosed and gasketed 80 watt fluorescent light fixtures shall be provided. The fixtures shall be NEMA 4, suitable for wet location. The fixtures shall be located to provide adequate

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light to all parts of the station and shall not constitute a physical hazard to inspection or service personnel. Light circuit shall be protected by a normal duty circuit breaker and shall be provided with a disconnect switch.

O. Station Heater:
   1. A 4 KW three-phase wall mounted forced air heater shall be provided for protection of the pump station equipment. The heater shall maintain an inside/outside temperature differential of 60 degrees F while operating on the primary electrical power available to the station. The heater shall be controlled by a thermostat and contactor and protected by a heavy duty circuit breaker.

P. Door Open Notification
   1. The station enclosure shall include limit switches with defeater switch alarm circuit and time delay, mounted and wired in the station enclosure to indicate that there has been a door left open or unauthorized entry to the station. There shall be an adjustable time period for the operator to disable alarm with an unmarked pushbutton located inside the station. The notification shall be activated when a station door or access panel is opened. Includes dry contacts pre-wired to a terminal strip for remote monitoring.

2.6 PUMPS

A. Pump shall be horizontal, self-priming centrifugal type, designed specifically for handling raw unscreened domestic sanitary sewage or industrial waste. Pump solids handling capability and performance criteria shall be in accordance with requirements listed under PART 1 - GENERAL of this Section.

B. The pump manufacturer must be ISO 9001:2000 revision certified, with scope of registration including design control and service after sales activities.

C. Materials and Construction Features
   1. Pump casing shall be cast iron Class 30 with integral volute scroll. Casing shall incorporate following features:
      a. Mounting feet sized to prevent tipping or binding when pump is completely disassembled for maintenance.
      b. Fill port cover plate, 3 1/2" diameter, shall be opened after loosening a positive lock clamp bar assembly. In consideration for safety, capscrew threads must provide slow release of pressure, and the clamp bar shall be retained by detente lugs. A non-metallic gasket shall prevent adhesion of the fill port cover to the casing while assuring a reliable seal.
      c. Casing drain plug shall be at least 1 1/4" NPT to insure complete and rapid draining.

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d. Liquid volume and recirculation port design shall be consistent with performance criteria listed under PART 1 - GENERAL of this Section.

2. Cover plate shall be cast iron Class 30. Design must incorporate the following maintenance features:
   a. Retained by hand nuts for complete access to pump interior. Coverplate removal must provide ample clearance for removal of stoppages, and allow service to the impeller, seal, wearplate or check valve without removing suction or discharge piping.
   b. A replaceable wearplate secured to the cover plate by weld studs and nuts shall be AISI 1015 HRS. Wearplate shall be self-cleaning design ensuring that debris is cleared away and does not collect on the impeller vanes.
   c. In consideration for safety, a pressure relief valve shall be supplied in the cover plate. Relief valve shall open at 75-200 psi.
   d. Two O-rings of Buna-N material shall seal cover plate to pump casing.
   e. Pusher bolt capability to assist in removal of cover plate. Pusher bolt threaded holes shall be sized to accept same retaining capscrews as used in rotating assembly.
   f. Easy-grip handle shall be mounted to face of cover plate.
3. Rotating assembly, which includes impeller, shaft, mechanical shaft seal, lip seals, bearings, seal plate and bearing housing, must be removable as a single unit without disturbing the pump casing or piping. Design shall incorporate the following features:
   a. Seal plate and bearing housing shall be cast iron Class 30. Anti-rotation ribs shall be cast into the sealplate to reduce internal wear and maximize component life. Separate oil filled cavities, vented to atmosphere, shall be provided for shaft seal and bearings. Cavities must be cooled by the liquid pumped. Three lip seals will prevent leakage of oil.
4. The bearing cavity shall have an oil level sight gauge and fill plug check valve. The clear sight gauge shall provide easy monitoring of the bearing cavity oil level and condition of oil without removal of the fill plug check valve. The check valve shall vent the cavity but prevent introduction of moist air to the bearings.
5. The seal cavity shall have an oil level sight gauge and fill/vent plug. The clear sight gauge shall provide easy monitoring of the seal cavity oil level and condition of oil without removal of the fill/vent plug.
6. Double lip seal shall provide an atmospheric path providing positive protection of bearings, with capability for external drainage monitoring.
   b. Impeller shall be ductile iron, two vane, semi-open, non-clog, with integral pump out vanes on the back shroud. Impeller shall be statically or dynamically balanced. Impeller shall thread onto the pump shaft and be secured with a lockscrew and conical washer.

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c. Shaft shall be AISI 4140 alloy steel unless otherwise specified by the Owner, in which case AISI 17-4 pH stainless steel shall be supplied.
d. Bearings shall be anti-friction ball type of proper size and design to withstand all radial and thrust loads expected during normal operation. Bearings shall be oil lubricated from a dedicated reservoir. Pump designs which use the same oil to lubricate the bearings and shaft seal shall not be acceptable.
e. Shaft seal shall be oil lubricated mechanical type. The stationary and rotating seal faces shall be silicon carbide alloy. Each mating surface shall be lapped to within three light bands flatness (35 millionths of an inch), as measured by an optical flat under monochromatic light. The stationary seal seat shall be double floating by virtue of a dual O-ring design. An external O-ring secures the stationary seat to the sealplate, and an internal O-ring holds the faces in alignment during periods of mechanical or hydraulic shock (loads which cause shaft deflection, vibration, and axial/radial movement). Elastomers shall be viton; cage and spring to be stainless steel. Seal shall be oil lubricated from a dedicated reservoir. The same oil shall not lubricate both shaft seal and shaft bearings. Seal shall be warranted in accordance with requirements listed under PART 1 - GENERAL of this Section.
f. Pusher bolt capability to assist in removal of rotating assembly. Pusher bolt threaded holes shall be sized to accept same capscrews as used for retaining rotating assembly.

7. Adjustment of the impeller face clearance (distance between impeller and wearplate) shall be accomplished by external means.
   a. Clearances shall be maintained by a four point external shimless cover plate adjustment system, utilizing a four collar and four adjusting screw design allowing for incremental adjustment of clearances by hand as required. Each of the four points shall be lockable to prevent inadvertent clearance increases or decreases due to equipment vibration or accidental operator contact. The four point system also allows for equal clearance gaps at all points between the impeller and wear plate. Requirement of realignment of belts, couplings, etc., shall not be acceptable. Coverplate shall be capable of being removed without disturbing clearance settings. Clearance adjustment systems that utilize less than four points will not be considered.
   b. There shall be provisions for additional clearance adjustment in the event that adjustment tolerances have been depleted from the cover plate side of the pump. The removal of stainless steel tabbed spacers from the rotating assembly side of the pump shall allow for further adjustment as described above.
   c. Clearance adjustment which requires movement of the shaft only, thereby adversely affecting seal working length or impeller back clearance, shall not be acceptable.

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5. An externally removable suction check valve shall be molded Neoprene with integral steel and nylon reinforcement. A blow-out center shall protect pump casing from hydraulic shock or excessive pressure. Removal or installation of the check valve must be accomplished from the top of pump without disturbing the suction piping or completely draining the casing. Sole function of check valve shall be to save energy by eliminating need to reprime after each pumping cycle. Pumps requiring a suction check valve to assist reprime will not be acceptable.
8. Pump shall include flange kit consisting of two ASA spool flanges that shall be one piece cast iron class 30 suitable for attachment to suction and discharge ports. Each spool shall have one 1-1/4" NPT and one 1/4" NPT tapped hole with pipe plugs for mounting gauges or other equipment.

D. Serviceability:
   1. The pump manufacturer shall demonstrate to the Owner's satisfaction that consideration has been given to reducing maintenance costs.
   2. No special tools shall be required for replacement of any components within the pump.

E. Drain Kit:
   1. Pumps to be supplied with a drain kit for ease of maintenance. The kit to contain 10' length of reinforced plastic hose with a female quick connect fitting at one end, and factory installed drain fittings in each pump. Fittings include a stainless steel pipe nipple, stainless steel bushing, stainless steel ball valve and aluminum male quick connect fitting.

F. Spare Parts Kit:
   1. The following minimum spare parts shall be furnished with the pump station:
      a. One spare pump mechanical seal (complete with shaft sleeve)
      b. One cover plate O-Ring
      c. One rotating assembly O-Ring
      d. One set of rotating assembly spacers

2.7 VALVES AND PIPING

A. Each pump shall be equipped with full flow type check valve capable of passing a 3" spherical solid. Valve shall be constructed with flanged ends and fitted with an external lever and torsional spring. Valve seat shall be constructed of stainless steel, secured to the body to ensure concentricity, sealed by an O-ring, and shall be replaceable. The valve body shall be cast iron incorporating a clean-out port large enough to allow removal and/or replacement of valve clapper without removing valve or piping from the line. Valve clapper shall have a molded Buna seating surface incorporating low pressure sealing rings. Valve hinge pin and internal hinge arm shall be stainless steel supported on each end in brass bushings. Shaft nut

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shall have double O-rings which shall be easily replaceable without requiring access to interior of valve body. All internal hardware shall be stainless steel. Valve shall be rated at 175 psi water working pressure, 350 psi hydrostatic test pressure. Valves other than full flow type or valves mounted in such a manner that prevents the passage of a 3" spherical solid shall not be acceptable.

B. Plug valves shall be of the non-lubricated, tapered type. Valve body shall be semi-steel with flanged end connection drilled to ANSI 125 lb. Standard. Valves shall have ports designed to pass spherical solids equal to the pump's capability. Valves shall be furnished with a drip-tight shutoff plug mounted in stainless steel or Teflon over phenolic bearings, and shall have a resilient facing bonded to the sealing surface.

C. Automatic Air Release Valves
   1. Each pump shall be equipped with an automatic air release valve designed to vent air to atmosphere during initial priming or unattended repriming cycles. Upon completion of the priming or repriming cycle, the valve shall automatically close operating solely on discharge pressure to prevent excess recirculation. A visible indication of valve closure shall be evident. Valves which connect to the suction line or rely on vacuum pumps shall not acceptable.
   2. The air release valve shall be constructed of UV-inhibiting, high impact composite polyester containing not less than 30% glass-filler. The valve body shall incorporate an internal passageway that allows all debris to pass through the valve chamber between operational cycles, thus making the valve self-cleaning upon sequential cycles. The valve diaphragms shall be Buna-N, Fluorocarbon or EPDM, and shall incorporate a polyester mesh sufficient to withstand 250 psi of pressure. Diaphragm materials of lesser-rated durability will not be deemed equal.
   3. The vertical valve plunger shall be constructed of Acetal and at least 20% PTFE fluorocarbon filler (DuPont Teflon or equivalent). The independent, dual diaphragms and single, vertical valve plunger shall incorporate a media fluid that passes through an orifice and separates the actions of each. This media fluid will impart sufficient energy for each diaphragm to act on the other to cause a metered stroke, allowing for predictable mechanical movement, thus opening and closing the valve smoothly, preventing chatter and harsh ramming forces. Valves with a single horizontal shaft or that do not incorporate straight-through passageways or media-limiting orifices will not be acceptable. The valve "seat" shall permit a prescribed bypass of the liquid being pumped to ensure that the valve does not become hydraulically locked in submerged discharge piping configurations.
   4. The valve shall employ an externally-adjustable restrictor for applications below four feet of static discharge head. Valves having no means to accurately adjust their action, or which require spring selection and lubrication are unacceptable. Being mechanically maintenance-free, provisions for clearing debris in the internal passageway normally

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associated with valves of this type are incorporated in the valve design and are accessible with only normal hand tools.

5. The valve body shall incorporate passageways having minimal constrictions and no directional course changes integral to the body of the valve. The inlet shall be 1 inch NPT female and the discharge outlet shall be 1-1/4 inch NPT female, assuring that any debris that makes its way through the valve body will have unobstructed passage back to the source. Valves having smaller throughput, bends or turns that restrict or impede flow and create pockets or traps for debris shall not be acceptable. The valve shall be mounted horizontally, 90 degrees to the vertical plunger by means of an integral mounting bracket.
6. The valve shall be able to operate on applications ranging from four to 400 feet of water column without the need for adjustment or interchange of springs or other parts.
7. Connection of the air release valves to pump station piping shall include stainless steel fittings.

D. Gauge Kit:
   1. A gauge kit shall be supplied for each pump. Suction pressure must be monitored by a glycerin-filled compound gauge, and discharge pressure by a glycerin-filled pressure gauge. Gauges to be at least 4 inches in diameter, graduated in feet water column. Rated accuracy shall be 1% of full scale reading. Compound gauge shall be graduated -34 to
   2. +34 feet water column minimum. Pressure gauge to be graduated 0 to 140 feet water column minimum.
   3. Gauges to be factory mounted on a resilient panel with frame assembly secured to pumps or piping. Gauge installations shall be complete with all hoses and stainless steel fittings, including a shutoff valve for each gauge line at the point of connection to suction and discharge pipes.

E. Piping:
   1. Flanged header pipe shall be centrifugally cast, ductile iron, complying with ANSI/AWWA A21.51/C115 and class 53 thickness.
   2. Flanges shall be cast iron class 125 and Comply with ANSI B16.1.
   3. Pipe and flanges shall be threaded and suitable thread sealant applied before assembling flange to pipe.
   4. Bolt holes shall be in angular alignment within 1/2o between flanges. Flanges shall be faced with a gasket finish.

F. Contractor must ensure all pipes connected to the pump station are supported to prevent piping loads from being transmitted to pumps or station piping. Pump station discharge force main piping shall be anchored with thrust blocks where shown on the contract drawings.

G. Portable Pump Discharge Connection:

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1. The station header pipe shall incorporate a 2-way plug valve to permit emergency access to the pump station force main after isolation of the pumps. Valve body shall be cast iron with flanged end connections drilled to 125 pound standard. The plug valve shall be non-lubricated type, furnished with a drip-tight shutoff plug mounted in stainless steel or Teflon over phenolic bearings, and shall have a resilient facing bonded to the sealing surface.
2. The bypass connection shall be accessible behind the hinged access panel on the wet well side of the station enclosure and shall terminate with a male OPW type quick connect fitting.

2.8 DRIVE UNIT

A. Motors (Note: Maximum motor frame size is 405T open drip-proof.)
   1. Pump motors shall be TBD HP, 3 phase, 60 hertz, 460 VAC, horizontal ODP, 1,800 RPM, NEMA design B with cast iron frame with copper windings, induction type, with Class F insulation and 1.15 service factor for normal starting torque and low starting current characteristics, suitable for continuous service. The motors shall not overload at the design condition or at any head in the operating range as specified.
   2. Motors shall be tested in accordance with provisions of ANSI/IEEE Std 112.

2.9 DRIVE TRANSMISSION

A. Power to pumps shall be transmitted through V-belt drive assemblies. The sheave/belt combination shall provide the speed ratio needed to achieve the specified pump operating conditions.

B. Each drive assembly shall utilize at least two V-belts providing minimum a combined safety factor of 1.5. Single belt drives or systems with a safety factor of less than 1.5 are not acceptable. Computation of safety factors shall be based on performance data published by the drive manufacturer.

C. Precise alignment tolerances of the drive assemblies shall be achieved by means of a belt/sheave laser alignment system resulting in the reduction of vibration, accelerated wear, and premature failure.

D. The pump manufacturer shall submit power transmission calculations which document the following:
   1. Ratio of pump/motor speed.
   2. Pitch diameter of driver and driven sheaves.
   3. Number of belts required per drive.
   4. Theoretical horsepower transmitted per belt, based on vendor's data.

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5. Center distance between pump and motor shafts.
6. Arc-length correction factor applied to theoretical horsepower transmitted.
7. Service factor applied to established design horsepower.
8. Safety factor ratio of power transmitted/brake horsepower required.

E. Pump drives to be enclosed on all sides by a guard constructed of fabricated steel or combination of materials including expanded, perforated, or solid sheet metal. No opening to a rotating member shall exceed 1/2 inch.
   1. Guards must be completely removable without interference from any unit component, and shall be securely fastened and braced to the unit base.
   2. Metal to be free from burrs and sharp edges. Structural joints shall be continuously welded. Rivet spacing on panels shall not exceed five inches. Tack welds shall not exceed four inch spacing.
   3. The guard shall be finished in accordance with Section 3, Color Definitions of ANSI 253.1; Safety Color Code for Marking Physical Hazards.

2.10 CORROSION PROTECTION

A. Pumps, piping, and exposed steel framework shall be cleaned prior to painting. Exposed surfaces to be coated with one coat gray W.R. non-lift primer and one coat white acrylic alkyd W.R. enamel. Paint shall be low VOC, alkyd based, high solids, semi-gloss white enamel for optimum illumination enhancement, incorporating rust inhibitive additives. The finish coat shall be 1.0 to 1.2 MIL dry film thickness (minimum), resistant to oil mist exposure, solvent contact, and salt spray. The factory finish shall allow for over-coating and touch up after final installation.

2.11 ELECTRICAL CONTROL COMPONENTS

A. The pump station control panel will be tested as an integral unit by the pump station manufacturer. The control panel shall also be tested with the pump station as a complete working system at the pump station manufacturer's facility.

B. Panel Enclosure:
   1. Electrical control equipment shall be mounted within a common NEMA 1 stainless steel, dead front type control enclosures. Doors shall be hinged and sealed with a neoprene gasket and equipped with captive closing hardware. Control components shall be mounted on removable steel back panels secured to enclosure with collar studs.
   2. All control devices and instruments shall be secured to the sub-plate with machine screws and lockwashers. Mounting holes shall be drilled and tapped; self-tapping screws shall not be used to mount any component. All control devices shall be clearly labeled to indicate function.

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C. UL Label Requirement:
   1. Pump station components and controls shall conform to third party safety certification. The station shall bear a UL label listed for “Pumping System”. The panel shall bear a serialized UL label listed for "Enclosed Industrial Control Panels". The pump station components, panel enclosure, and all components mounted on the sub-panel or control cover shall conform to UL descriptions and procedures.

D. Branch Components
   1. All Motor branch and power circuit components shall be of highest industrial quality. The short circuit current rating of all power circuit devices shall be a tested combination or evaluated per the National Electric Code Article 409. The lowest rated power circuit component shall be the overall control panel short circuit rating and shall not be less than the fault current available. The minimum control panel rating shall not be less than 10 kA, rms symmetrical. Control assemblies operating at 120 volts nominal or less may be provided with transformers which limit the fault current and may be rated less than the minimum required short circuit rating.
   2. Circuit Breakers and Operating Mechanisms:
      a. A properly sized heavy duty circuit breaker shall be furnished for each pump motor. The circuit breakers must be sealed by the manufacturer after calibration to prevent tampering.
      b. An operating mechanism installed on each motor circuit breaker shall penetrate the control panel door. A padlockable operator handle shall be secured on the exterior surface. Interlocks must prevent opening the door until circuit breakers are in "OFF" position. An additional mechanism(s) shall be provided on the circuit breaker permitting the breaker to be operated and/or locked with the control panel door in the open position.
   3. Motor Starters:
      a. An open frame, across-the-line, NEMA rated magnetic starter with under-voltage release, and overload protection on all three phases, shall be furnished for each pump motor. Starters of NEMA size 1 and above shall allow addition of at least two auxiliary contacts. Starters rated "0", "00", or fractional size are not acceptable. Power contacts to be double-break type made of cadmium oxide silver. Coils to be epoxy molded for protection from moisture and corrosive atmospheres. Contacts and coils shall be easily replaceable without removing the starter from its mounted position. Each starter shall have a metal mounting plate for durability.
      b. Overload relays shall be solid-state block type, having visual trip indication with trip-free operation. Electrically resetting the overload will cause one (1) normally open and one (1) normally closed isolated alarm/control contact to reset, thus re-establishing a control circuit. Trip setting shall be governed by solid-state circuitry

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and adjustable current setting. Trip classes shall be 10, 15 and 20. Additional features to include phase loss protection, selectable jam/stall protection and selectable ground fault protection.

c. A reset pushbutton, mounted through the control panel door, shall permit resetting the overload relays without opening the door.

4. Phase Monitor:
   a. The control panel shall be equipped to monitor the incoming power and shut down the pump motors when required to protect the motor(s) from damage caused by phase reversal, phase loss, high voltage, low voltage, and voltage unbalance. An adjustable time delay shall be provided to minimize nuisance trips. The motor(s) shall automatically restart, following an adjustable time delay, when power conditions return to normal.

E. Transient Voltage Surge Suppressor:
   1. The control panel shall be equipped with a transient voltage surge suppressor to minimize damage to the pump motor and control from transient voltage surges. The suppressor shall utilize thermally protected silicon-oxide varistors encapsulated in a non-conductive housing. Mechanical indicators shall be provided on each phase to indicate protection has been lost. The suppressor shall have a surge current rating of 100,000 Amps per phase and a 100 kA interrupting rating.

F. Control Circuit:
   1. A normal duty thermal-magnetic circuit breaker shall protect all control circuits by interrupting control power.
   2. Pump mode selector switches shall permit manual start or stop of each pump individually, even if the controller is non-operational, or permit automatic operation under control of the liquid level control system. Manual operation shall override all shutdown systems, except the motor overload relays. Selector switches to be oil-tight design with contacts rated NEMA A300 minimum.
   3. Pump alternation shall be integral to the liquid level controller. Provisions for automatic alternation or manual selection shall also be integral to the liquid level controller.
   4. Six digit elapsed time meter (non-reset type) shall be connected to each motor starter to indicate total running time of each pump in "hours" and "tenths of hours". Separate pilot lights shall be provided to indicate which motor is energized and should be running.
   5. A high pump temperature protection circuit shall override the level control and shut down the pump motor(s) when required to protect the pump from excessive temperature. A thermostat shall be mounted on each pump casing. If casing temperature rises to a level sufficient to cause pump damage, the high pump temperature protection circuit shall interrupt power to the pump motor. A visible indicator, mounted through the control

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panel door shall indicate motor stopped due to high pump temperature. The motor shall remain locked out until the pump has cooled and circuit has been manually reset. Automatic reset of this circuit is not acceptable.

6. A duplex ground fault receptacle providing 115 VAC, 60 Hz, single phase current, will be mounted on the side of the control enclosure. Receptacle circuit shall be protected by a 15 ampere thermal-magnetic circuit breaker.
7. The lift station shall be equipped with a 5 KVA step-down transformer to supply 115 volt, AC, single phase for the control and auxiliary equipment. The primary and secondary side of the transformer shall be protected by a thermal magnetic circuit breakers, sized to meet the power requirements of the transformer. An operating mechanism shall penetrate the control panel door and a padlockable operator handle shall be secured on the exterior surface. Interlocks must prevent opening the door until primary circuit breaker is in "OFF" position. An additional mechanism(s) shall be provided on the circuit breaker permitting the breaker to be operated and/or locked with the control panel door in the open position.
    a. Pump Start Delay
        1. The control circuit for pump #2 shall be equipped with a time delay to prevent simultaneous motor starts.
8. Wiring:
    a. The pump station, as furnished by the manufacturer, shall be completely wired, except for power feed lines to the main entrance terminal blocks and final connections to remote alarm devices.
    b. All wiring, workmanship, and schematic wiring diagrams shall comply with applicable standards and specifications of the National Electric Code (NEC).
    c. All user serviceable wiring shall be type MTW or THW, 600 volts, color coded as follows:

1. Line and Load Circuits, AC or DC power	Black
2. AC Control Circuit Less Than Line Voltage	Red
3. DC Control Circuit	Blue
4. Interlock Control Circuit, from External Source	Yellow
5. Equipment Grounding Conductor	Green
6. Current Carrying Ground	White
7. Hot With Circuit Breaker Open	Orange

    d. Control circuit wiring inside the panel, with exception of internal wiring of individual components, shall be 16 gauge minimum, type MTW or THW, 600 volts. Power wiring to be 14 gauge minimum. Motor branch wiring shall be 10 gauge minimum.
    e. Motor branch and other power conductors shall not be loaded above the temperature of the connected termination. Wires must be clearly numbered at each end in conformance with applicable standards. All wire connectors in the control panel shall

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be ring tongue type with nylon insulated shanks. All wires on the sub-plate shall be bundled and tied. All wires extending from components mounted on door shall terminate at a terminal block mounted on the back panel. All wiring outside the panel shall be routed through conduit.

f. Control wires connected to door mounted components must be tied and bundled in accordance with good commercial practice. Bundles shall be made flexible at the hinged side of the enclosure. Adequate length and flex shall allow the door to swing full open without undue stress or abrasion. Bundles shall be held on each side of hinge by mechanical fastening devices.

9. Factory installed conduit shall conform to the following requirements:
   a. All conduit and fittings to be UL listed.
   b. Liquid tight flexible metal conduit to be constructed of smooth, flexible galvanized steel core with smooth abrasion resistant, liquid tight polyvinyl chloride cover.
   c. Conduit to be supported in accordance with articles 346, 347, and 350 of the National Electric Code.
   d. Conduit shall be sized according to the National Electric Code.
10. Grounding:
   a. Station manufacturer shall ground all electrical equipment inside the pump station to the control panel back plate. All paint must be removed from the grounding mounting surface before making final connection.
   b. The Contractor shall provide an earth driven ground connection to the pump station at the main grounding lug in accordance with the National Electric Code (NEC).
11. Equipment Marking:
   a. Permanent corrosion resistant name plate(s) shall be attached to the control and include following information:
      1. Equipment serial number
      2. Control panel short circuit rating
      3. Supply voltage, phase and frequency
      4. Current rating of the minimum main conductor
      5. Electrical wiring diagram number
      6. Motor horsepower and full load current
      7. Motor overload heater element
      8. Motor circuit breaker trip current rating
      9. Name and location of equipment manufacturer
   b. Control components shall be permanently marked using the same identification keys shown on the electrical diagram. Labels shall be mounted adjacent to device being identified.

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c. Switches, indicators, and instruments mounted through the control panel door shall be labeled to indicate function, position, etc. Labels shall be mounted adjacent to, or above the device.

2.12 LIQUID LEVEL CONTROL

A. The manufacturer of the liquid level control system must be ISO 9001:2000 revision certified, with scope of registration including design control and service after sales activities.

B. The level control system shall start and stop the pump motors in response to changes in wet well level, as set forth herein.

C. The level control system shall be capable of operating as either an air bubbler type level control system, submersible transducer type system, or ultrasonic transmitter type system.

D. The level control system shall utilize alternation to select first one pump, then the second pump, then the third pump (if required), to run as lead pump for a pumping cycle. Alternation shall occur at the end of a pumping cycle, or in the event of excessive run time.

E. The level control system shall utilize an electronic pressure switch which shall continuously monitor the wet well level, permitting the operator to read wet well level at any time. Upon operator selection of automatic operation, the electronic pressure switch shall start the motor for one pump when the liquid level in the wet well rises to the "lead pump start level". When the liquid is lowered to the "lead pump stop level", the electronic pressure switch shall stop this pump. These actions shall constitute one pumping cycle. Should the wet well level continue to rise, the electronic pressure switch shall start the second and/or third pump (if required) when the liquid reaches the "lag pump start level", or “standby pump start level” so that all pumps are operating. These levels shall be adjustable as described below.
   1. The electronic pressure switch shall include integral components to perform all pressure sensing, signal conditioning, EMI and RFI suppression, DC power supply and 120 volt outputs. Comparators shall be solid state, and shall be integrated with other components to perform as described below.
   2. The electronic pressure switch shall be capable of operating on a supply voltage from 12-24VDC in an ambient temperature range of -10 degrees C (14 degrees F) through 55 degrees C (131 degrees F). Control range shall be 0 to 12.0 feet of water with an overall repeat accuracy of (plus/minus) 0.1 feet of water. Memory shall be non-volatile.
   3. The electronic pressure switch shall consist of the following integral components: pressure sensor, display, electronic comparators and output relays.
      a. The internal pressure sensor shall be a strain gauge transducer and shall receive an input pressure from the air bubbler system. The transducer shall convert the input

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to a proportional electrical signal for distribution to the display and electronic comparators. The transducer output shall be filtered to prevent control response to level pulsations or surges. The transducer range shall be 0-15 psi, temperature compensated from -40 degrees C (-40 degrees F) through 85 degrees C (185 degrees F), with a repeat accuracy of (plus/minus) 0.25% full scale about a fixed temperature. Transducer overpressure rating shall be 3 times full scale.

b. The electronic pressure switch shall incorporate a digital back lighted LCD panel display which, upon operator selection, shall indicate liquid level in the wet well, and the preset start and stop level for both lead and lag pump. The display shall include twenty (20), 0.19" high alpha-numeric characters calibrated to read out directly in feet of water, accurate to within one-tenth foot (0.1 foot), with a full scale indication of not less than 12 feet. The display shall be easily convertible to indicate English or metric units.
c. Level adjustments shall be electronic comparator set-points to control the levels at which the pumps start and stop. Each of the level settings shall be easily adjustable with the use of membrane type switches, and accessible to the operator without opening any cover panel on the electronic pressure switch. Controls shall be provided to permit the operator to read the selected levels on the display. Such adjustments shall not require hard wiring, the use of electronic test equipment, artificial level simulation or introduction of pressure to the electronic pressure switch.
d. Each output relay in the electronic pressure switch shall be solid state. Each relay input shall be optically isolated from its output and shall incorporate zero crossover switching to provide high immunity to electrical noise. The "ON" state of each relay shall be indicated by illumination of a light emitting diode. The output of each relay shall be individually fused providing overload and short circuit protection. Each output relay shall have an inductive load rating equivalent to one NEMA size 4 contactor. A pilot relay shall be incorporated for loads greater than a size 4 contactor.

4. The electronic pressure switch shall be equipped with an output board which shall include LED status indicators and a connector with cable for connection to the main unit.
5. The electronic pressure switch shall be equipped with pump start delay(s) preset at a fixed delay time of five (5) seconds.
6. Circuit design in which application of power to the lag pump motor starter is contingent upon completion of the lead pump circuit shall not be acceptable.
7. The electronic pressure switch shall be equipped with a simulator system capable of performing system cycle testing functions.
8. The electronic pressure switch shall have internal capability of providing automatic alternation, manual selection of pump sequence operation, and alternation in the event of 1-199 hours excessive run time.

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9. The electronic pressure switch shall be equipped with a security access code to prevent accidental set-up changes and provide liquid level set-point lock-out.
10. The electronic pressure switch shall be equipped with one (1) 0-33 ft. W.C. input, one (1) scalable analog input of either 0-5VDC, 0-10VDC, or 4-20mA, and one (1) 4-20mA scalable output. Output is powered by 10-24VDC supply. Load resistance for 4-20mA output shall be 100-1000 ohms.
11. The electronic pressure switch shall include a DC power supply to convert 120VAC control power to 12 or 24VDC EPS power. The power supply shall be 500mA (6W) minimum and be UL listed Class II power limited power supply.
12. The electronic pressure switch shall be equipped with an electronic comparator and solid state output relay to alert maintenance personnel to a high liquid level in the wet well. An indicator, visible on the front of the control panel, shall indicate that a high wet well level exists. The alarm signal shall be maintained until the wet well level has been lowered and the circuit has been manually reset. High water alarm shall be furnished with a dry contact wired to terminal blocks.
13. The electronic pressure switch shall be equipped with an electronic comparator and solid state output relay to alert maintenance personnel to a low liquid level in the wet well. An indicator, visible on the front of the control panel, shall indicate that a low wet well level exists. The alarm signal shall be maintained until the cause for the low wet well level has been corrected and the circuit has been manually reset. A low liquid level condition shall disable both pump motors. When the wet well rises above the low level point, both pump motors shall be automatically enabled. Low water alarm shall be furnished with a dry contact wired to terminal blocks.
14. EPS Analog Output circuit will be furnished with transient voltage surge suppression to protect related equipment from induced voltage spike from lighting.

F. An alarm silence pushbutton and relay shall be provided to permit maintenance personnel to de-energize the audible alarm device while corrective actions are under way. After silencing the alarm device, manual reset of the alarm condition shall clear the alarm silence relay automatically. The pushbutton shall be oil tight design with contacts rated NEMA A300 minimum.

G. Air Bubbler System:
   1. The level control system shall be the air bubbler type, containing air bubbler piping which extends into the wet well. A pressure sensor contained within the electronic pressure switch shall sense the air pressure in this piping to provide wet well level signals for the remainder of the level control system.
   2. Two vibrating reed, industrial rated, air pumps shall be furnished to deliver free air at a rate of approximately 5 cubic feet per hour and a pressure not to exceed 7 psi. Liquid

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level control systems utilizing air compressors delivering greater quantities of air at higher pressures, requiring pressure reducing valves, air storage reservoirs, and other maintenance nuisance items will not be acceptable. A selector switch shall be furnished to provide manual alternation of the air pumps. The switch shall be connected in such a manner that either pump may be selected to operate continuously. The selector switch shall be oil-tight design with contacts rated NEMA A300 minimum.

3. An air bell constructed of PVC 3 inches in diameter shall be provided for installation at the outlet of the air bubbler line in the wet well. The air bell shall have a 3/8" NPT tapped fitting for connection to the bubbler line.
4. An air flow indicator gauge shall be provided and connected to the air bubbler piping to provide a visual indication of rate of flow in standard cubic feet per hour.

2.13 ALARM LIGHT (EXTERNAL)

A. Station manufacturer will supply one 115 VAC NEMA 4X alarm light fixture with red globe, conduit box, and mounting base. The design must prevent rain water from collecting in the gasketed area of the fixture, between the base and globe. The alarm light will be shipped loose for installation by the Contractor.

2.14 SPARE CIRCUIT BREAKERS

A. Station manufacturer will supply four (4) spare 20 amp, 115 volt circuit breakers designed to provide power to SCADA RTU and flow meter. two (2) circuit breakers will serve as spares.

2.15 SCADA RTU AND MASTER UPGRADE

A. The Contractor shall supply and install a SCADA RTU compatible with the Owner's existing system. The Contractor shall provide services to upgrade the existing Master to accept the new RTU including all programming, radio licensing, start-up services, antennas and other accessories and services to allow monitoring of the pump station by the Owner.

2.16 FLOW METER

A. The Contractor shall supply and install a magnetic flow meter designed to provide instantaneous flow readout in GPM. Flow meter sensor shall be installed in external vault and loop powered. Remote readout shall be mounted and wired in pump station enclosure. Flow meter shall be Magnetoflow model as manufactured by Badger Meter.

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2.17 GENERATOR RECEPTACLE AND MANUAL TRANSFER SWITCH

A. Contractor shall supply and install a manual transfer switch and generator connection compatible with the Owner's portable generator.

2.18 ONLINE INTERACTIVE O&M TRAINING PROGRAM

A. The pump station shall be supplied with an online interactive O&M training program. Program shall be approved for continuing education by the State of Tennessee and as provided by 360water, Inc.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Contractor shall off-load equipment at installation site using equipment of sufficient size and design to prevent injury or damage. Station manufacturer shall provide written instruction for proper handling. Immediately after off-loading, Contractor shall inspect complete pump station and appurtenances for shipping damage or missing parts. Any damage or discrepancy shall be noted in written claim with shipper prior to accepting delivery. Validate all station serial numbers and parts lists with shipping documentation. Notify the manufacturer's representative of any unacceptable conditions noted with shipper.

3.2 INSTALLATION

A. Install, level, align, and lubricate pump station as indicated on project drawings. Installation must be in accordance with written instructions supplied by the manufacturer at time of delivery.

B. Suction pipe connections must be vacuum tight. Fasteners at all pipe connections must be tight. Install pipe with supports and thrust blocks to prevent strain and vibration on pump station piping. Install and secure all service lines (level control, air release valve or pump drain lines) as required in wet well.

C. Check motor and control data plates for compatibility to site voltage. Install and test the station ground prior to connecting line voltage to station control panel.

D. Prior to applying electrical power to any motors or control equipment, check all wiring for tight connection. Verify that protective devices (fuses and circuit breakers) conform to project design documents. Manually operate circuit breakers and switches to ensure operation

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without binding. Open all circuit breakers and disconnects before connecting utility power. Verify line voltage, phase sequence and ground before actual start-up.

E. After all anchor bolts, piping and control connections are installed, completely fill the grout dam in the pump station base with non-shrink grout.

3.3 FIELD QUALITY CONTROL

A. Operational Test:
   1. Prior to acceptance by Owner, an operational test of all pumps, drives, and control systems shall be conducted to determine if the installed equipment meets the purpose and intent of the specifications. Tests shall demonstrate that all equipment is electrically, mechanically, structurally, and otherwise acceptable; it is safe and in optimum working condition; and conforms to the specified operating characteristics.
   2. After construction debris and foreign material has been removed from the wet well, Contractor shall supply water volume adequate to operate station through several pumping cycles. Observe and record operation of pumps, suction and discharge gauge readings, ampere draw, pump controls, and liquid level controls. Check calibration of all instrumentation equipment, test manual control devices, and automatic control systems.

B. Coordinate station start-up with manufacturer's technical representative. The representative or factory service technician will inspect the completed installation. The technician will calibrate and adjust instrumentation, correct or supervise correction of defects or malfunctions, and instruct operating personnel in proper operation and maintenance procedures.

C. Prior to acceptance, inspect interior and exterior of pump station for dirt, splashed material or damaged paint. Clean or repair accordingly. Remove from the job site all tools, surplus materials, scrap and debris.

D. The pump station should be placed into service immediately. If operation is delayed, station is to be stored and maintained per manufacturer's written instructions.

3.4 EARTHWORK

A. Excavation, trenching, and backfilling are specified in Division 31 Section "Earthwork."

3.5 IDENTIFICATION

A. Install identifying labels permanently attached to equipment.

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B. Install operating instruction signs permanently attached to equipment or on pumping station wall near equipment.

3.6 CONNECTIONS

A. Sanitary sewer piping installation requirements are specified in Division 33 Section "Sanitary Sewer (Gravity)." Drawings indicate general arrangement of piping.

END OF SECTION

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PART 1 – GENERAL

1.1 STANDARDS

A. Reclaimed water distribution piping shall be PVC unless directed otherwise by the Owner.

B. Buried piping shall be of the bell and spigot, mechanical joint, butt fusion, and/or electrofusion type as required by material and application.

C. Non-buried piping shall have flanged ends, unless otherwise noted on the Drawings.

D. Use Mechanical Joint Fitting Restraining Device for plain end piping connections to fittings, valves, etc.

1.2 SUBMITTALS

A. Product Data:
   1. Ductile iron fittings.
   2. Polyvinyl Chloride Plastic (PVC) Pipe.
   3. Pipe insulation and accessories.
   4. Mechanical joint restraint devices.
   5. Flanged coupling adapters.
   6. Flexible expansion joint.
   7. Concrete vaults and accessories.
   8. Line markers.
   9. Utility warning tape.
   10. Detection wire.

B. Shop Drawings:
   1. Concrete vaults and manholes, including hatches, frames and covers, ladders, and drains.

C. Operation and Maintenance Data: For specialties to include in emergency, operation, and maintenance manuals.

1.3 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of piping and specialties and are based on the specific system indicated.

B. Comply with regulatory requirements of local, state and federal agencies having jurisdiction.

C. Piping material shall bear label, stamp, or other markings of specified testing agency.

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D. Comply with ASTM F645 for selection, design, and installation of thermoplastic water piping.

E. Comply with NSF 61 for materials.

F. The pipe manufacturer must furnish the Owner a notarized certificate stating that the pipe furnished has been manufactured and tested in accordance with the applicable standards.

G. Polyvinyl chloride (PVC) pipe shall have proper markings which include manufacturer's name or trademark, nominal pipe size and size base, pressure rating for water at 73.4 degrees Fahrenheit, PVC cell classification or material code, dimension ratio or standard dimension ratio, AWWA or ASTM designation, pressure class with which the pipe complies, and the National Sanitation Foundation (NSF) Seal of Approval.

H. Coordinate this work with that required by other sections for timely execution.

I. It shall be the Contractor's responsibility to ensure that all necessary materials are furnished to them and that those found to be defective in manufacture are replaced at no extra cost to the Owner. Materials damaged in handling after being delivered by the manufacturer shall be replaced at the Contractor's own expense. If installed material is found to be defective before the final acceptance of the Work, the cost of both the material and labor needed to replace it shall not be passed on to the Owner.

J. Furnish all material, equipment, tools, and labor in connection with the reclaimed water distribution piping, complete and in accordance with the drawings and these specifications.

1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Delivery: Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.

B. Storage:
   1. The Contractor shall be responsible for safely storing materials needed for the Work that has been accepted by them until they have been incorporated into the completed project.
   2. Protect stored piping from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing inside.
   3. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

C. Handling: Protect flanges, fittings, and specialties from moisture and dirt.

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1.5 GENERAL REQUIREMENTS

A. The minimum pipe size for reclaimed water main lines is 8 inches unless otherwise approved by the WMD.

B. When a reclaimed water line is to be parallel to a sanitary sewer line there shall be a minimum of 10 feet measured edge to edge between the two lines unless otherwise approved by the WMD.

If this cannot be achieved, the bottom of the reclaimed water line shall be at least 18 inches above the top of the sanitary sewer line.

If neither condition can be met, the sanitary sewer line shall be constructed of similar materials and have a joint design equivalent to the reclaimed water line.

C. When a reclaimed water line is to be parallel to a water line there shall be a minimum of 10 feet measured edge to edge between the two lines.

If this cannot be achieved, the top of the reclaimed water line shall be 18 inches below water line.

The reclaimed water line shall always be located below water lines and above sanitary sewer lines.

D. The reclaimed water system shall be separate and independent of any water system. Cross connections are prohibited.

E. Water and reclaimed water lines are not to be installed in the same trench.

F. Where reclaimed water lines are installed in new fill, a compaction letter sealed by a Geotechnical Engineer registered in the State of Tennessee shall be submitted to the Owner prior to accepting said utilities. An acceptable compaction letter shall state that field density testing indicates the fill has been compacted to at least 95% of the maximum dry density according to the Standard Proctor. If a compaction letter is not available, special protection such as replacement with ductile iron pipe with joint restraint or encasement with flowable fill shall be utilized as approved by the WMD.

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PART 2 – PRODUCTS

2.1 TRANSITION GASKETS

A. Gaskets:
   1. Gaskets shall be Styrene Butadiene Copolymer (SBR) or Ethylene Propylene Diene Monomer (EPDM) in accordance with ANSI A21.11/AWWA C111, latest revision made in the form of a solid ring to exact dimensions.
      a. Push-on Joint Gaskets: The design of the gasket groove in the bell of the pipe and the design, hardness, and other properties of the gasket itself shall be such that the joint is liquid tight for all pressures from a vacuum to a maximum rating of 350 psi of internal liquid pressures. Gaskets for pipe with an operating pressure greater than 160 psi shall be restrained joint gaskets.
         1. Manufacturer / Model:
            a) American Ductile Iron Pipe "Fastite,"
            b) U.S. Pipe "Tyton," or
            c) Approved equal.
      b. Push-on Restrained Joint Gaskets: Restrained pipe and fittings are as shown on the Drawings. Retainer glands and similar devices will not be allowed unless otherwise noted or shown on the Drawings or approved by the Owner. Push-on joint restraint shall be incorporated in the design of the pipe bell and gasket. The restraint shall be provided by the wedging action developed between pairs of hardened high-strength, stainless steel elements spaced around the gasket. The push-on restrained joint shall be rated for 250 psi working pressure.
         1. Manufacturer / Model:
            a) American Ductile Iron Pipe "Fast-Grip" (for pipe sizes 24-inch and less),
            b) U.S. Pipe "Field Lok" Gaskets (for pipe sizes 24-inch and less),
            c) American Ductile Iron Pipe "Flex-Ring" (for pipe sizes 30 and 36 inch),
            d) American Ductile Iron Pipe "Lok-Ring" (for pipe sizes greater than 46 inches),
            e) U.S. Pipe "TR Flex" (for pipe sizes 24-inch and larger), or
            f) Approved equal.
         2. Lubricant: Lubricant shall be furnished with each order to provide for the proper installation of the pipe supplied with said order. This lubricant shall be nontoxic, impart no taste or smell to the water, and have no harmful effect on the rubber gasket. It shall have a consistency that will allow it to be easily applied to the pipe in either hot or cold weather and that will enable it to adhere to either wet or dry pipe.

2.2 DUCTILE IRON FITTINGS

A. Standard and special fittings shall be Pressure Class 350 ductile iron. Use standard mechanical joint fittings or anchoring tees at hydrant locations. All fittings shall conform to the

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specifications of ANSI A21.10/AWWA C110 (Full Body) or ANSI A21.53/AWWA C153 (Compact), latest revisions.

B. All buried fittings shall be mechanical joint with a restrained joint gland. Non-buried fittings shall be flanged unless otherwise shown on Drawings or directed by the Owner. Where flanged pipe is shown, no substitution of a Uni-Flange type joint will be used without prior approval of the Owner. Where push-on joint fittings are used, the fittings must be rodded to an anchor (i.e. dead-man, valve, etc.), have a mechanical joint fitting restraining device, or push-on restrained joint gasket. Use anchor tees or joint restraint device at hydrant locations.

C. Coatings and Lining: Fittings shall be lined with cement as specified in ANSI A21.4/AWWA C104. In addition, an asphaltic coat approximately 1 mil thick shall be applied to the cement lining in accordance with the pipe manufacturer's standard practices. The outside coating shall be an asphaltic coating approximately 1 mil thick in accordance with ANSI A21.51/AWWA C151. Ductile iron pipe will need to be painted or wrapped in some type of polyethylene sleeve colored purple.

D. Manufacturer:
   1. Tyler/Union
   2. American Cast Iron Pipe Company
   3. U.S. Pipe and Foundry
   4. Approved equal

2.3 POLYVINYL CHLORIDE PIPE

A. PVC plastic pipe shall conform to the latest edition of ASTM Specification – D2241, AWWA C900, and/or AWWA C905, as appropriate; Maximum Length – 20 feet.

B. Joints on pipe larger than 2-inches shall be integral bell and spigot type joints conforming to ASTM D-3139. Elastomeric gasket shall conform to the requirements of ASTM F-477. Gaskets shall be part of a complete pipe section and purchased as such. Lubricant shall be as recommended by the pipe or fitting manufacturer and shall not adversely affect the potable qualities of the water to be transported.

C. PVC pipe meeting C900 and C905 standards shall have the following pressure ratings unless specified otherwise (DR 18 Recommended):

DR	Pressure Rating (psi)	Maximum Allowable Pressure Use (psi)
18	235	165
14	305	230

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D. All new buried reclaimed water pipe shall be colored purple, Pantone® 522C or equivalent.

E. Manufacturer:
   1. Diamond,
   2. Vulcan Plastic Corporation,
   3. North American Pipe Corporation, or
   4. Approved equal

2.4 PIPE INSULATION AND ACCESSORIES

A. Pipe Insulation:
   1. Pipe insulation shall be polyisocyanurate foam insulation and meet the requirements of ASTM-C591. Insulation shall have a maximum thermal conductivity of 0.19 BTU- in/hr-ft^2-°F at a mean temperature of 75°F and 180 days aging.
   2. Manufacturer / Model:
      a. Pittsburg-Corning,
      b. Trymer 2000, or
      c. Approved equal.

B. Aluminum Roll Jacketing:

1. Jacketing is to be manufactured from aluminum alloy conforming to ASTM B209 designation with 3/16-inch corrugated surface. Minimum thickness shall be 0.010 inch. All jacketing shall have an integrally bonded moisture barrier over the entire surface in contact with the insulation. Overlap jacketing 2 inch minimum at butt joints.
2. Manufacturer / Model:
   a. Childers, or
   b. Approved equal.

C. Fastening Devices:
   1. All insulation and jacketing shall be secured using a ½-inch wide aluminum strapping conforming to ASTM-B209. Strapping shall be 0.020-inch thick and installed on 12-inch centers.
   2. Manufacturer / Model:
      a. Childers, or
      b. Approved equal.

2.5 MECHANICAL JOINT FITTING RESTRAINT DEVICES

A. Ductile Iron Pipe Restraint Devices:

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1. Restraint devices for nominal pipe sizes 3 inch through 48 inch shall consist of multiple gripping wedges incorporated into a follower gland meeting the applicable requirements of ANSI/AWWA C110/A21.10. Restraint device shall have torque limiting twist-off nuts.
2. Restraint devices shall have a working pressure rating of 350 psi for 4 through 16 inch and 250 psi for 18 through 48 inch. Ratings are for water pressure and must include a minimum safety factor of 2 to 1 in all sizes.
3. Gland body, wedges and wedge actuating components shall be cast from grade 65-45- 12 ductile iron material in accordance with ASTM A536.
4. Manufacturer / Model:
   a. EBAA Iron Inc. Megalug Series 1100, or
   b. Approved equal.

B. Plain End to Plain End Pipe Restraint Device:
1. Joint restraint to prevent axial separation shall be incorporated into the design of the sleeve or coupling used to connect two plain ends of same or dissimilar materials, such as ductile iron pipe, steel pipe, or PVC pipe (C900, C905, or ASTM D2241).
2. To prevent movement causing fitting to slide or rotate, internal pipe wall stiffeners must be used. The stiffeners must be sized to encompass the entire bearing length of the restraint devices.
3. Restraint devices shall consist of multiple gripping wedges incorporated into a follower gland. Restraint device shall have torque limiting twist-off nuts.
4. The coupling sleeve shall be coated internally with a minimum of 5mils of fusion bonded epoxy conforming to the applicable requirements of ANSI/AWWA C213.
5. Ductile Iron components shall meet or exceed the requirements of ASTM A536.
6. The restrained joining system shall meet the applicable requirements of AWWA C219, ANSI/AWWA C111/A21.11, and ASTM D2000.
7. Manufacturer / Model:
   a. EBAA Iron, Inc. Series 3800, or
   b. Approved equal.

2.6 FLANGED COUPLING ADAPTERS

A. Flanged coupling adapters shall be used to connect plain end pipe to flanged fittings, meters, valves, or equipment as shown on the Drawings shall be rated for 200 psi working pressure unless indicated otherwise.

B. Materials of Construction:
1. Body or Sleeve: Steel per ASTM A53
2. Flange Type: 3-inch to 5-inch Pipe Size = ANSI 150 lb flat face
   6-inch Pipe Size and above = AWWA C207 Class D, ANSI 150 lb drilling
3. Follower: 3-inch to 12-inch Pipe Size = Ductile Iron per ASTM A536

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14-inch Pipe Size and above	=	Heavy Rolled Steel per AISI C1018

4. Gasket = Grade 30
5. Bolts and Nuts = 304 Stainless Steel
6. Interior Coating = Fusion Bonded Epoxy
7. Exterior Coating = 2 coats of Rust Inhibiting Synthetic Resin or Asphaltum Enamel

C. Manufacturer / Model
   1. Smith-Blair Model 913 Steel Restrained Flanged Coupling Adapter with Optional Anchor Studs, or
   2. Approved equal.

2.7 FLEXIBLE EXPANSION JOINT

A. Flexible expansion joints shall be installed in the locations indicated on the Drawings. Flexible expansion joints shall be cast from grade 65-45-12 ductile iron conforming to the material requirements of ASTM A536 and ANSI/AWWA C153/A21.53.

B. Each flexible expansion joint shall be pressure tested at the factory against its own restraint to a minimum of 350 psi (250 psi for 30" diameter and larger.) A minimum 2:1 safety factor shall apply.

C. Each flexible expansion joint shall consist of an expansion joint designed and cast as an integral part of a ball and socket type flexible joint, having a minimum per ball deflection of: 20 degrees, 3 inch – 12 inch; 15 degrees, 14 inch – 36 inch; 12 degrees, 48 inch and 4-inches minimum expansion. Additional expansion sleeves shall be available and easily added or removed at the factory or in the field. Both standardized mechanical joint and flange end connections shall be available.

D. All internal surfaces (wetted parts) shall be lined with a minimum of 15 mils of fusion bonded epoxy conforming to the applicable requirements of ANSI/AWWA C213. Sealing gaskets shall be constructed of EPDM. The coating and gaskets shall meet ANSI/NSF-61.

E. All external surfaces shall be coated with a catalyzed coal tar epoxy conforming to the material requirements of AWWA C210. Appropriately sized polyethylene sleeves, meeting ANSI/AWWA C105/A21.5, shall be included for direct buried applications.

F. Manufacturer / Model
   1. EBAA Iron, Inc. FLEX-TEND, or
   2. Approved equal.

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2.8 CONCRETE VAULTS AND ACCESSORIES

A. Concrete vaults shall be rectangular or circular, either precast or cast-in-place reinforced concrete, of the dimensions and specifications noted on the Drawings. Concrete shall have a 28-day compressive strength of 4000 psi. Circular precast concrete barrel sections for valve vaults shall conform to ASTM C478 except sections deeper than 12 feet shall have reinforcing equal to that ASTM C76 Class III reinforced concrete pipe unless otherwise noted on the Drawings.

B. Precast section joints shall be mortared or grouted; joined with ASHTO M-198-75 preformed flexible butyl type joint sealant. Joints should be water tight.
   1. Manufacturer / Model:
      a. Hamilton-Kent “Kent-Seal No. 2”,
      b. K.T. Snyder Company “rub ‘r-Nek”,
      c. Press Seal Gasket “E-Z Stik”, or
      d. Approved equal.

C. Concrete Vault Hatch
   1. Channel frame shall be 1/4 inch (7 mm) thick extruded aluminum with a mill finish, incorporating a continuous concrete anchor. A 1-1/2 inch (38 mm) drainage coupling shall be located in the front left corner of the channel frame. A bituminous coating shall be applied to the frame exterior where it will come into contact with concrete. The entire frame must be supported by a full bed of Class A concrete (H-20 load rating).
   2. The door panel(s) shall be 1/4 inch (7 mm) aluminum diamond plate, reinforced to withstand a live load of 300 psf or H-20 uniform live load with a maximum allowable deflection of 1/150 of the span and shall not protrude into the channel frame when in the open position. In grassed or landscaped (non-traffic) areas the access door shall be designed for 300 psf loading. In areas that may receive light vehicle traffic, such as sidewalks or edges of parking lots, the access door shall be designed for H-20 wheel loading.
   3. Doors shall open to 90 degrees and automatically lock with a T-316 stainless steel hold open arm with an aluminum release handle. For ease of operation, the door hold open arm shall incorporate an enclosed stainless steel compression spring assist.
   4. Doors shall close flush with the frame and rest on a built-in neoprene cushion/gasket (300 psf load rating).
   5. Hinges and all fastening hardware shall be T-316 stainless steel.
   6. Unit shall lock with a T-316 stainless steel slam lock with removable key and have a non-corrosive handle.
   7. Unit shall carry a lifetime guarantee against defects in material and/or workmanship.
   8. Manufacturer / Model:
      a. Halliday Products, Inc., Orlando, Florida, Series W2C (double leaf), or
      b. Approved equal.

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D. Ladder/Steps:
   1. Ladder/steps shall be steel encased in copolymer polypropylene plastic (or equal), "Press Fit" type, have an overall width of 12 inches, and spaced at 12 inches.
   2. Manufacturer:
      a. M.A. Industries, or
      b. Approved equal.

E. A vent shall be provided in the top of the vault. The vent shall be constructed of PVC, a minimum of 3 feet tall, and a minimum of 4-inches in diameter with a 24 mesh stainless steel screen. The vent shall be located such that it does not interfere with the opening/closing of the hatch or impede access to the vault interior. The vault penetration shall be a thrust collar wall pipe cast integrally into the vault top. The vent shall be flanged and bolt to the wall sleeve.

F. Pipe Penetrations shall be water tight and sealed in the vault wall opening with flexible and/or rigid connections. At least one pipe penetration shall be a rigid connection.
   1. Flexible connections shall be provided using resilient connectors meeting the requirements of ASTM C-923. Resilient connectors shall be compression type cast integrally into the vault wall.
      a. Manufacturer:
         1. A-Lok Products, Inc., Tullytown, PA, or
         2. Approved equal.
   2. Rigid Connections shall be provided using a thrust collar wall pipe. Thrust collar wall pipes shall be cast integrally into the vault wall. Thrust collar wall pipes shall meet the requirements of ductile iron flanged piping, as specified herein, unless otherwise specified.
      a. Manufacturer:
         1. U.S. Pipe,
         2. American Ductile Iron Pipe, or
         3. Approved equal

G. Vault Drainage:
   1. Vault drainage shall be as noted on the Drawings and according to the following.
      a. Drain pipe shall be schedule 80 PVC and penetrate the wall at floor level. Slope of drain line shall be in accordance with local plumbing codes. A varmint screen shall be installed on the drain line inside the vault for ease of maintenance. A flap valve shall be installed on the drain line discharge.
      b. The vault floor shall have a sump with a minimum depth of 12-inches and a minimum inside diameter of 14-inches. The sump is not required to be cast integrally in the floor of precast vaults. However, the seal between the vault and the sump shall be

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watertight and no part of the sump will be allowed to extend above the floor thereby inhibiting drainage. The sump shall be concrete or HDPE.

1. The sump pump shall be automatic with level operation. It shall operate on 115 volt, single phase, 60 hz power. The pump shall be 1/3 horsepower and pump a maximum flow of 30 gpm at 10-feet of head with a 1-1/2 inch discharge.
2. Manufacturer / Model:
   a) Water Ace Model R3V, or
   b) Approved equal.

H. Vault electrical, if any, shall be in accordance with the requirements of the Specifications and Drawings.

I. Vault Piping:
   1. Piping shall be supported with column type pipe saddle supports, concrete block, or other Owner-approved method.
      a. Column type pipe saddle supports shall be stanchion type with vertical adjustability and U-bolt attachment to pipe. The stanchion shall be properly sized to carry the pipe load. The saddle assembly and base shall be cast iron or carbon steel.
         1) Manufacturer:
            a) Grinnell Corporation, Providence, RI, or
            b) Approved equal.
      b. Concrete pipe supports shall be full or half-size, solid CMU placed under pipe, valves, meters, etc. flanges or under flanged base bends. Flanged base bends shall be bolted to the concrete pipe support.
   2. Piping shall be insulated in accordance with Paragraph 2.8 subparagraphs a and c and/or have heat tape.

J. Valves shall be in accordance with Division 33 Section "Valves".

K. Meters shall be in accordance with Division 33 Section “Reclaimed Service Assemblies.”

L. Manufacturer:
   1. Barger Precast,
   2. Old Castle, or
   3. Approved equal.

2.9 LINE MARKERS

A. Markers shall be single piece design, constructed of durable, UV resistant, composite material, and have a pointed end for ease of installation. The marker shall have a constant flat “T” cross-sectional design and be 3.75 inch in width and of such length to provide a

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minimum height above the ground surface of 44 inches and a minimum embedment depth of 18 inches. The marker shall resist displacement from wind and vehicle impact forces. The marker shall be free of burns, discoloration, cracks, bulges, or other objectionable marks. A line shall be stamped horizontally across the front of the marker to indicate proper burial depth.

B. The marker shall be pigmented throughout the entire cross-section so as to produce a uniform color which is an integral part of the material. The marker shall be colored purple.

C. Line markers shall be labeled with the lettering "CAUTION RECLAIMED WATER - DO NOT DRINK" with the Owner's name and telephone number written below the lettering.

D. Manufacturer / Model:
   1. Carsonite International, Early Branch, SC Model CUM 375 or
   2. Approved equal.

E. All new common areas where reclaimed water is used and that are accessible to the general public shall be posted with conspicuous signs that include the following wording in a size acceptable to the WMD:

"**CAUTION RECLAIMED WATER - DO NOT DRINK**" and

"**AVISA - AGUA IMPURA - NO TOMAR**" on the other side.

Each sign shall also display an international symbol conveying the same warning.

2.10 UTILITY WARNING TAPE

A. Detectable underground utility warning tape, which can be located from the surface by a pipe detector, shall have of a minimum thickness of 0.35 mils solid aluminum foil encased in a protective inert plastic jacket that is impervious to all known alkalis, acid, chemical reagents and solvents found in the soil. The tape shall have a minimum overall thickness of 5.0 mils and a minimum width of 6 inch (metallic piping) with a minimum unit weight of 2-1/2 pounds/ 1 inch x 1,000 foot. The tape shall be color coded purple in accordance with APWA National Color Code and permanently imprinted "Caution Buried Reclaimed Water Line Below".

B. Manufacturer / Model:
   1. Allen Systems, "Detect Tape",
   2. Empire Level Mfg. Corp., "Magnatee", or
   3. Approved equal.

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2.11 DETECTION WIRE

A. Detection wire shall be UL approved, 14 AWG, type THHN solid copper. The wire shall be color coded purple in accordance with APWA National Color Code.

PART 3 – EXECUTION

3.1 EARTHWORK

A. Refer to Division 31 Section "Earthwork" for excavating, trenching, and backfilling.

B. Do not excavate pipe trenches more than 200 feet ahead of the pipe laying, and not more than two hundred (200) feet of open ditch shall be left behind the pipe laying and perform all Work so as to cause the least possible inconvenience to the public. Construct temporary bridges or crossings when and where the Owner deems necessary to maintain vehicular or pedestrian traffic.

C. In all cases where materials are deposited along open trenches, place them so that in the event of rain no damage will result to the Work and/or to adjacent property.

3.2 PIPING APPLICATIONS

A. Use pipe, fittings, and joining methods for piping systems according to the following applications.
   1. Transition couplings and special fittings with pressure ratings at least equal to piping pressure rating maybe used in applications below, unless otherwise indicated.
   2. Do not use flanges, unions, or keyed couplings for underground piping.
   3. Flanges, unions, keyed couplings, and special fittings shall be used, instead of joints indicated, on aboveground piping and piping in vaults.

3.3 JOINT CONSTRUCTION

A. Clean and assemble pipe joints and fittings according to the following:
   1. PVC Piping Gasketed Joints: Use joining materials according to AWWA C900. Construct joints with elastomeric seals and lubricant according to ASTM D 2774 or ASTM D 3139 and pipe manufacturer's written instructions.
   2. Dissimilar Materials Piping Joints: Use adapters compatible with both piping materials, with OD, and with system working pressure.

3.4 PIPING INSTALLATION

A. Install PVC pipe and fittings according to AWWA M23 and ASTM F645.

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B. Unless otherwise indicated by the Drawings or Division 33 requirements, bury piping with a depth of cover of at least 36 inches, with top of pipe at least 12 inches below level of maximum frost penetration, and according to the following:
   1. Under Driveways: With at least 36 inches cover over top of pipe.
   2. Under Roadways: With at least 42 inches cover over top of pipe.
   3. Under Railroad Tracks: With at least 48 inches cover over top of pipe.
   4. Over or Under Gas Pipelines: Minimum 18 inches vertical separation and 10 feet horizontal separation.
   5. Over Sewer Lines: With at least 18 inches vertical separation and 10 feet horizontal separation.

C. Lay the pipe to and keep it at the lines and grades required by the drawings. All fittings shall be at the required locations, and spigots well centered in the bells and all valves and stems plumb.
   1. The pipe shall slope continuously between high and low points and have a minimum of 60 inches cover at the high points. No departure from this policy shall be made except at the order of the Owner.
   2. After a length of pipe has been placed in the trench, center the spigot end in the bell of the adjacent pipe, and then insert to the depth specified by the manufacturer and bring to the correct line and grade. Secure the pipe in place by tamping an approved backfill material around it.
   3. Make all joints, whether standard mechanical or push-on joints, in conformance with the recommendations of the joint manufacturer as approved by the Owner.

D. Provide and use tools and facilities that are satisfactory to the Owner and that will allow the Work to be done in a safe and convenient manner. Use a derrick, ropes, or other suitable equipment to lower all pipe and fittings into the trench one piece at a time. Carefully lower each piece so that neither it nor any protective coating or lining it may have will be damaged. Under no circumstances, drop or dump pipe materials into the trench.
   1. Lower no pipes and fittings into the trench until they have been swabbed to remove any mud, debris, etc., that may have accumulated within them. After the pipe has been lowered, remove all unnecessary materials from it. Before any pipe is laid, brush and wipe clean the outside of its spigot end and the inside of its bell and ensure that the pipe is dry and oil-free.
   2. Take every precaution to keep foreign material from getting into the pipe while it is being placed in the line. If the crew laying the pipe cannot put it into the trench and in place without allowing earth to get inside it, then place a heavy, tightly woven canvas bag of suitable size over each end of the pipe and leave it there until it is time to connect that pipe to the one adjacent to it.
   3. Place no debris, tools, clothing, or other materials in the pipe during laying operations.

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E. Bell holes shall be big enough so that there is ample room for the pipe joints to be properly made. Between bell holes, carefully grade the bottom of the trench so that each pipe barrel will rest on a solid foundation for its entire length.

F. Whenever pipe laying is not in progress, close the open ends of pipe in the trench with a watertight plug or by other means approved by the Owner. Caulk the joints of any pipe in the trench that cannot be completed until a later time with packing in order to make them as watertight as possible; this shall be done not only at the end of each working day but also before work is stopped for lunch periods, bad weather, or any other reason. If there is water in a trench, this seal shall remain in place until the trench has been pumped completely dry.

G. The cutting of pipe so that fittings or closure pieces can be inserted shall be done in a neat and workmanlike manner and without any damage to the pipe. Follow the manufacturer's recommendations concerning how to cut and machine the ends of the pipe in order to leave a smooth end at right angles to the pipe's axis.
   1. The flame cutting of pipe by means of an oxyacetylene torch will not be allowed.

H. Unless otherwise directed by the Owner, lay pipe with the bell ends facing in the direction of laying.

I. Wherever pipe must be deflected from a straight line (in either the vertical or horizontal plane) in order to avoid obstructions or plumb stems, or wherever long radius curves are permitted, the amount of deflection shall not exceed that necessary for the joint to be satisfactorily made, nor that recommended by the pipe manufacturer, and shall be approved by the Owner.

J. Lay no pipe in water or when it is the Owner's opinion that trench conditions are unsuitable. If crushed stone is used to improve trench conditions or as backfill for bedding the pipe, this shall be considered incidental to the project, and no separate payment will be made for its use.

K. When required, utility warning tape and detection wire shall be buried below the surface and directly above pipe as specified in Division 33 sections.
   1. For all non-metallic piping installations, install continuous underground detection wire. Affix wire to top of pipe prior to backfilling. Wire shall be stripped and tied to valves for continuity.
   2. For all underground piping installations, install continuous underground detectable warning tape during backfilling of trench.
      a. Installation of detectable tape shall be per manufacturer’s recommendations and shall be as close to the grade as is practical for optimum protection and detectability.

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Allow a minimum of 18 inches between the tape and the utility line. Allow a minimum of 6 inches between the tape and the ground surface.

b. Installation of detectable tape shall be per manufacturer's recommendations. Allow a minimum of 18 inches between the tape and the utility line. Allow a minimum of 12 inches between the tape and the ground surface.

L. Install piping by trenchless methods, where indicated on the Drawings, in accordance with Division 33 Section "Trenchless Installation of Utilities".

M. Install underground piping with restrained joints at horizontal and vertical changes in direction. Use restrained joint piping, thrust blocks, anchors, mechanical joint restraint, tie-rods and clamps, and other supports.

1. Install thrust blocks wherever the pipe line changes direction (e.g., at tees and bends), at dead ends, or at any other point where the manufacturer recommends, and/or the Owner indicates that they are to be used.

N. Contractor shall adhere to the requirements of Division 31 Section "Earthwork" for installation and backfilling.

1. Begin backfilling after the line construction is completed and then inspected and approved by the Owner. On each side of the line, from the bottom of barrel to 1 foot above the top of the pipe, the backfill material shall be select backfill consisting of either of fine, loose earth like sandy soil or loam or of granular material that is free from clods, vegetable matter, debris, stone, and/or other objectionable materials and that has a size of not more than 2 inches. Place this backfill simultaneously on either side of the pipe in even layers that before compaction, are no more than 6 inches deep. Thoroughly and completely tamp each layer into place before placing additional layers. At locations beneath or closely adjacent to pavement this backfill shall consist of No. 67 (TDOT) crushed stone.
2. If pipe is installed in a rock trench, install 6 inches bedding of No. 67 (TDOT) crushed stone. Then add additional No. 67 (TDOT) stone backfill up to 1 foot above the top of the pipe as shown on the plans.
3. From 1 foot above the pipe upward, the backfill material may contain broken stones that make up approximately 3/4 of the backfill's total volume. However, if this type of backfill is used, there must be enough spalls and earth materials to fill all voids completely. The maximum dimension of individual stones in such backfill shall not exceed 6 inches, and the backfill material shall be placed and spread in even layers not more than 12 inches deep. At locations beneath or closely adjacent to pavement or at locations of improvements subject to damage by displacement the backfill shall be entirely No. 67 (TDOT) stone. Tamp and thoroughly compact the backfill in layers that, before compaction, are 6 inches deep. In other areas, the backfill for the upper portion of the trenches may be placed without tamping but shall be compacted to a density equivalent

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to that of adjacent earth material as determined by laboratory tests. Use special care to prevent the operation of backfilling equipment from causing any damage to the pipe.

4. Wherever pipes have diameters of 15 inches or less, do not use power operated tampers to tamp that portion of the backfill around the pipe within 1 foot above the pipe.
5. Perform backfilling so as not to disturb or injure any pipe and/or structure against which the backfill is being placed. If any pipe or structure is damaged and/or displaced during backfilling, open up the backfill and make whatever repairs are necessary.
6. Backfilling and clean-up operations shall closely follow pipe laying; failure to comply with this provision will result in the Owner's requiring that the Contractor's other activities be suspended until backfilling and clean-up operations catch up with pipe laying.

O. Install line markers directly above pipeline alignment at intervals of 1,000 feet where indicated on the Drawings. Line markers shall be installed after final clean-up is completed.

3.5 CONCRETE VAULT INSTALLATION

A. Concrete vaults will be required for 3-inch diameter and larger meters.

B. Dewater sufficiently to maintain the ground water level at or below the bottom of the vault foundation prior to and during placement of the foundation.

C. Obtain an adequate foundation for the structure by removing and replacing unsuitable material with well graded granular material, by tightening with coarse rock, or by such other means as provided for foundation preparation of the connected lines or as directed by the Owner. Wherever water is encountered at the site, place all cast-in-place bases or monolithic structures on a one-piece waterproof membrane to prevent any movement of water into the fresh concrete.

D. When the foundation subgrade has been prepared and is approved by the Owner, carefully construct the foundation for precast and monolithic structures to the line and grade required by the Drawings. The foundation shall be well graded granular material. In no case shall the vault be supported directly on rock.

E. Vault foundation shall be constructed such that the vault is fully and uniformly supported in true alignment according to the Drawings and as site conditions allow. Make sure that all entering pipe can be installed at proper grade.

F. Thoroughly wet and the completely fill all lift holes and all interior joints between precast elements with non-shrink grout. Smooth them inside to ensure water tightness.

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G. Carefully set the vault top at the required elevation, and properly bond it to the vault with cement grout or rubber sealant. Wherever vaults are constructed in paved areas, tilt the vault top so as to conform to the exact slope and grade of the existing adjacent pavement.

H. Place backfill by hand around the vault and to a distance of at least one pipe length into each trench and tamp with selected material up to an elevation of 12 inches above the crown of all entering pipes. Continue backfilling in accordance with the requirements for trench backfilling.

I. Install pipe supports in accordance with the manufacturer's recommendations. Supports shall be installed in the locations shown on the Drawings. In cases where supports are not shown, supports shall be furnished and installed at appropriate locations to ensure adequate support of piping, valves, etc. Supports shall be installed in locations that ease removal and re-alignment of valves, meters, etc.

J. After the vault had been adjusted to the proper grade, it shall be visually inspected by the Contractor in the presence of the Resident Project Representative. Any defects noted shall be corrected by the Contractor until the work is found satisfactory to the Resident Project Representative. In addition, at the Owner's request, the Contractor may be required within one year to visually inspect any vault(s) that were adjusted. Any work that has become defective shall be redone by the Contractor at no additional expense to the Owner.

K. Vault shall have positive drainage when site conditions allow. When positive drainage is not available, a sump pump shall be installed.

3.6 REMOVAL AND DISPOSAL OF DEBRIS

A. Cleanup: Contractor is required to grade and clean all areas affected by the installation and backfilling of the pipe trench. The Contractor shall do this work within the following constraints:
   1. At a minimum:
      a. No earlier than 2 weeks of pipe trench backfilling; and,
      b. No later than 10,000 feet of additional pipe installation.
   2. At a maximum:
      a. No later than 3 weeks of pipe trench backfilling.

B. Piping Tests: Conduct piping tests after thrust blocks have hardened sufficiently. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water. Conduct tests in accordance with AWWA C600 for ductile iron AWWA C605 for PVC, and AWWA Manual M55 for HDPE. The pipes must hold a pressure of 200 psi for a duration of 2 hours.

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1. Pressure Tests:
   a. Slowly fill each valved section of pipe with water and apply the specified test pressure (based on the elevation of the lowest point of the line or section under test and corrected to the elevation of the test gauge) with a pump connected to the pipe in a manner satisfactory to the Owner. Furnish the pump, pipe, connections, gauges, and all necessary apparatus.
   b. Before applying the specified test pressure, expel all air from the pipe. If air release valves are not available at high points, make the necessary taps at the point of highest elevation before testing, and insert plugs after the test has been completed.
   c. Carefully examine all exposed pipe, fittings, valves, and air release valves during the test. Remove any cracked or defective pipes, fittings, valves, or air release valves discovered in consequence of this pressure test and replace with sound material in the manner specified. Repeat the test until the results are satisfactory to the Owner/Engineer.

END OF SECTION

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PART 1 – GENERAL

1.1 STANDARDS

A. DIP shall be used for sewage force mains 4 inches and larger.

B. Buried piping shall be of the bell and spigot, mechanical joint, butt fusion, and/or electrofusion type as required by material and application.

C. Non-buried piping shall have flanged ends, unless otherwise noted on the Drawings.

D. Use Mechanical Joint Fitting Restraining Device for plain end piping connections to fittings, valves, etc.

1.2 SUBMITTALS

A. Product Data:
   1. Ductile iron pipe.
   2. Ductile iron fittings.
   3. Ductile iron flanged pipe.
   4. Polyvinyl chloride pipe.
   5. Pipe insulation and accessories.
   6. Mechanical joint restraint devices.
   7. Flanged coupling adapters.
   8. Flexible expansion joint.
   9. Concrete vaults and accessories.
   10. Line markers.
   11. Utility warning tape.
   12. Detection wire.

B. Shop Drawings:
   1. Concrete vaults and manholes, including hatches, frames and covers, ladders, and drains.

C. Operation and Maintenance Data: For specialties to include in emergency, operation, and maintenance manuals. Include the following:
   1. Hatches for concrete vaults.
   2. Valves.
   3. Protective enclosures.

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1.3 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of piping and specialties and are based on the specific system indicated.

B. Comply with regulatory requirements of local, state and federal agencies having jurisdiction.

C. Piping material shall bear label, stamp, or other markings of specified testing agency.

D. Comply with ASTM F645 for selection, design, and installation of thermoplastic water piping.

E. Comply with NSF/ANSI 61 for materials.

F. The pipe manufacturer must furnish the Owner a notarized certificate stating that the pipe furnished has been manufactured and tested in accordance with the applicable standards.

G. The length of each individual piece of ductile iron pipe shipped must be plainly marked on each piece of pipe. Each piece of pipe shall bear the manufacturer's name or trademark, the year in which it was produced, and the letters "DI" or the word "DUCTILE".

H. All ductile iron pipe shall be the product of one American based manufacturer with a minimum of five (5) years of experience in manufacturing the size, class, and quantity of pipe specified herein. The manufacturer must have a successful performance record on projects of comparable scope and magnitude.

I. Coordinate this work with that required by other sections for timely execution.

J. It shall be the Contractor's responsibility to ensure that all necessary materials are furnished to them and that those found to be defective in the manufacturing process are replaced at no extra cost to the Owner. Materials damaged in handling after being delivered by the manufacturer shall be replaced at the Contractor's own expense. If installed material is found to be defective before the final acceptance of the work, the cost of both the material and labor needed to replace it shall not be passed on to the Owner.

K. Furnish all material, equipment, tools, and labor in connection with the sewage force main, complete and in accordance with the drawings and these specifications.

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1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Delivery: Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.

B. Storage:
   1. The Contractor shall be responsible for safely storing materials needed for the work that have been accepted by them until they have been incorporated into the completed project.
   2. Protect stored piping from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing inside.
   3. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

C. Handling: Protect flanges, fittings, and specialties from moisture and dirt.

1.5 GENERAL REQUIREMENTS

A. Force mains may be installed within the same ditch line as gravity sewer provided that the same spacing requirement regarding to water lines is maintained. Special care shall be provided to protect both the force main and the gravity sewer during construction and during the operation of the sanitary sewer system.

B. Where force mains are installed in new fill, a compaction letter sealed by a Geotechnical Engineer registered in the State of Tennessee shall be submitted to the Owner prior to accepting said utilities. An acceptable compaction letter shall state that field density testing indicates the fill has been compacted to at least 95% of the maximum dry density according to the Standard Proctor. If a compaction letter is not available, special protection such as replacement with ductile iron pipe with joint restraint or encasement with flowable fill shall be utilized as approved by the WMD.

PART 2 – PRODUCTS

2.1 DUCTILE IRON PIPE

A. Ductile iron pipe for sewage force main use shall have TNEMEC Perma Shield PL Series 431 ceramic epoxy lining. Refer to Division 33 Section “Sanitary Sewer (Gravity)” for detailed specifications for ductile iron pipe.

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2.2 DUCTILE IRON FITTINGS

A. Ductile iron fittings for sewage force main use shall have TNEMEC Perma Shield PL Series 431 ceramic epoxy lining. Refer to Division 33 Section "Sanitary Sewer (Gravity)" for detailed specifications for ductile iron fittings.

2.3 DUCTILE IRON FLANGED PIPE

A. Flanged pipe shall meet the requirements of ductile iron pipe, as specified herein, unless otherwise specified.

B. All ductile iron flanged pipe shall comply with ANSI A21.15/AWWA C115, latest revision. The pipe barrel shall be manufactured in accordance with ANSI A21.51/AWWA C151, latest revision. All flanges shall be ductile iron and rated for 250 psi working pressure. To insure accountability, all flanged pipe shall be fabricated at the factory by the barrel manufacturer.

C. All flanges (unless otherwise indicated or required) shall be faced and drilled ANSI B16.1 125-pound for ductile iron and ANSI B16.5 150-pound for steel.

D. Provide a flanged pipe gasket for each joint made of Styrene Butadiene Copolymer (SBR) or Ethylene Propylene Diene Monomer (EPDM) which meet all the material requirements of ANSI A21.11/AWWA C111.

E. Gaskets for flanged pipe with an operating pressure greater than 160 psi shall be Toruseal Flange Gasket as manufactured by American Cast Iron Pipe Company, American Ductile Iron Pipe Division, or approved equal.

F. Manufacturer:
   1. U.S. Pipe
   2. American Cast Iron Pipe Company
   3. Approved equal

2.4 PIPE INSULATION AND ACCESSORIES

A. Refer to Division 33 Section "Sanitary Sewer (Gravity)" for pipe insulation and accessories.

2.5 MECHANICAL JOINT FITTING RESTRAINT DEVICES

A. Refer to Division 33 Section "Sanitary Sewer (Gravity)" for ductile iron pipe restraint devices.

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2.6 FLANGED COUPLING ADAPTERS

A. Refer to Division 33 Section "Sanitary Sewer (Gravity)" for flanged coupling adapters.

2.7 FLEXIBLE EXPANSION JOINT

A. Refer to Division 33 Section "Sanitary Sewer (Gravity)" for flexible expansion joints.

2.8 CONCRETE VAULTS AND ACCESSORIES

A. Refer to Division 33 Section "Sanitary Sewer (Gravity)" for concrete vaults and accessories.

2.9 LINE MARKERS

A. Markers shall be single piece design, constructed of durable, UV resistant, composite material, and have a pointed end for ease of installation. The marker shall have a constant flat "T" cross-sectional design and be 3.75 inch in width and of such length to provide a minimum height above the ground surface of 44 inches and a minimum embedment depth of 18 inches. The marker shall resist displacement from wind and vehicle impact forces. The marker shall be free of burns, discoloration, cracks, bulges, or other objectionable marks. A line shall be stamped horizontally across the front of the marker to indicate proper burial depth.

B. The marker shall be pigmented throughout the entire cross-section so as to produce a uniform color which is an integral part of the material. The marker shall be colored green.

C. Line markers shall be labeled with the lettering "CAUTION FORCE MAIN" with the Owner's name and telephone number written below the lettering.

D. Manufacturer / Model:
   1. Carsonite International, Early Branch, SC Model Carsonite Utility Marker 375 or
   2. Approved equal.

2.10 UTILITY WARNING TAPE

A. Detectable underground utility warning tape, which can be located from the surface by a pipe detector, shall have of a minimum thickness of 0.35 mils solid aluminum foil encased in a protective inert plastic jacket that is impervious to all known alkalis, acid, chemical reagents and solvents found in the soil. The tape shall have a minimum overall thickness of 5.0 mils and a minimum width of 3 inch (non-metallic piping) with a minimum unit weight of 2-1/2 pounds/

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1 inch x 1,000 foot. The tape shall be color coded green permanently imprinted “Caution Buried Force Main Below”.

B. Non-detectable underground utility warning tape shall be installed directly above all utility lines. The tape shall be polyethylene and have a minimum thickness of 4 mils and a minimum width of 3 inches. The tape shall be color coded brown in accordance with APWA National Color Code and permanently imprinted “Caution Buried Force Main Below”.

C. Manufacturer / Model:
   1. Allen Systems, “Detect Tape”,
   2. Empire Level Mfg. Corp., “Magnatee”, or
   3. Approved equal.

2.11 DETECTION WIRE

A. Detection wire shall be UL approved, 14 AWG, type THHN solid copper. The wire shall be color coded green in accordance with APWA National Color Code for sanitary sewer.

PART 3 – EXECUTION

3.1 EARTHWORK

A. Refer to Division 31 Section “Earthwork” for excavating, trenching, and backfilling.

B. Unless the construction of lines by tunneling, jacking, or boring is called for by the drawings or specifically authorized by the Owner, make excavation for pipelines in open cut and true to the lines and grades shown on the drawings or established by the Owner on the ground. Cut the banks of trenches between vertical parallel planes equidistant from the pipe centerline. The horizontal distance between the vertical planes (or, if sheeting is used, between the inside faces of that sheeting) shall vary with the size of the pipe to be installed, but shall not be more than the distance determined by the following formula: 4/3d + 15 inches, where "d" represents the internal diameter of the pipe in inches. When approved in writing by the Owner, the banks of trenches from the ground surface down to a depth not closer than 1 foot above the top of the pipe may be excavated to non-vertical and non-parallel planes, provided the excavation below that depth is made with vertical and parallel sides equidistant from the pipe centerline in accordance with the formula given above. Any cut made in excess of formula 4/3d + 15 inches shall be at the expense of the Contractor and may be cause for the Owner to require that stronger pipe and/or a higher class of bedding be used at no cost to the Owner.

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C. Do not excavate pipe trenches more than 200 feet ahead of the pipe laying, and not more than two hundred (200) feet of open ditch shall be left behind the pipe laying and perform all work so as to cause the least possible inconvenience to the public. Construct temporary bridges or crossings when and where the Owner deems necessary to maintain vehicular or pedestrian traffic.

D. In all cases where materials are deposited along open trenches, place them so that in the event of rain no damage will result to the work and/or to adjacent property.

3.2 PIPING APPLICATIONS

A. Use pipe, fittings, and joining methods for piping systems according to the following applications.
   1. Transition couplings and special fittings with pressure ratings at least equal to piping pressure rating maybe used in applications below, unless otherwise indicated.
   2. Do not use flanges, unions, or keyed couplings for underground piping.
   3. Flanges, unions, keyed couplings, and special fittings shall be used, instead of joints indicated, on aboveground piping and piping in vaults.

3.3 JOINT CONSTRUCTION

A. Clean and assemble pipe joints and fittings according to the following:
   1. Ductile-Iron Piping, Gasketed Joints: AWWA C600 and AWWA M41.
   2. Ductile-Iron Piping, Grooved Joints: Cut-groove pipe. Assemble joints with keyed couplings, gaskets, lubricant, and bolts according to coupling manufacturer's written instructions.
   3. Dissimilar Materials Piping Joints: Use adapters compatible with both piping materials, with OD, and with system working pressure.

3.4 PIPING INSTALLATION

A. Install ductile iron pipe and fittings according to AWWA C600 and AWWA M41.

B. Unless otherwise indicated by the Drawings or Division 33 requirements, bury piping with a depth of cover of at least 36 inches, with top of pipe at least 12 inches below level of maximum frost penetration, and according to the following:
   1. Under Driveways: With at least 36 inches cover over top of pipe.
   2. Under Roadways: With at least 42 inches cover over top of pipe. Under Railroad Tracks: With at least 48 inches cover over top of pipe.

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3. Over or Under Gas Pipelines: Minimum 12 inches vertical separation and 10 feet of horizontal separation.

C. Lay the pipe to and keep it at the lines and grades required by the drawings. All fittings shall be at the required locations, and spigots well centered in the bells and all valves and stems plumb.
   1. The pipe shall slope continuously between high and low points and have a minimum of 60 inches cover at the high points. No departure from this policy shall be made except at the order of the Owner.
   2. After a length of pipe has been placed in the trench, center the spigot end in the bell of the adjacent pipe, and then insert to the depth specified by the manufacturer and bring to the correct line and grade. Secure the pipe in place by tamping an approved backfill material around it.
   3. Make all joints, whether standard mechanical or push-on joints, in conformance with the recommendations of the joint manufacturer as approved by the Owner.

D. Provide and use tools and facilities that are satisfactory to the Owner and that will allow the work to be done in a safe and convenient manner. Use a derrick, ropes, or other suitable equipment to lower all pipe and fittings into the trench one piece at a time. Carefully lower each piece so that neither it nor any protective coating or lining it may have will be damaged. Under no circumstances, drop or dump force main materials into the trench.
   1. Lower no pipes and fittings into the trench until they have been swabbed to remove any mud, debris, etc., that may have accumulated within them. After the pipe has been lowered, remove all unnecessary materials from it. Before any pipe is laid, brush and wipe clean the outside of its spigot end and the inside of its bell and ensure that the pipe is dry and oil-free.
      a. Take every precaution to keep foreign material from getting into the pipe while it is being placed in the line. If the crew laying the pipe cannot put it into the trench and in place without allowing earth to get inside it, then place a heavy, tightly woven canvas bag of suitable size over each end of the pipe and leave it there until it is time to connect that pipe to the one adjacent to it.
      b. Place no debris, tools, clothing, or other materials in the pipe during laying operations.

E. Bell holes shall be big enough so that there is ample room for the pipe joints to be properly made. Between bell holes, carefully grade the bottom of the trench so that each pipe barrel will rest on a solid foundation for its entire length.

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F. Whenever pipe laying is not in progress, close the open ends of pipe in the trench with a watertight plug or by other means approved by the Owner. Caulk the joints of any pipe in the trench that cannot be completed until a later time with packing in order to make them as watertight as possible; this shall be done not only at the end of each working day but also before work is stopped for lunch periods, bad weather, or any other reason. If there is water in a trench, this seal shall remain in place until the trench has been pumped completely dry.

G. The cutting of pipe so that fittings or closure pieces can be inserted shall be done in a neat and workmanlike manner and without any damage to the pipe. Follow the manufacturer's recommendations concerning how to cut and machine the ends of the pipe in order to leave a smooth end at right angles to the pipe's axis.
   1. The flame cutting of pipe by means of an oxyacetylene torch will not be allowed.

H. Unless otherwise directed by the Owner, lay pipe with the bell ends facing in the direction of laying.

I. Wherever pipe must be deflected from a straight line (in either the vertical or horizontal plane) in order to avoid obstructions or plumb stems, or wherever long radius curves are permitted, the amount of deflection shall not exceed that necessary for the joint to be satisfactorily made, nor that recommended by the pipe manufacturer, and shall be approved by the Owner.

J. Lay no pipe in water or when it is the Owner's opinion that trench conditions are unsuitable. If crushed stone is used to improve trench conditions or as backfill for bedding the pipe, this shall be considered incidental to the project, and no separate payment will be made for its use.

K. When required, utility warning tape and detection wire shall be buried below the surface and directly above pipe as specified in Division 33 sections.
   1. For all non-metallic piping installations, install continuous underground detection wire. Affix wire to top of pipe prior to backfilling. Wire shall be stripped and tied to valves for continuity.
   2. For all underground piping installations, install continuous underground non-detectable warning tape during backfilling of trench.
      a. Installation of non-detectable tape shall be per manufacturer’s recommendations and shall be as close to the grade as is practical for optimum protection. Allow a minimum of 24 inches between the tape and the utility line. Allow a minimum of 6 inches between the tape and the ground surface.

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L. Install piping by trenchless methods, where indicated on the Drawings, in accordance with Division 33 Section "Trenchless Installation of Utilities".

M. Install underground piping with restrained joints at horizontal and vertical changes in direction. Use restrained joint piping, thrust blocks, anchors, mechanical joint restraint, tie-rods and clamps, and other supports.
   1. Install thrust blocks wherever the pipe line changes direction (e.g., at tees and bends), at dead ends, or at any other point where the manufacturer recommends and/or the Owner indicates that they are to be used.

N. Contractor shall adhere to the requirements of Division 31 Section “Earthwork” for installation and backfilling.
   1. Begin backfilling after the line construction is completed and then inspected and approved by the Owner. On each side of the line, from the bottom of barrel to 1 foot above the top of the pipe, the backfill material shall be select backfill consisting of either of fine, loose earth like sandy soil or loam or of granular material that is free from clods, vegetable matter, debris, stone, and/or other objectionable materials and that has a size of not more than 2 inches. Place this backfill simultaneously on either side of the pipe in even layers that before compaction, are no more than 6 inches deep. Thoroughly and completely tamp each layer into place before placing additional layers. At locations beneath or closely adjacent to pavement this backfill shall consist of No. 67 (TDOT) crushed stone.
   2. If pipe is installed in a rock trench, install 6 inches bedding of No. 67 (TDOT) crushed stone. Then add additional No. 67 (TDOT) stone backfill up to 1 foot above the top of the pipe as shown on the plans.
   3. From 1 foot above the pipe upward, the backfill material may contain broken stones that make up approximately 3/4 of the backfill's total volume. However, if this type of backfill is used, there must be enough spalls and earth materials to fill all voids completely. The maximum dimension of individual stones in such backfill shall not exceed 6 inches, and the backfill material shall be placed and spread in even layers not more than 12 inches deep. At locations beneath or closely adjacent to pavement or at locations of improvements subject to damage by displacement the backfill shall be entirely No. 67 (TDOT) crushed stone. Tamp and thoroughly compact the backfill in layers that, before compaction, are 6 inches deep. In other areas, the backfill for the upper portion of the trenches may be placed without tamping but shall be compacted to a density equivalent to that of adjacent earth material as determined by laboratory tests. Use special care to prevent the operation of backfilling equipment from causing any damage to the pipe.
   4. Wherever pipes have diameters of 15 inches or less, do not use power operated tampers to tamp that portion of the backfill around the pipe within 1 foot above the pipe.

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5. Perform backfilling so as not to disturb or injure any pipe and/or structure against which the backfill is being placed. If any pipe or structure is damaged and/or displaced during backfilling, open up the backfill and make whatever repairs are necessary.
6. Backfilling and clean-up operations shall closely follow pipe laying; failure to comply with this provision will result in the Owner's requiring that the Contractor's other activities be suspended until backfilling and clean-up operations catch up with pipe laying.

O. Install line markers directly above pipeline alignment at intervals of 1,000 feet where indicated on the Drawings. Line markers shall be installed after final clean-up is completed.

3.5 CONCRETE VAULT INSTALLATION

A. Rectangular concrete vaults shall be either precast or cast-in-place reinforced concrete of the dimensions and specifications noted on the Drawings. Concrete shall have a 28-day compressive strength of 4000 psi.

B. Circular precast concrete barrel sections for valve vaults shall conform to ASTM C478 except sections deeper than 12 feet shall have reinforcing equal to that ASTM C76 Class III reinforced concrete pipe unless otherwise noted on the Drawings.

C. Precast section joints shall be mortared or grouted; joined with ASHTO M-198-75 preformed flexible butyl type joint sealant. Joints should be water tight.
   1. Manufacturer / Model:
   2. Hamilton-Kent “Kent-Seal No. 2”,
   3. K.T. Snyder Company “rub ‘r-Nek”,
   4. Press Seal Gasket “E-Z Stik”, or
   5. Approved equal.

D. Rectangular Concrete Vault Hatch
   1. Channel frame shall be 1/4 inch (7 mm) thick extruded aluminum with a mill finish, incorporating a continuous concrete anchor. A 1-1/2 inch (38 mm) drainage coupling shall be located in the front left corner of the channel frame. A bituminous coating shall be applied to the frame exterior where it will come into contact with concrete. The entire frame must be supported by a full bed of Class A concrete (H-20 load rating).
   2. The door panel(s) shall be 1/4 inch (7 mm) aluminum diamond plate, reinforced to withstand a live load of 300 psf or H-20 uniform live load with a maximum allowable deflection of 1/150 of the span and shall not protrude into the channel frame when in the open position. In grassed or landscaped (non-traffic) areas the access door shall be designed for 300 psf loading. In areas that may receive light vehicle traffic, such as

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sidewalks or edges of parking lots, the access door shall be designed for H-20 wheel loading.

3. Doors shall open to 90 degrees and automatically lock with a T-316 stainless steel hold open arm with an aluminum release handle. For ease of operation, the door hold open arm shall incorporate an enclosed stainless steel compression spring assist.
4. Doors shall close flush with the frame and rest on a built-in neoprene cushion/gasket (300 psf load rating).
5. Hinges and all fastening hardware shall be T-316 stainless steel.
6. Unit shall lock with a T-316 stainless steel slam lock with removable key and have a non-corrosive handle.
7. Unit shall carry a lifetime guarantee against defects in material and/or workmanship.
8. Manufacturer / Model:
   a. Halliday Products, Inc., Orlando, Florida, Series W2C (double leaf), or
   b. Approved equal.

E. Ladder/Steps:
   1. Ladder/steps shall be steel encased in copolymer polypropylene plastic (or equal), “Press Fit” type, have an overall width of 12 inches, and spaced at 12 inches.
   2. Manufacturer:
      a. M.A. Industries, or
      b. Approved equal.

F. A vent shall be provided in the top of the vault. The vent shall be constructed of PVC, a minimum of 3 feet tall, and a minimum of 4-inches in diameter with a 24 mesh stainless steel screen. The vent shall be located such that it does not interfere with the opening/closing of the hatch or impede access to the vault interior. The vault penetration shall be a thrust collar wall pipe cast integrally into the vault top. The vent shall be flanged and bolt to the wall sleeve.

G. Pipe Penetrations shall be water tight and sealed in the vault wall opening with flexible and/or rigid connections. At least one pipe penetration shall be a rigid connection.
   1. Flexible connections shall be provided using resilient connectors meeting the requirements of ASTM C-923. Resilient connectors shall be compression type cast integrally into the vault wall.
      a. Manufacturer:
         1) A-Lok Products, Inc., Tullytown, PA, or
         2) Approved equal.
   2. Rigid Connections shall be provided using a thrust collar wall pipe. Thrust collar wall pipes shall be cast integrally into the vault wall. Thrust collar wall pipes shall meet the

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requirements of ductile iron flanged piping, as specified herein, unless otherwise specified.

a. Manufacturer:
    1) U.S. Pipe,
    2) American Ductile Iron Pipe, or
    3) Approved equal.

H. Vault Drainage:
1. Vault drainage shall be as noted on the Drawings and according to the following.
    a. Drain pipe shall be schedule 80 PVC and penetrate the wall at floor level. Slope of drain line shall be in accordance with local plumbing codes. A varmint screen shall be installed on the drain line inside the vault for ease of maintenance. A flap valve shall be installed on the drain line discharge.
    b. Ensure that the drain pipe has positive drainage away from the vault.
    c. The vault floor shall have a sump with a minimum depth of 12-inches and a minimum inside diameter of 14-inches. The sump is not required to be cast integrally in the floor of precast vaults. However, the seal between the vault and the sump shall be watertight and no part of the sump will be allowed to extend above the floor thereby inhibiting drainage. The sump shall be concrete or HDPE.
        1) The sump pump shall be automatic with level operation. It shall operate on 115 volt, single phase, 60 Hz power. The pump shall be 1/3 horsepower and pump a maximum flow of 30 gpm at 10-feet of head with a 1-1/2 inch discharge.
        2) Manufacturer / Model:
            a) Water Ace Model R3V, or
            b) Approved equal.

I. Vault electrical, if any, shall be in accordance with the requirements of the Specifications and Drawings.

J. Vault Piping:
1. Piping shall be supported with column type pipe saddle supports, concrete block, or other Owner-approved method.
    a. Column type pipe saddle supports shall be stanchion type with vertical adjustability and U-bolt attachment to pipe. The stanchion shall be properly sized to carry the pipe load. The saddle assembly and base shall be cast iron or carbon steel.
        1. Manufacturer:
            a) Grinnell Corporation, Providence, RI, or
            b) Approved equal.

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b. Concrete pipe supports shall be full or half-size, solid CMU placed under pipe, valves, meters, etc. flanges or under flanged base bends. Flanged base bends shall be bolted to the concrete pipe support.

2. Piping shall be insulated in accordance with Paragraph 2.8 subparagraphs a and c and/or have heat tape.

K. Valves shall be in accordance with Division 33 Section "Valves".

L. Manufacturer:
1. Barger Precast,
2. Old Castle, or
3. Approved equal

3.6 FIELD QUALITY CONTROL

A. Cleanup: Contractor is required to grade and clean all areas affected by the installation and backfilling of the pipe trench. The Contractor shall do this work within the following constraints:
1. At a minimum:
a. No earlier than 2 weeks of pipe trench backfilling; and,
b. No later than 10,000 feet of additional pipe installation.
2. At a maximum:
a. No later than 3 weeks of pipe trench backfilling.

B. Piping Tests: Conduct piping tests after thrust blocks have hardened sufficiently. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water. If the water is in another utility district then the Contractor is responsible for supplying potable water. Conduct tests in accordance with AWWA C600 for ductile iron.

PIPE TEST METHODS TABLE

Procedure	Pressure	Duration of Test
Separate Pressure Test	150% of working pressure* at point of test, but not less than 125% of normal working pressure at highest elevation.**	1 hour

*Working pressure is defined as maximum anticipated sustained operating pressure.
**In no case shall the test pressure be allowed to exceed the design pressure for pipe, appurtenances, or thrust restraints.

1. Pressure Tests:
a. Slowly fill each valved section of pipe with water and apply the specified test pressure (based on the elevation of the lowest point of the line or section under test and

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corrected to the elevation of the test gauge) with a pump connected to the pipe in a manner satisfactory to the Owner. Furnish the pump, pipe, connections, gauges, and all necessary apparatus.

b. Carefully examine all exposed pipe, fittings, valves, and air release valves during the test. Remove any cracked or defective pipes, fittings, valves, or air release valves discovered in consequence of this pressure test and replace with sound material in the manner specified. Repeat the test until the results are satisfactory to the Owner/Engineer.

END OF SECTION

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PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. Manholes shall be placed no further than 400’ apart; 500’ apart for pipes 24” and larger.

B. Manholes shall be required at the end of each line, change in grade or size, change in alignment, or intersection of two (2) or more mains.

C. All manholes shall be adjusted to final grades.

D. Manholes located within the floodplain or areas known to flood shall have watertight manhole covers.

E. Minimum diameter shall be 48-inches and larger sizes will be required as shown in the following table:

MANHOLE SIZES		
SEWER MAIN (inches)	**MAXIMUM BRANCH SIZE (inches)**	**MANHOLE SIZE (inches)**
8 – 15	10	48
18 – 24	12	60
24 – 36	15	72
Greater than 36	TBD by WMD	TBD by WMD

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F. Ventilation of gravity wastewater mains should be considered where continuous watertight sections greater than 1,000 feet are incurred. The height of the vent pipe opening shall be a minimum of 1 foot above the 100-year flood plain elevation.

G. Manholes shall be precast with eccentric cones unless otherwise approved by the WMD.

H. Manholes entered by a force main shall be lined per Section 33 0133 Rehabilitation of Manholes.

I. Dog House manholes shall be used only with the permission of the City of Franklin Water Management Department.

J. Flat top manholes shall be used only with the permission of the City of Franklin Water Management Department.

1.2 QUALITY ASSURANCE

A. Material Testing: All precast reinforced concrete manhole risers and tops specified herein shall be tested and inspected by a commercial testing laboratory approved by the Owner prior to delivery to the site, and all materials that fail to conform to these specifications shall be rejected. After delivery to the site, any materials that have been damaged in transit or are otherwise unsuitable for use in the work shall be rejected and removed from the site.

B. The commercial testing laboratory shall be engaged and paid for by the Developer/Contractor.

C. Manholes shall be watertight and of high quality.

1.3 SUBMITTALS

A. Shop drawings are required for castings, plastic gaskets, manhole steps, resilient pipe connection, and precast manholes specified in this section.

B. Supply certified copies in duplicate for the inspection and acceptance reports of the testing laboratory to the Owner before using the materials.

C. Submit a certificate from the manufacturer of the castings indicating that they meet all applicable requirements of these specifications.

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PART 2 - PRODUCTS

2.1 CONCRETE

A. All concrete shall be reinforced.

2.2 GRADE ADJUSTMENT RING (FOR CASTING ADJUSTMENT)

A. Grade rings shall only be used with the approval of the Water Management Department.

B. Reinforced concrete adjustment rings shall conform to ASTM C478.

2.3 MORTAR

A. Composed of one part Portland cement and two parts sand (volumetric measure) thoroughly mixed in a tight box, with water added gradually and mixed continually until mortar has attained the proper consistency for use in the work; prepared only in such quantities as needed for immediate use; mortar mixed for more than 30 minutes, re-tempered, or previously set will not be allowed.

2.4 GRAY IRON CASTINGS

A. Cast iron conforming to the requirements of Class 30, ASTM A48; made accurately to the required dimensions; sound, smooth, clean, and free from blisters and other defects; not plugged or otherwise treated to remedy defects; machined so that covers rest securely in the frames with no rocking and are in contact with frame flanges for the entire perimeter of the contact surfaces; thoroughly cleaned subsequent to machining and, before rusting begins, painted with a bituminous coating so as to present a smooth finish; tough and tenacious when cold, but not tacky and with no tendency to scale; and with the actual weight in pounds stenciled or printed by the manufacturer on each casting in white paint.

2.5 STANDARD FRAME AND COVER

A. The standard frame and cover shall be traffic typed gray cast iron ASTM Designation A48 - Latest Revision, with a 24-inch (minimum) diameter opening weighing not less than 410 pounds. The covers shall be the solid self- sealing type with no holes except watertight pick notches. The surface between the cover and frame shall fit smoothly without rocking and shall be thoroughly cleaned. The gray iron castings shall be painted with a bituminous coating.

B. Cover shall be of the solid indented type with the words "Historic City of Franklin, Sanitary Sewer" cast in raised letters thereon as shown on the manhole frame and cover detail. Manhole frames and covers shall be John Bouchard and Sons No. 1152M or approved equal. All private sanitary sewer shall have a cover with the words “Private Sanitary Sewer” cast in raised letters as shown on the manhole frame and cover detail.

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2.6 WATERTIGHT MANHOLE FRAMES AND COVERS

A. The manhole frames shall be set in the same manner prescribed for standard frames except special attention shall be paid to securing a watertight bolted connection to the manhole barrel.

The watertight manhole frame and cover shall be a traffic type of grey cast iron ASTM A48-64 with a 24 inch diameter minimum clear opening weighing not less than 550 pounds and shall be of the two-cover design as shown on the Plans. Manhole frame and cover shall be John Bouchard and Sons No. 1123 or approved equal.

B. The surface cover shall be the solid type with no holes except watertight pick notches or a heavy lifting ring. The surface between this cover and frame shall fit without rocking. The inner cover shall be of the solid type with no holes, shall have not less than two lifting handles and shall have a neoprene sealing gasket at last 3/8 inch diameter cross-section. The inner cover shall be mechanically sealed by means of a removable metal bar located over the inner cover with a centrally-located stainless steel tightening bolt. This bolt shall be fitted for a tee-handle or bent-handle for turning which shall be included with each cover. The bolt shall have Acme threads for durability and coaxed with an anti-seize compound. The inner cover shall have appropriate reinforcing ribs to prevent cracking or distortion when tightened. The inner cover shall have sufficient clearance to allow easy installation of the cover.

2.7 MANHOLE JOINT SEALANT FOR PRECAST MANHOLES

A. Flexible plastic sealant for joints in pre-cast manhole sections shall provide permanently flexible watertight joints, shall remain workable over wide temperature range and shall not shrink, harden or oxidize upon aging. Material shall be butyl resin sealant ConSeal CS-102 or CS-202 as manufactured by Concrete Sealants, Inc. of New Carlisle, Ohio, RUB'R-NEK L-T-M manufactured by K.T. Snyder Company, Inc. of Houston, Texas, or other approved equal.

2.8 MANHOLE JOINT WRAP

A. Joint wrap, at all joints between riser sections, shall be installed in accordance with ASTM C909. Joint wrap shall be 6-inch minimum width, and as manufactured by Press-Seal Gasket Corporation of Fort Wayne, Indiana, or approved equal.

2.9 BUTYL MASTIC SEALANT

A. The sealant shall be used when joining the casting frame to the precast manhole and for all manhole adjustments to provide watertight structure. The sealing compound shall be produced from blends refined hydrocarbon resins and plasticizing compounds reinforced with inert mineral filler, and shall contain no solvents, irritating fumes, or obnoxious odors. The

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compound shall not depend on oxidizing, evaporating, or chemical action for its adhesive or cohesive strength. It shall be supplied in extruded rope form of suitable cross section and in such sizes as to seal the joint space. Use two complete ropes at each joint. The sealing compound shall be protected by a suitable removable two-piece wrapper, which shall be designed so that half may be removed longitudinally without disturbing the other half in order to facilitate application of the sealing compound. The sealant shall also meet the requirements of the following table:

Composition	Test Method	Minimum	Maximum
Bitumen (Petroleum Plastic Content)	ASTM D4	50	70
Ash Inert Mineral Matter	AASHTO T11	30	50
Volatile Matter	ASTM D6	---	2.0
Property	**Test Method**	**Minimum**	**Maximum**
Specific Gravity at 77 degrees F	ASTM D71	1.2	1.3
Ductility at 77 degrees F(cm)	ASTM D113	5.0	---
Softening Point	ASTM D36	320 degrees F	---
Penetration 77 degrees F (150 gms) 5 sec.	ASTM D217	50	120

2.10 MANHOLE STEPS

A. Manhole steps shall be made of copolymer polypropylene plastic meeting the latest revision of ASTM D4101-08, Type II, Grade 16906 and shall have a 1/2 inch diameter Grade 60 reinforcing rod meeting the latest revision of ASTM A615 through its center. Each step shall be 12 inches in width and capable of carrying a load of 1,000 pounds in the center of the step when projected 6 inches from the wall. Each step shall be equipped with non-skid grooves.

2.11 MANHOLE INVERTS

A. Manhole inverts shall be formed from 3,000 psi concrete. Inverts for "Straight-through" manholes may be formed by laying the pipe straight through the manhole, pouring the concrete invert and then removing the top half of the pipe. Curved inverts shall be constructed of concrete and shall form a smooth even, half-pipe section as shown on the Plans. The inverts shall be constructed when the manhole is being built.

B. The bench or top portion of the invert shall slope to the flow line to prevent standing water.

C. Services within the manhole, higher than 2 foot above the manhole invert, shall be constructed of an outside drop structure as shown in the details.

2.12 RESILIENT PIPE CONNECTIONS AT MANHOLES

A. Resilient pipe connectors shall be manufactured in accordance with ASTM C923 and shall provide a positive watertight joint and minimum of 10 degrees deflection in any direction.

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There shall be no water leakage through the connector when pipe is in its maximum deflected position. Connectors shall be manufactured of durable construction. Connectors shall be manufactured of durable rubber which offers superior resistance to water, sewage, oils, acid, ozone, weathering and aging. Conical type flexible boot of the proper size to match the OD of the connection pipes shall be clamped securely to the cut out in the manhole wall and to the pipe by means of stainless steel clamps or bands. The void area between the pipe and the connector shall be sealed with an approved flexible gasket material. The flexible boot shall meet ASTM C443. Connectors shall be as manufactured by the KOR-N-SEAL Company of Milford, New Hampshire, Press-Boot by Press-Seal Gasket Corporation of Fort Wayne, Indiana, or equal.

B. Compression-type connectors cast integrally into the manhole wall shall be equivalent to the A-Lok Manhole Pipe Connector as manufactured by A-Lok Products, Inc. Compression-type connectors shall only be used when specifically called for on the drawings.

2.13 PRE-CAST CONCRETE MANHOLES

A. Precast manholes shall be constructed on a reinforced concrete foundation and shall be wet cast as modified herein. The bottom section of the manhole shall be precast integrally with the precast ring and shall be 4'-0" in diameter. All concrete used in connection with the construction of manholes shall be 4,000 psi concrete. Wet cast precast manholes shall be Foley, Inc. or approved equivalent.

B. The precast manhole manufacturer shall use the additive Xypex Admix C-1000 Red, or approved equal, during batching at the rate as specified by the manufacturer. The amount of cement shall remain the same and not be reduced. Any other additive shall be approved by the Water Management.

C. Precast concrete rings shall be constructed using standard forms and shall conform to ASTM C478 including steel reinforcement. The precast ring manufacturer shall use the additive Xypex Admix C-1000 Red or approved equal.

D. The precast manhole sections shall be manufactured and installed in a manner so that there is no visible leakage in the manholes. The manhole section shall be manufactured in lengths such that a finished manhole will have the least possible number of joints. One section less than four feet in length will be allowed per manhole and that being the section required to bring the manhole to grade. No more than 1 foot of riser rings may be used in total. The sections shall be of the tongue and groove design sealed watertight. A resilient pipe connection shall be utilized in the sewer line to manhole connection, unless specifically noted on the drawings.

E. The manhole casting shall be adjusted with Xypex, or approved equal, protected concrete grade adjustment rings as required to bring the casting to grade.

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F. Manufacturer:
   1. Barger Precast, or
   2. Old Castle, or
   3. Approved equal

PART 3 - EXECUTION

3.1 PREPARATION

A. Dewater sufficiently to maintain the ground water level at or below the bottom of the manhole foundation prior to and during placement of the foundation.

B. Obtain an adequate foundation for all manhole structures by removing and replacing unsuitable material with well graded granular material, by tightening with coarse rock, or by such other means as provided for foundation preparation of the connected sewers or as directed by the Owner. Wherever water is encountered at the site, place all cast in place bases or monolithic structures on a one-piece waterproof membrane to prevent any movement of water into the fresh concrete.

3.2 INSTALLATION

A. When the foundation subgrade has been prepared and is approved by the Owner, carefully construct the concrete foundation for monolithic manholes to the line and grade required by the drawings. Construct the manholes after the concrete foundation has been allowed to set for a period of not less than 24 hours.

B. For precast manholes, carefully block the base section above the prepared surface so that it is fully and uniformly supported in true alignment; make sure that all entering pipe can be inserted at proper grade. Then place the concrete foundation and invert under and upon this base section as shown in the standard drawings. A base section with monolithic foundation (bottom) may be used when approved by the Owner.

C. Construct monolithic concrete manholes and bases of 4,000 psi concrete in accordance with the provisions of this section. The manhole steps shall be cast in place.

D. Carefully set the cast iron frame for the cover at the required elevation, and properly bond it to the concrete cone with butyl mastic sealant. Wherever manholes are constructed in paved areas, install a Cretex Pro-ring, or approved equal, per the manufacturer's standard to conform to the exact slope, crown, and grade of the existing adjacent pavement. Existing frames and covers reused for elevation adjustment shall be thoroughly cleaned before reinstallation.

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E. Manhole inverts shall be constructed of concrete or mortared masonry fill and may, at the Contractor's option, be covered with cement mortar to the approximate cross section of the sewers connected to them. Make any necessary changes in cross sections gradually from side to side of the manhole; make changes in direction of flow of the sewers to a true curve of as large a radius as is permitted by the size of the manhole.

F. Use flexible watertight manhole couplings on all pipes at connections to manholes. Connector shall meet the requirement of ASTM C923. Connector shall be supplied with external stainless steel pipe clamp. Connector shall be Kor-N-Seal or approved equal.

G. Where the difference in the invert elevation of two or more sewers intersecting in one manhole is 24 inch or more, install a precast drop manhole. Drop manholes shall be similar in construction to standard manholes except that a drop connection of pipe and fittings of the proper sizes and materials shall be constructed outside the manhole and supported by 3,000 psi concrete as indicated by the standard drawings. Pipe material used in the drop is the same as the service.

   If a precast manhole cannot be constructed, the Contractor shall install drop manhole per detail.

H. Place backfill by hand around the manhole and to a distance of at least one pipe length into each trench, and tamp with selected material up to an elevation of 12 inch above the crown of all entering pipes. Continue backfilling in accordance with the requirements for trenching backfilling.

I. A 10 foot graded area shall be constructed concentric with center of manhole casting to provide a level access for entry.

J. Vacuum Testing of New Manholes or any Existing Manhole that has been altered:

   1. Manholes shall be pre-tested immediately after assembly. Final testing shall be performed after binder course of asphalt is installed.
   2. Manholes altered shall be retested per testing requirements below.
   3. Manholes are to be retested after 2 weeks or 2 substantial rainfalls (1” or greater). No standing water shall be allowed in the manhole excavation which may affect the accuracy of the test. Adjustments in the manhole will require additional testing.
   4. All pipes and other openings into the manhole shall be suitably plugged in such a manner as to prevent displacement of the plugs while the vacuum is drawn.
   5. Installation and operation of vacuum equipment and indicating devices shall be in accordance with equipment specifications and instructions provided by the manufacturer.
   6. The test head shall be placed to include the manhole casting (frame).

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7. A vacuum of 10 inches of mercury shall be drawn. The time for the vacuum to drop to 9 inches of mercury shall be recorded.
8. Acceptance for 4 foot diameter manholes shall be defined as when the time to drop to 9 inches of mercury conforms to the table below. Contractor shall keep a log of all tests which shall be submitted to the Owner for approval.

Manholes Depth	Diameter	Time to Drop 1 Inch Hg
10 feet or less	4 feet	60 seconds
10.1 feet to 15 feet	4 feet	75 seconds
15.1 feet to 25 feet	4 feet	90 seconds

9. For manholes 5 feet in diameter, add an additional 15 seconds and for manholes 6 feet in diameter, add an additional 30 seconds to the time requirements for four foot diameter manholes.
10. If the manhole fails to test, necessary repairs shall be made and vacuum test repeated until the manhole passes the test.
11. If the manhole joint mastic or gasket is displaced during the vacuum test, the manhole shall be disassembled and the seal replaced.
12. No additional payment will be made for testing and cost shall be merged into cost of manholes.

3.3 ACCEPTANCE TEST FOR EXISTING MANHOLE GRADE ADJUSTMENT

A. After the manhole has been adjusted to the proper grade, the manhole shall be visually inspected and retested by the Contractor in the presence of the Resident Project Representative. Any defects noted shall be corrected by the Contractor until the work is found satisfactory to the Resident Project Representative. In addition, at the Owner's request, the Contractor may be required within one year to visually inspect the manholes that were adjusted. Any work that has become defective shall be redone by the Contractor at no additional expense to the Owner.

END OF SECTION

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PART 1 - GENERAL

1.1 GENERAL DESCRIPTION

A. The manufacturer shall furnish complete grinder pump station(s), consisting of a grinder pump, a tank constructed of high density polyethylene, NEMA 6P electrical quick disconnect, pump removal system, discharge piping assembly with shut-off valve, anti-siphon valve, check valve, electrical alarm panel, and all necessary internal wiring and controls. All pump motor/grinder units shall be of like type and horsepower throughout the system.

B. Prior to design of a low pressure sewer system, a meeting with the City of Franklin Engineering and Water Management Departments to determine the applicability of this type of system is required.

1.2 SHOP DRAWINGS

A. The manufacturer shall furnish a minimum of six (6) sets of shop drawings detailing the equipment to be furnished including dimensional data and materials of construction. The Engineer shall review this data, and return two (2) copies as accepted, or with requested modifications. Upon the Engineer's acceptance of the shop drawings and the manufacturer's receipt of notice to proceed, the manufacturer shall begin fabrication of the equipment.

1.3 MANUFACTURER

A. Grinder pump stations, complete with all appurtenances, shall be supplied by one grinder pump station manufacturer. The equipment specified shall be a product of a company experienced in the design and manufacture of grinder pumps for specific use in low pressure sewage systems. The company shall submit detailed installation and user instructions for its product, submit evidence of an established service program including complete parts and service manuals, and be responsible for maintaining a continuing inventory of grinder pump replacement parts. The manufacturer shall provide a reference and contact list from five (5) of its largest contiguous grinder pump installations of the type of grinder pumps described within this specification.

B. The Manufacturer/Model of the grinder pump station shall be Environment One Corporation/DH071.

C. Attention is directed to the fact that the drawings and overall system design are based on a particular piece of equipment from a particular manufacturer. These specifications are intended to provide guidelines for standard equipment of a recognized manufacturer who already meets all the requirements of this specification.

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1.4 OPERATING CONDITIONS

A. The pump(s) shall be capable of delivering 15 GPM against a total dynamic head of 0 feet (0 PSIG) and 9 GPM against a total dynamic head of 138 feet (60 PSIG) at a maximum of 8.0 amps. The pump(s) must also be capable of operating at negative total dynamic head without overloading the motor(s). Under no conditions shall in-line piping or valving be allowed to create a false apparent head.

1.5 WARRANTY

A. The grinder pump manufacturer shall provide a part(s) and labor warranty on the complete station, accessories and control panel for a period of twelve (12) months from the date of acceptance.

PART 2 - PRODUCTS

2.1 PUMP

A. The pump shall be an integral, vertical rotor, motor driven, solids handling pump of the progressing cavity type with a single mechanical seal. The rotor shall be constructed of stainless steel. Plating on the rotor will not be acceptable due to its tendency to delaminate. The stator shall be a compounded ethylene propylene synthetic elastomer. The material shall be suitable for domestic wastewater service. Its physical properties shall include high tear and abrasion resistance, grease resistance, water and detergent resistance, temperature stability, excellent aging properties, and outstanding wear resistance. Buna-N is not acceptable as a stator material.

2.2 GRINDER

A. The grinder shall be placed immediately below the pumping elements and shall be direct-driven by a single, one-piece, stainless steel motor shaft. The grinder impeller assembly shall be securely fastened to the pump motor shaft. The grinder will be of the rotating type with a stamped, stainless steel shredder ring assembly spaced in accurate, close annular alignment with the driven impeller assembly, which shall carry two hardened, 400 series stainless steel cutter bars. This assembly shall be dynamically balanced and operate without vibration over the entire range of specified operating pressures. The grinder shall be constructed so as to eliminate clogging and jamming under all normal operating conditions including pump starting. Sufficient vortex action shall be created to scour the tank free of deposits or sludge banks which would impair the operation of the pump. These requirements shall be accomplished by the following, in conjunction with the pump:

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1. The grinder shall be positioned in such a way that solids are fed in an upward flow direction.
2. The maximum flow rate through the cutting mechanism must not exceed 4 feet per second.
3. The inlet shroud shall have a diameter of no less than 5 inches which promotes a ft/sec inlet velocity that prevents unnecessary jamming of the cutter mechanism and eliminates blinding of the pump by large objects blocking the inlet shroud.
4. The impeller mechanism must rotate at a nominal speed of no greater than 1800 rpm.
5. The grinder shall be capable of reducing all components in normal domestic sewage, including a reasonable amount of "foreign objects," such as paper, wood, plastic, glass, rubber and the like, to finely divided particles that will pass freely through the passages of the pump and the 1-1/4" diameter discharge piping.

2.3 ELECTRIC MOTOR

A. The motor shall be a 1 HP, 1725 RPM, 240 Volt 60 Hertz, 1 Phase, capacitor start, ball bearing, air-cooled induction type with a low starting current not to exceed 30 amperes and high starting torque of 8.4 foot pounds. Inherent protection against running overloads or locked rotor conditions for the pump motor shall be provided by the use of an automatic-reset, integral thermal overload protector incorporated into the motor. This motor protector combination shall have been specifically investigated and listed by Underwriters Laboratories, Inc., for the application. Non-capacitor start motors or permanent split capacitor motors will not be accepted. Oil-filled motors will not be accepted.

2.4 MECHANICAL SEAL

A. The pump shall be provided with a mechanical shaft seal to prevent leakage between the motor and pump. The seal shall have a stationary ceramic seat and carbon rotating surface with faces precision lapped and held in position by a stainless steel spring.

2.5 TANK AND INTEGRAL ACCESSWAY

A. Simplex Unit: The tank shall be made of high density polyethylene, with a melt index of 2.0 grams/10 minutes or lower to assure high environmental stress cracking resistance. Corrugated sections are to be made of a double wall construction with the internal wall being generally smooth to promote scouring. Corrugations of the outside wall are to be of a minimum amplitude of 1-½" to provide necessary transverse stiffness. Any incidental sections of a single wall construction are to be a minimum 0.250 inch thick. All seams created during tank construction are to be thermally welded and factory tested for leak tightness. Tank wall and bottom must withstand the pressure exerted by saturated soil loading at maximum burial depth. All station components must function normally when exposed to 150 percent of the maximum external soil and hydrostatic pressure.

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B. Duplex Unit: The tank shall be made of rotationally molded high density polyethylene, with a melt index of 2.0 grams/10 minutes or lower to assure high environmental stress cracking resistance. The tank shall have a nominal thickness of ½". All seams created during tank construction are to be thermally welded and factory tested for leak tightness. Tank wall and bottom must withstand the pressure exerted by saturated soil loading at maximum burial depth. All station components must function normally when exposed to 150 percent of the maximum external soil and hydrostatic pressure.

C. The tank shall be furnished with one EPDM grommet fitting to accept a 4.50" OD DWV or Schedule 40 pipe. Tank capacities shall be as shown on the contract drawings.

D. The accessway shall be an integral extension of the wet well assembly and include a lockable cover assembly providing low profile mounting and watertight capability. Accessway design and construction shall enable field adjustment of the station height by adding either 2-inch or 4-inch vertical extensions without the use of any adhesives or sealants requiring cure time before installation can be completed.

E. The accessway shall include a single NEMA 6P electrical quick disconnect (EQD) for all power and control functions, factory installed with accessway penetrations warranted by the manufacturer to be watertight. Plug-type connections of the power cable onto the pump housing will not be acceptable due to the potential for leaks and electrical shorts. The accessway shall also include a 2-inch PVC vent to prevent sewage gases from accumulating in the tank.

F. The station shall have all necessary penetrations molded in and factory sealed. No field penetrations shall be acceptable.

G. All discharge piping shall be constructed of 304 Series Stainless Steel and terminate outside the accessway bulkhead with a stainless steel, 1-¼ inch female NPT fitting. The discharge piping shall include a stainless steel ball valve rated for 200 psi WOG; PVC ball valves will not be accepted. The bulkhead penetration shall be factory installed and warranted by the manufacturer to be watertight.

2.6 CHECK VALVE

A. The pump discharge shall be equipped with a factory installed, gravity operated, flapper-type integral check valve built into the stainless steel discharge piping. The check valve will provide a full-ported passageway when open and shall introduce a friction loss of less than 6 inches of water at maximum rated flow. Moving parts will be made of a 300 series stainless steel and fabric reinforced synthetic elastomer to ensure corrosion resistance, dimensional stability, and fatigue strength. A nonmetallic hinge shall be an integral part of the flapper assembly providing a maximum degree of freedom to assure seating even at a very low back-pressure.

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The valve body shall be an injection molded part made of glass filled PVC. Ball type check valves are unacceptable.

B. Each grinder pump installation shall also include one separate check valve of the type detailed above for installation in the 1-1/4" service lateral between the grinder pump station and the sewer main, preferably next to the curb stop.

2.7 ANTI-SIPHON VALVE

A. The pump discharge shall be equipped with a factory-installed, gravity operated, flapper-type integral anti-siphon valve built into the stainless steel discharge piping.

B. Moving parts will be made of 300 series stainless steel and fabric-reinforced synthetic elastomer to ensure corrosion resistance, dimensional stability, and fatigue strength. A nonmetallic hinge shall be an integral part of the flapper assembly, providing a maximum degree of freedom to ensure proper operation even at a very low pressure. The valve body shall be injection-molded from a glass-filled thermoplastic resin. Holes or ports in the discharge piping are not acceptable anti-siphon devices.

2.8 CORE UNIT

A. The grinder pump station shall have a removable core assembly consisting of the pump, motor, grinder, all motor controls, check valve, anti-siphon valve, EQD and wiring. The watertight integrity of the core unit shall be established by 100 percent factory test at a minimum of 5 PSIG.

2.9 CONTROLS

A. All necessary controls, including motor and level controls, shall be located in the top housing of the core unit. The top housing will be attached with stainless steel fasteners. Non-fouling wastewater level controls for controlling pump operation shall be accomplished by monitoring the pressure changes in an integral air column connected to a pressure switch. The level detection device shall have no moving parts in direct contact with the wastewater. High-level sensing will be accomplished in the manner detailed above by a separate air-bell sensor and pressure switch of the same type. Closure of the high-level sensing device will energize an alarm circuit as well as a redundant pump-on circuit. Pump ON/OFF and High level alarm functions shall not be controlled by the same switch. Float switches of any kind, including float trees, will not be accepted.

B. Each core shall be equipped with a pressure equalization chamber. The equalization chamber shall continuously calibrate the level sensing pressure switches to fluctuations in barometric

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pressure & prevent fluid from entering the control compartment during high water level conditions. The equalization chamber shall be constructed from EPDM, High Impact Polystyrene and stainless steel and measure 12" in diameter by 6" high. The chamber shall be assembled by the core manufacturer and factory tested at the point of assembly to verify proper operation. The grinder pump will be furnished with a 6 conductor, 14 gauge, type SJOW cable, pre-wired and watertight to meet UL requirements with a FACTORY INSTALLED NEMA 6P EQD half attached to it.

2.10 ALARM PANEL

A. All necessary controls, including motor and level controls, shall be located in the top housing of the core unit. The top housing will be attached with stainless steel fasteners. Non-fouling wastewater level controls for controlling pump operation shall be accomplished by monitoring the pressure changes in an integral air column connected to a pressure switch. The level detection device shall have no moving parts in direct contact with the wastewater. High-level sensing will be accomplished in the manner detailed above by a separate air-bell sensor and pressure switch of the same type. Closure of the high-level sensing device will energize an alarm circuit as well as a redundant pump-on circuit. Pump ON/OFF and High level alarm functions shall not be controlled by the same switch. Float switches of any kind, including float trees, will not be accepted.

B. Each core shall be equipped with a pressure equalization chamber. The equalization chamber shall continuously calibrate the level sensing pressure switches to fluctuations in barometric pressure & prevent fluid from entering the control compartment during high water level conditions. The equalization chamber shall be constructed from EPDM, High Impact Polystyrene and stainless steel and measure 12" in diameter by 6" high. The chamber shall be assembled by the core manufacturer and factory tested at the point of assembly to verify proper operation. The grinder pump will be furnished with a 6 conductor, 14 gauge, type SJOW cable, pre-wired and watertight to meet UL requirements with a FACTORY INSTALLED NEMA 6P EQD half attached to it.
   1. When liquid level in the sewage wet well rises above the alarm level, visual and audio alarms will be activated. The contacts on the alarm pressure switch will close. The redundant pump starting system will be energized.
   2. The audio alarm may be silenced by means of the externally mounted, push-to- silence button.
   3. Visual alarm remains illuminated until the sewage level in the wet well drops below the "off" setting of the alarm pressure switch.

C. The control panel shall be equipped with an outside quick disconnect to facilitate usage of a generator during a power outage.

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2.11 SERVICEABILITY

A. The grinder pump core unit shall be furnished with polypropylene lifting harness connected to the pump body to facilitate easy removal when necessary. All mechanical and electrical connections must provide disconnect accessibility for core unit removal and installation. All motor control components shall be mounted on a replaceable bracket for ease of field service.

2.12 SAFETY

A. The grinder pump station shall be free from objectionable noise, odor, or health hazards, in its capability to perform as specified in either individual or low pressure sewer system applications.

PART 3 - EXECUTION

3.1 FACTORY TEST

A. Each grinder pump shall be submerged and operated for 5 minutes (minimum). Included in this procedure will be the testing of all ancillary components such as the anti-siphon valve, check valve, level sensors and each unit's dedicated controls. All factory tests shall incorporate each of the above listed items. Certified test results shall be available upon request showing the operation of each grinder pump at two (2) different points on its curve, with the maximum discharge pressure no less than 60 psi. The Engineer reserves the right to inspect such testing procedures with representatives of the City, at the grinder pump manufacturer's facility.

3.2 INSTALLATION

A. Earth excavation and backfill are specified under Section 31 0000 "Earthwork" but are also to be done as a part of the work under this section, including any necessary sheeting and bracing. The Contractor shall be responsible for handling ground water to provide a firm, dry subgrade for the structure, and shall guard against flotation or other damage resulting from general water or flooding.

B. The Grinder Pump Stations shall not be set into the excavation until the installation procedures and excavation have been approved by the Engineer.

C. Remove packing material. User instructions MUST be given to the City. Hardware supplied with the unit, if required, will be used at installation. The basin will be supplied with a standard 4" inlet grommet (4.50" OD) for connecting the incoming sewer line. Appropriate inlet piping must be used. The basin may not be dropped, rolled or laid on its side for any reason. Installation shall be accomplished so that 1" to 4" of accessway, below the bottom of the lid, extends above the finished grade line. The finished grade shall slope away from the unit. The

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diameter of the excavated hole must be large enough to allow for the concrete anchor. A 6-inch (minimum) layer of naturally rounded aggregate, clean and free flowing, with particle size of not less than 1/8" or more than 3/4" shall be used as bedding material under each unit. A concrete anti-flotation collar, as detailed on the drawings, and sized according to the manufacturer's instructions, shall be required and shall be pre-cast to the grinder pump or poured in place. Each Grinder Pump Station with its pre-cast anti-flotation collar shall have a minimum of three (3) lifting eyes for loading and unloading purposes. If the concrete is poured in place, the unit shall be leveled, and filled with water, to the bottom of the inlet, to help prevent the unit from shifting while the concrete is being poured. The concrete must be manually vibrated to ensure there are no voids. If it is necessary to pour the concrete to a level higher than the inlet piping, an 8" sleeve is required over the inlet prior to the concrete being poured. The Contractor will provide and install a four (4) foot piece of four inch SCH 40 PVC pipe with water tight cap, to stub-out the inlet for the property owners' installation contractor, as depicted on the contract drawings.

D. When the grinder pump is being installed at the property with an existing septic tank, the Contractor shall install two (2) knife valves at the point of intercepting the 4-inch diameter service line between the building and the septic tank. The existing septic tank shall remain in an operable condition in case of pump failure. Valve leading to pump shall be tagged accordingly (open/closed).

E. The electrical enclosure shall be furnished, installed and wired to the Grinder Pump Station by the Contractor. An alarm device is required on every installation, there shall be NO EXCEPTIONS. It will be the responsibility of the Contractor to coordinate with the individual property owner(s) to determine the optimum location for the Alarm Panel. The Contractor shall mount the alarm device in a conspicuous location, as per national and local codes. The Alarm Panel will be connected to the Grinder Pump Station by a length of six (6) conductor 12 gauge type TC cable, in conduit where exposed. The power and alarm circuits must be on separate power circuits. The grinder pump stations will be provided with a minimum of 32' (25' of useable electrical supply cable outside the station) to connect to the alarm panel. This cable shall be supplied with a factory installed EQD half to connect to the mating EQD half on the core.

F. Minimum electrical wiring requirements: All LPS electrical systems are to be single phase, 240V AC, 30A, four-wire weatherproof disconnect service. The external NEMA 3 electrical disconnect, installed within five feet (5’) of the present location of the sewer line leaving the house to the septic tank, can be fused, non fused or breaker type. The height of the disconnect shall be a minimum of four feet (4’) from the grade. The wiring from the main breaker to the disconnect shall be four-wire (two hot: one insulated neutral and one ground wire). The

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installation of these conductors shall be in conduit where exposed. The permit can be obtained at the Building and Neighborhood Services Department.

3.3 START UP AND FIELD TESTING

A. The manufacturer shall provide the services of qualified factory-trained technician(s) who shall inspect the placement and wiring of each station, perform field tests as specified herein, and instruct the City personnel in the operation and maintenance of the equipment before the stations are accepted by the City. All equipment and materials necessary to perform testing shall be the responsibility of the installing Contractor. This will include, as a minimum, a portable generator (if temporary power is required) and water in each basin. The services of a trained factory-authorized technician shall be provided at a rate of one (1) four (4) day week for each 100 grinder pump stations supplied. Each day shall be ten (10) person hours in duration.

B. Upon completion of the installation, the authorized factory technicians will perform the following test on each station:
   1. Make certain the discharge shut-off valve is fully open. This valve must not be closed when the pump is operating. In some installations, there may be a valve(s) at the street main that must also be open.
   2. Turn ON the alarm power circuit.
   3. Fill the tank with water to a depth sufficient to verify the high level alarm is operating. Shut off water.
   4. Close the pump power circuit breaker. The pump should immediately turn ON. Within one (1) minute the alarm light will turn OFF. Within three (3) minutes the pump will turn OFF.
   5. Drawdown Test.

C. Upon completion of the start-up and testing, the manufacturer shall submit to the City the start-up authorization form describing the results of the tests performed for each Grinder Pump Station. Final acceptance of the system will not occur until authorization forms have been received for each pump station installed and all installation deficiencies have been corrected.

3.4 OPERATION AND MAINTENANCE

A. MANUALS: The manufacturer shall supply two (2) copies of Operation and Maintenance Manuals to the Owner.

END OF SECTION

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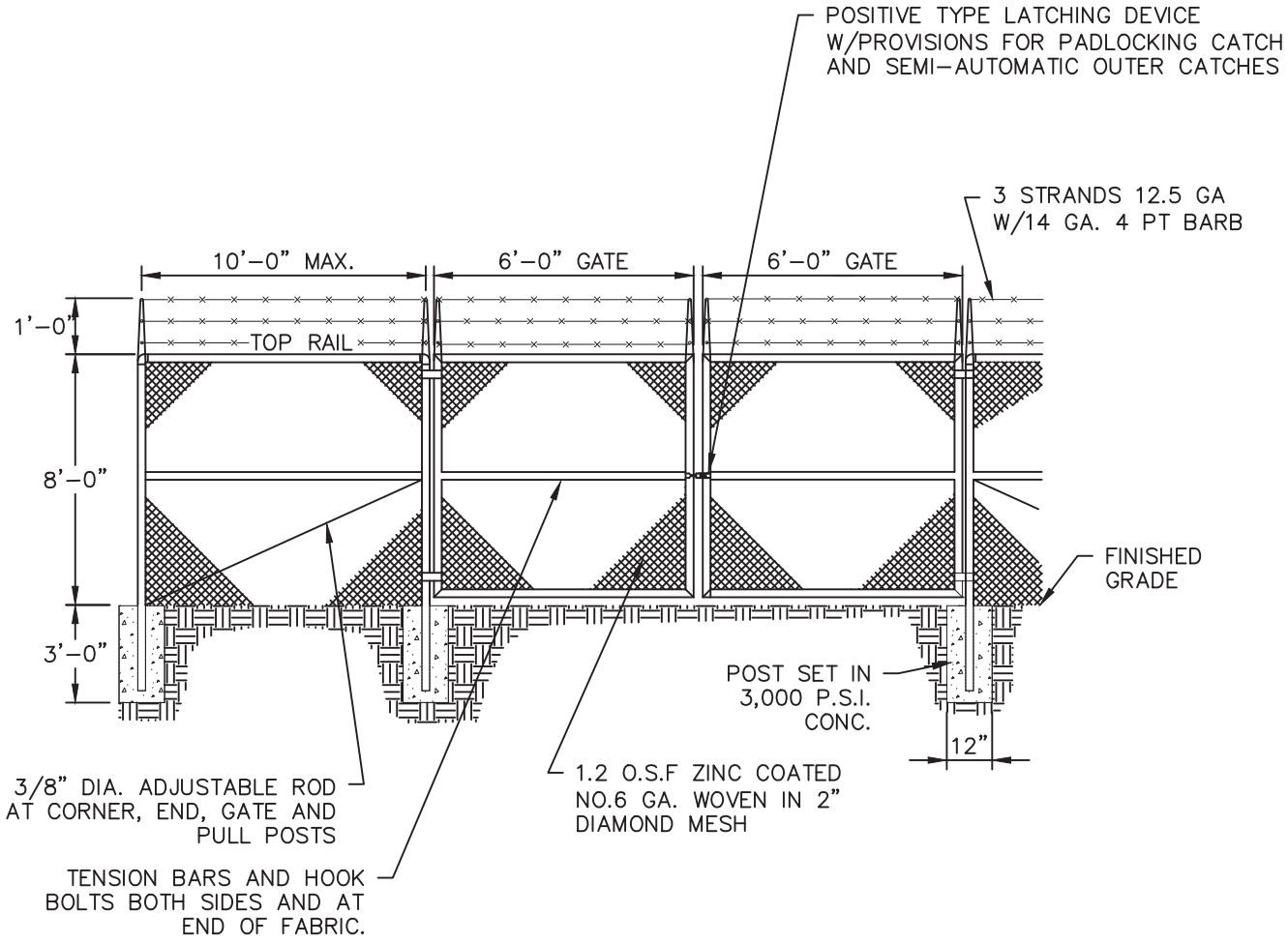


NOTES:

1) ALL POSTS AND OTHER APPURTENANCES SHALL BE HOT DIP GALVANIZED W/ MIN. 1.8 O.S.F. ZINC. ALL FITTINGS SHALL BE MALLEABLE OR DUCTILE IRON OR STEEL.

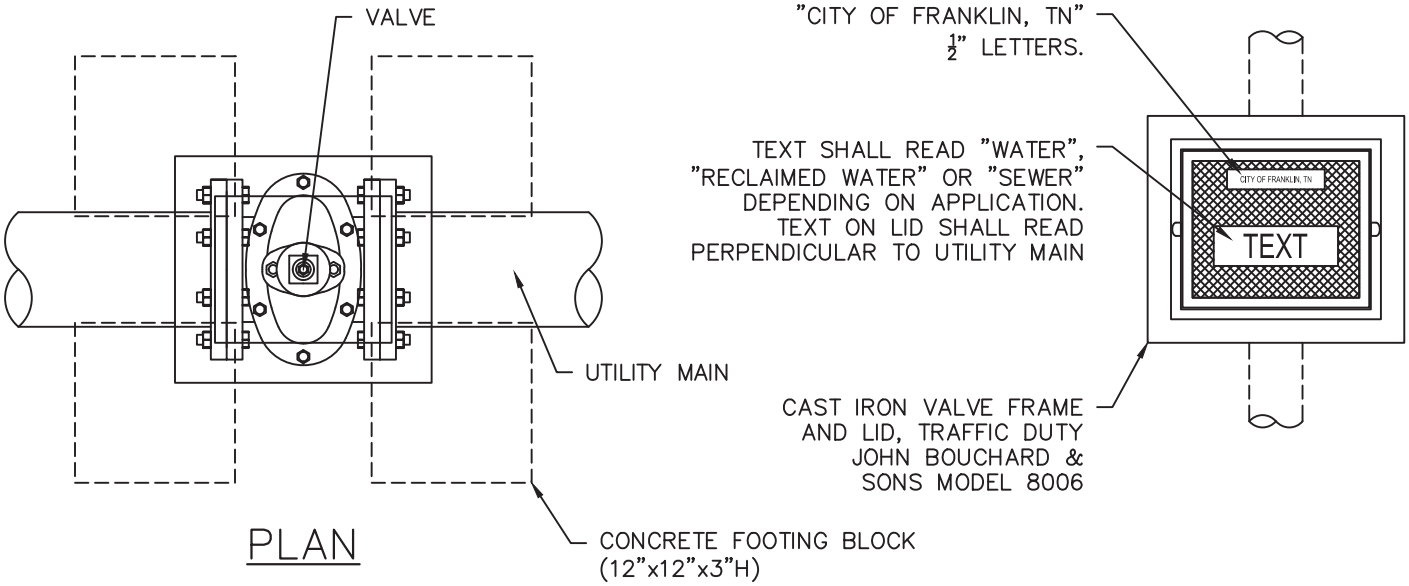
HISTORIC FRANKLIN TENNESSEE

CHAIN LINK FENCE WITH DOUBLE 6-FOOT GATES

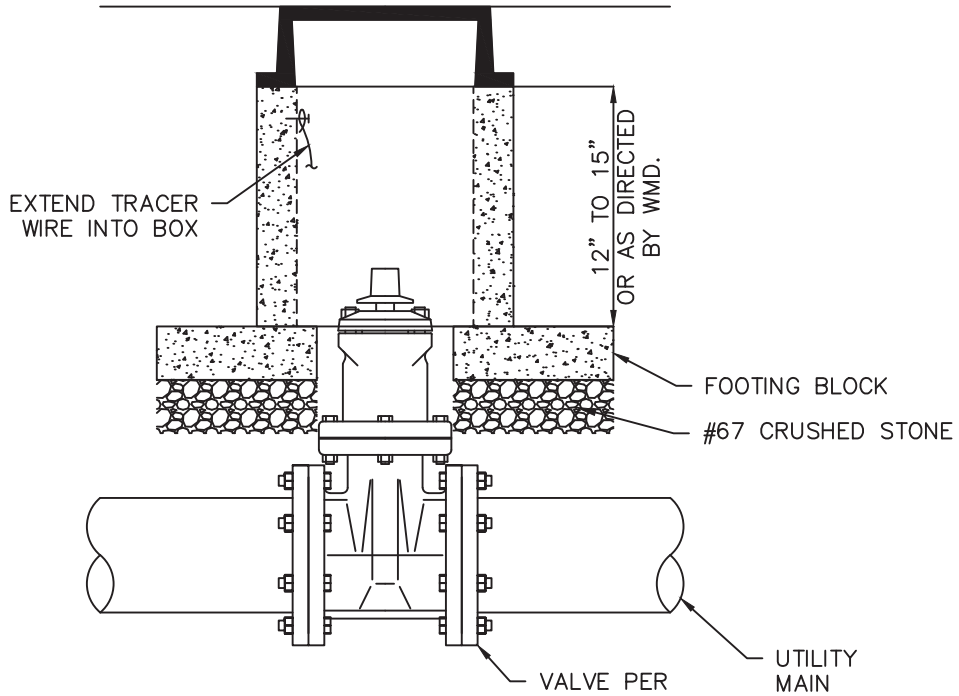
DWG. NO.

G-1

CITY OF FRANKLIN	WATER MANAGEMENT DIRECTOR:	DATE: 10/16/2019
NOT TO SCALE		



PLAN



ELEVATION

NOTES:

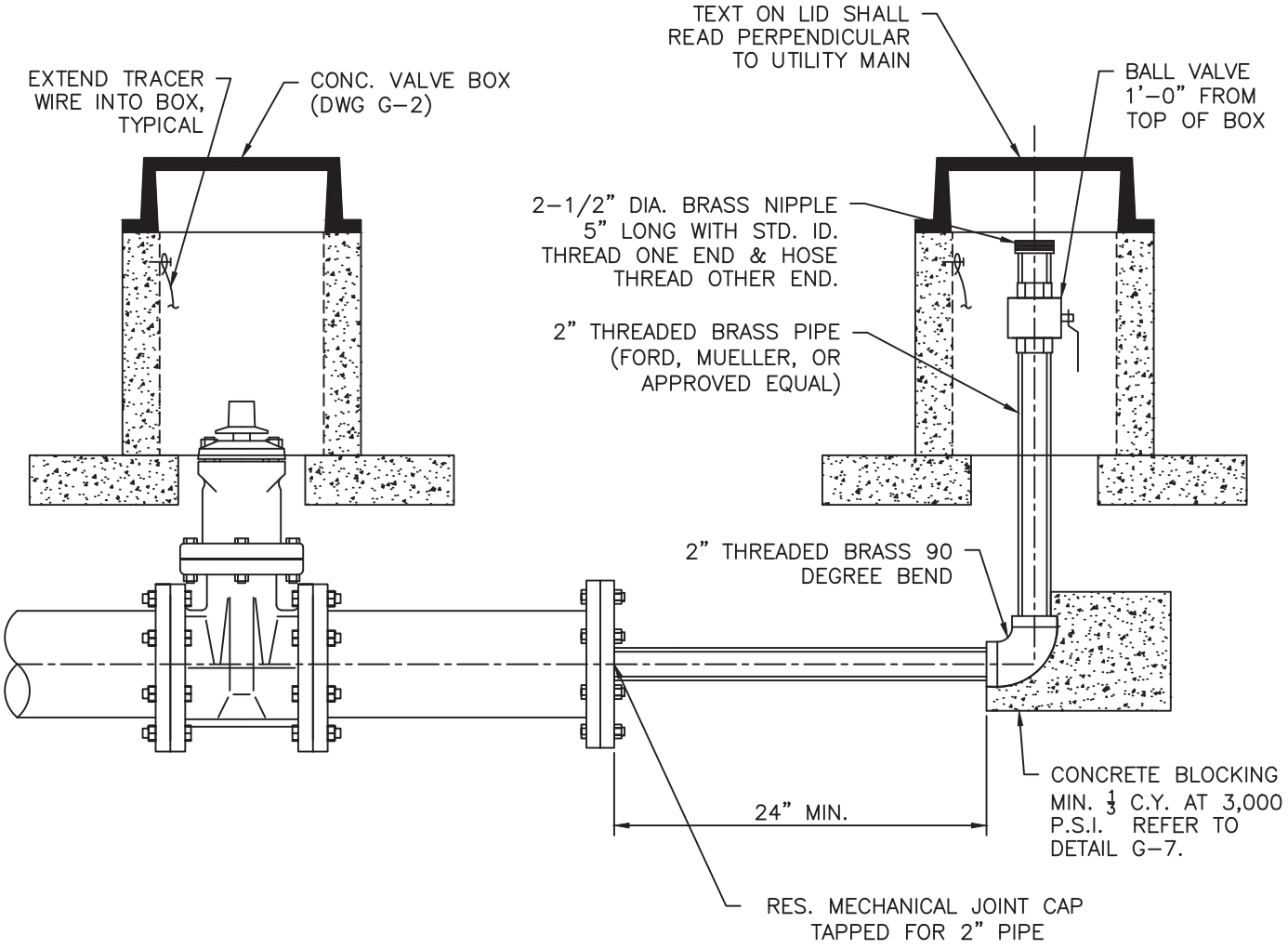
1) FOUR (4) CONCRETE BLOCKS ARE TO BE PLACED UNDER EACH CORNER OF THE VALVE BOX AS SHOWN.
2) CONCRETE SHALL BE 4,000 PSI @ 28 DAYS REINFORCED WITH WELDED WIRE MESH.
3) STRUCTURE SHALL CONFORM TO ASTM C858.

HISTORIC FRANKLIN TENNESSEE

CONCRETE VALVE BOX

DWG. NO. **G-2**

CITY OF FRANKLIN	WATER MANAGEMENT DIRECTOR:	DATE: 10/16/2019
NOT TO SCALE		



MAIN SIZE	END PIPE SIZE
4" – 12"	2" BLOW-OFF

NOTES:

1) FOR MAINS THAT ARE TO BE EXTENDED USE A VALVE EQUAL TO THE MAIN SIZE AS THE BLOW-OFF CONTROL VALVE AND THEN REDUCE TO 2" PIPE.

HISTORIC FRANKLIN TENNESSEE

2" BLOW-OFF ASSEMBLY FOR WATER AND RECLAIMED WATER

DWG. NO. G-3

CITY OF FRANKLIN

NOT TO SCALE

WATER MANAGEMENT DIRECTOR:

DATE: 10/16/2019

RECLAIMED WATER MARKER LABEL:

CAUTION – RECLAIMED WATER PIPELINE
NON–POTABLE WATER
DO NOT DRINK

CITY OF FRANKLIN WATER MANAGEMENT
DEPARTMENT (615) 794–4554

MARKER COLOR: PURPLE

SANITARY SEWER MARKER LABEL:

CAUTION – SANITARY SEWER PIPELINE
DO NOT DRINK

CITY OF FRANKLIN WATER MANAGEMENT
DEPARTMENT (615) 794–4554

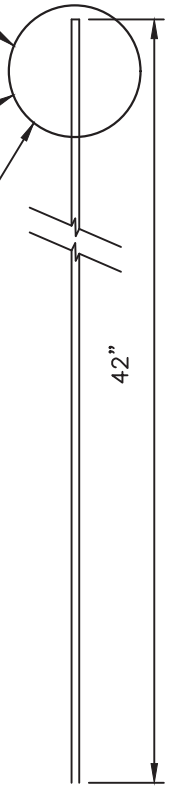
MARKER COLOR: GREEN

DRINKING WATER LABEL:

CAUTION – WATER PIPELINE

CITY OF FRANKLIN WATER MANAGEMENT
DEPARTMENT (615) 794–4554

MARKER COLOR: BLUE



NOTES:
1) MARKER SHALL BE INSTALLED DIRECTLY BEHIND STRUCTURE WITH LABEL FACING ROADWAY.
2) MARKERS TO BE INSTALLED AS INDICATED ON PLANS OR WHERE DIRECTED BY OWNER.
3) MARKER SHALL BE CONSTRUCTED OF DURABLE, UV RESISTANT, COMPOSITE MATERIAL.

HISTORIC FRANKLIN TENNESSEE

UTILITY IDENTIFICATION MARKER

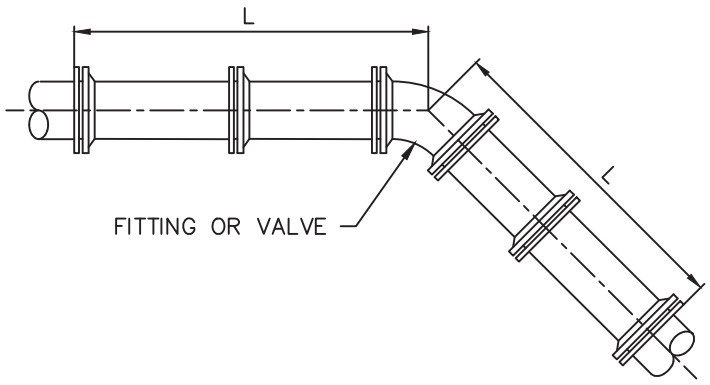
DWG. NO. G-4

CITY OF FRANKLIN

NOT TO SCALE

WATER MANAGEMENT DIRECTOR:

DATE: 10/16/2019



NOTES:

1) RESTRAINED JOINTS SHALL BE PROVIDED ON EACH SIDE OF ALL VERTICAL OR HORIZONTAL BENDS, TEES, DEAD ENDS, REDUCERS, AND VALVES.
2) MAXIMUM LENGTHS OF PIPE SHALL BE USED WITHIN RESTRAINED SECTIONS.
3) LENGTH OF RESTRAINED PIPE IS BASED ON THE FOLLOWING ASSUMPTIONS USING THE EBAA IRON CALCULATOR. IF OTHER CONDITIONS ARE ENCOUNTERED, THE LENGTH OF RESTRAINED PIPE SHALL BE ADJUSTED ACCORDINGLY. ENGINEER SHALL SUPPLY CALCULATIONS TO THE CITY OF FRANKLIN FOR REVIEW.
   - A. DESIGN SOIL TYPE: ML (WORST CASE)
   - B. SAFETY FACTOR: 1.5
   - C. TRENCH TYPE: 3
   - D. DEPTH OF BURY: 3 FEET
   - E. TEST PRESSURE: 200 PSI
   - F. REDUCERS BASED ON A REDUCTION OF ONE PIPE SIZE SMALLER

PVC PIPE									
LENGTH (L) OF PIPE TO BE RESTRAINED ON EACH SIDE OF FITTING OR VALVE (FT)									
	HORIZONTAL ELBOWS				VERTICAL ELBOWS			REDUCERS	TEES, DEAD ENDS, VALVES
PIPE DIAMETER	11 ¼	22 ½	45	90	11 ¼	22 ½	45		
4”	3	6	12	29	7	14	29	23	70
6”	4	8	17	41	10	20	41	51	99
8”	6	11	22	53	13	26	54	54	129
12”	8	15	31	73	18	37	76	97	182
16”	10	19	39	93	23	47	97	99	233
20”	11	22	46	111	28	56	118	99	282
24”	13	26	53	127	33	66	136	98	328

HISTORIC FRANKLIN TENNESSEE

RESTRAINED JOINT TABLE - PVC

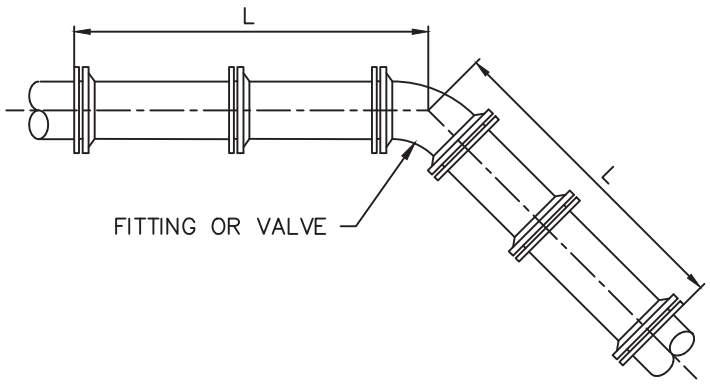
DWG. NO. G-5

CITY OF FRANKLIN

NOT TO SCALE

WATER MANAGEMENT DIRECTOR:

DATE: 10/16/2019



NOTES:

1) RESTRAINED JOINTS SHALL BE PROVIDED ON EACH SIDE OF ALL VERTICAL OR HORIZONTAL BENDS, TEES, DEAD ENDS, REDUCERS, AND VALVES.
2) MAXIMUM LENGTHS OF PIPE SHALL BE USED WITHIN RESTRAINED SECTIONS.
3) LENGTH OF RESTRAINED PIPE IS BASED ON THE FOLLOWING ASSUMPTIONS USING DIPRA THRUST RESTRAINT DESIGN FOR DUCTILE IRON PIPE. IF OTHER CONDITIONS ARE ENCOUNTERED, THE LENGTH OF RESTRAINED PIPE SHALL BE ADJUSTED ACCORDINGLY. ENGINEER SHALL SUPPLY CALCULATIONS TO THE CITY OF FRANKLIN FOR REVIEW.
   - A. DESIGN SOIL TYPE: SILT 1 (WORST CASE)
   - B. SAFETY FACTOR: 1.5
   - C. TRENCH TYPE: 3 WITH 4–INCH MINIMUM BEDDING (EXCEPT WHERE NOTED)
   - D. DEPTH OF BURY: 3 FEET
   - E. TEST PRESSURE: 200 PSI
   - F. REDUCERS BASED ON A REDUCTION OF ONE PIPE SIZE SMALLER
   - G. NON–POLY WRAPPED

DIP PIPE									
LENGTH (L) OF PIPE TO BE RESTRAINED ON EACH SIDE OF FITTING OR VALVE (FT)									
	HORIZONTAL ELBOWS				VERTICAL ELBOWS			REDUCERS	TEES, DEAD ENDS, VALVES
PIPE DIAMETER	11 ¼	22 ½	45	90	11 ¼	22 ½	45		
4”	3(6)	7(12)	14(24)	34(58)	6(9)	12(18)	24(37)	19(29)	58(90)
6”	5(8)	9(16)	20(33)	47(81)	8(12)	16(25)	34(52)	42(65)	81(126)
8”	6(10)	12(21)	26(44)	62(106)	11(16)	21(33)	44(68)	45(69)	107(165)
12”	8(15)	17(29)	36(61)	86(147)	15(23)	30(46)	62(96)	79(123)	150(231)
16”	11(18)	22(37)	45(77)	109(187)	19(29)	38(59)	79(122)	81(125)	191(295)
20”	13(22)	26(44)	54(93)	131(224)	23(35)	46(71)	95(147)	81(125)	230(355)
24”	15(25)	30(51)	63(107)	151(259)	26(41)	53(82)	111(171)	80(124)	268(414)

LENGTHS IN PARENTHESES ( ) REPRESENT LINEAL FEET TO BE RESTRAINED WHEN PIPE IS PLACED DIRECTLY ON UNDISTURBED SUBGRADE WITHOUT BEDDING (FLAT BOTTOM TRENCH TYPE 2)

HISTORIC FRANKLIN TENNESSEE

RESTRAINED JOINT TABLE - DIP

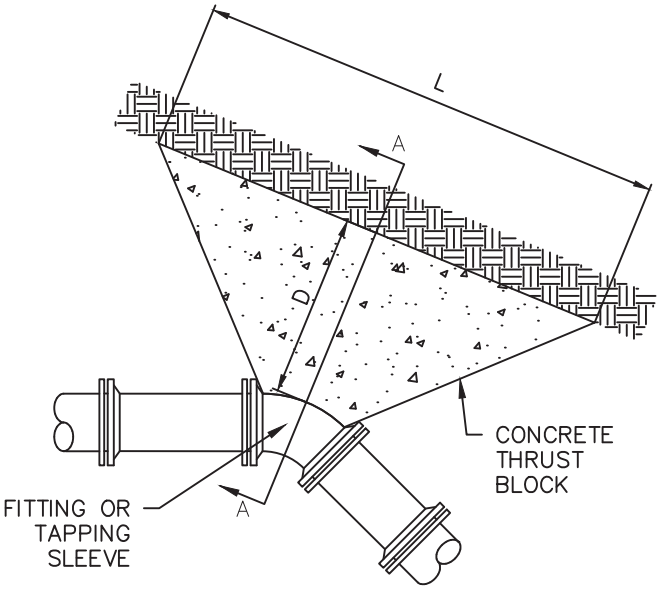
DWG. NO. G-6

CITY OF FRANKLIN

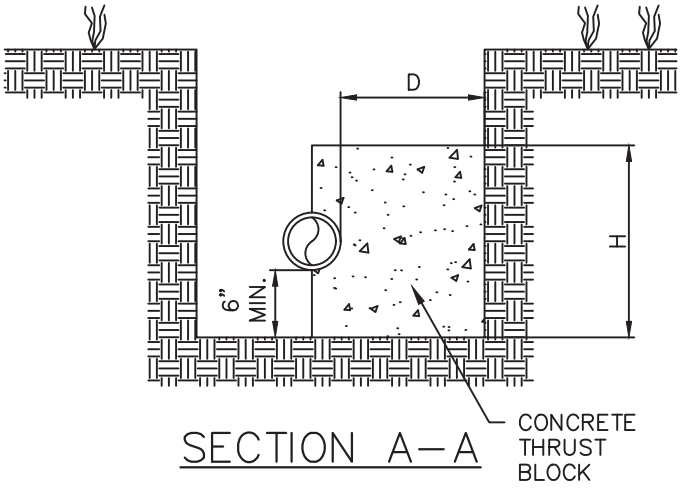
NOT TO SCALE

WATER MANAGEMENT DIRECTOR:

DATE: 10/16/2019



PLAN



SECTION A–A

NOTES:

1) THRUST BLOCKS TO BE PLACED AGAINST SUITABLE, UNDISTURBED EARTH, AS APPROVED BY THE WATER MANAGEMENT DEPARTMENT.
2) CONCRETE STRENGTH f'c = 3,000 PSI AT 28 DAYS.
3) ALL DIMENSIONS ARE MINIMUMS EXCEPT WHERE LARGER DIMENSION WILL INTERFERE WITH PIPE JOINTS OR BOLT REMOVAL ON FITTINGS. IN THESE CASES, SUBMIT REVISED DRAWINGS TO THE WATER MANAGEMENT DEPARTMENT.
4) VERTICAL BENDS REQUIRE SEPARATE DESIGN AND DETAIL BY ENGINEER.
5) THRUST BLOCKING SHOWN IS BASED ON THE FOLLOWING ASSUMPTIONS. IF OTHER CONDITIONS ARE ENCOUNTERED, SPECIAL DESIGN IS REQUIRED. ENGINEER SHALL SUPPLY CALCULATIONS TO THE CITY OF FRANKLIN FOR REVIEW.
   - A. BEARING AGAINST SOFT CLAY, SILT, OR ORGANIC SOILS NOT PERMITTED.
   - B. GROUNDWATER TABLE ELEVATION LOCATED BELOW BOTTOM OF BLOCK.
   - C. SAFETY FACTOR: 1.5
   - D. DEPTH OF BURY: 3 FEET
   - E. TEST PRESSURE: 200 PSI
   - F. HORIZ. SOIL BEARING: 2,000 PSF

THRUST BLOCK DIMENSIONS									
PIPE DIAMETER	D	HORIZONTAL ELBOWS						TEES, DEAD ENDS, TAPPING SLEEVES	
		22 ½		45		90			
		L	H	L	H	L	H	L	H
4"	1'–6"	1'–6"	1'–6"	1'–6"	1'–6"	2'–0"	1'–6"	1'–6"	1'–6"
6"	1'–6"	2'–0"	1'–6"	2'–6"	1'–6"	3'–0"	2'–0"	3'–0"	1'–6"
8"	1'–6"	2'–0"	1'–6"	3'–0"	2'–0"	4'–6"	2'–6"	4'–0"	2'–0"
12"	2'–0"	4'–0"	2'–0"	5'–0"	2'–6"	7'–0"	3'–6"	6'–0"	3'–0"
16"	2'–0"	5'–0"	2'–6"	7'–0"	3'–6"	10'–0"	4'–6"	8'–0"	4'–0"

HISTORIC FRANKLIN TENNESSEE

THRUST BLOCK TABLE (NON-RESTRAINED JOINTS)

DWG. NO. G-7

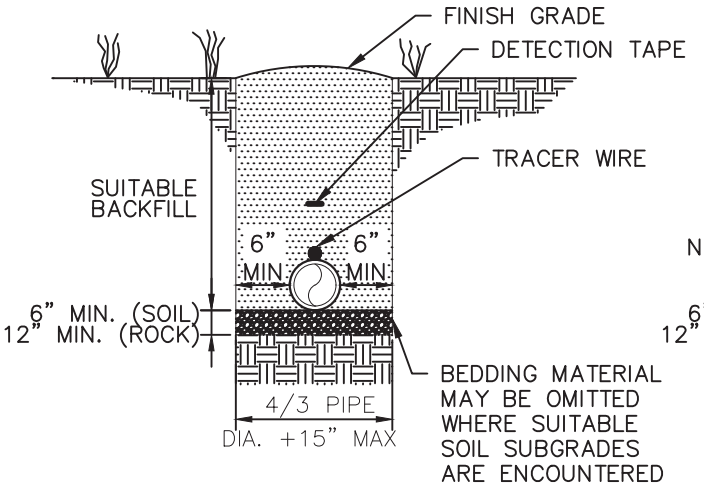
CITY OF FRANKLIN

NOT TO SCALE

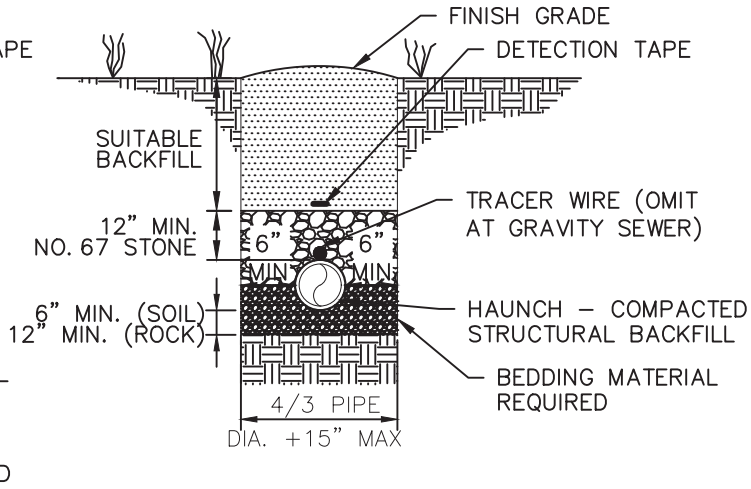
WATER MANAGEMENT DIRECTOR:

DATE: 10/16/2019

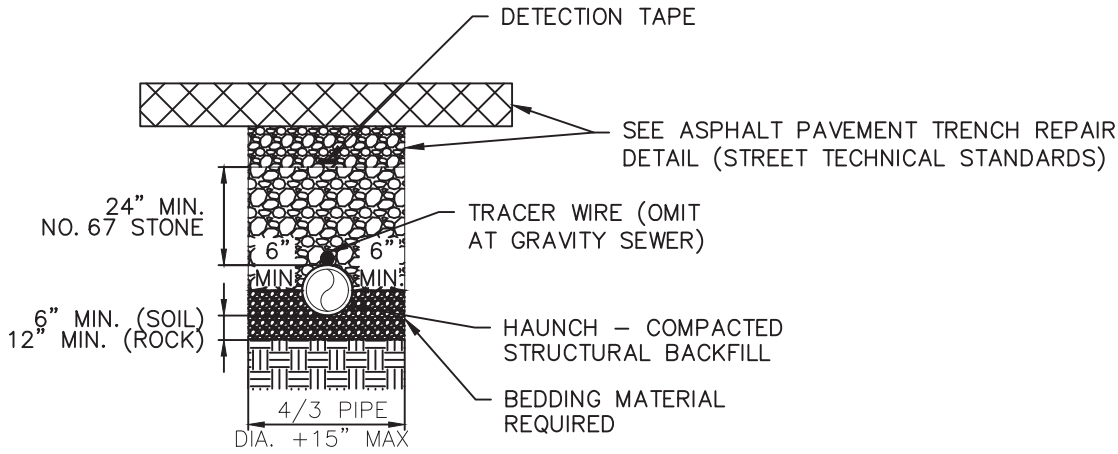
NOTE: 36" MIN. COVER FOR ALL UTILITIES UNLESS OTHERWISE APPROVED



DIP PRESSURE PIPE



OTHER PIPE



ALL PIPE UNDER PAVEMENT

NOTES:

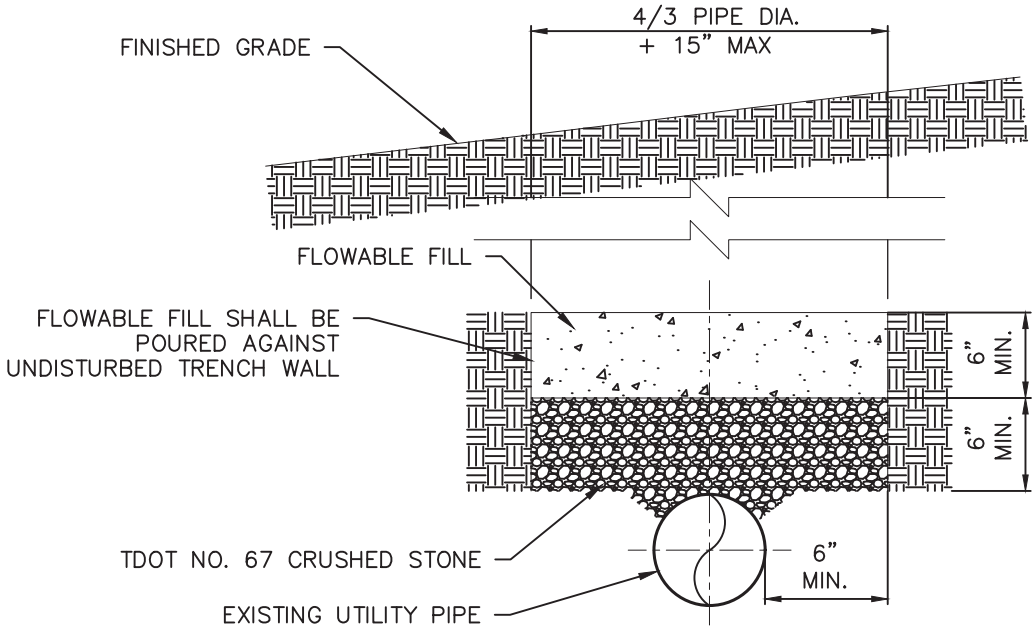
1) ALL SUITABLE BACKFILL MATERIAL AND SUBGRADES SHALL BE APPROVED BY THE WATER MANAGEMENT DEPT.
2) ALL ROCK LOOSENED SHALL BE REMOVED; VOIDS CREATED BY SUCH REMOVAL SHALL BE FILLED WITH CRUSHED STONE.
3) REMOVE STONE FOR PIPE BELLS TO PROVIDE FULL CONTACT OF BEDDING.
4) BACKFILL SHALL BE TAMPED IN 6" LIFTS.
5) ACHIEVE 95% COMPACTION ON ALL BACKFILL.
6) NO ROCKS 6" IN DIAMETER OR GREATER ALLOWED IN SUITABLE BACKFILL.
7) PROVIDE STONE BACKFILL FOR PIPING WITHIN DRIVEWAYS, ROADWAYS AND PARKING AREAS UNLESS OTHERWISE APPROVED. SEE ASPHALT PAVEMENT TRENCH REPAIR DETAIL WHEN IN PAVED AREAS.
8) TRENCH DEWATERING SHALL BE DONE IN ACCORDANCE WITH TDOT STD DRAWING EC–STR–1 AND EC–STR–2
9) TRACER WIRE SHALL BE COPPER CLAD, 12 GA. MIN., WITH COLOR–CODED 30 MIL. HDPE INSULATED JACKET. PROVIDE WATERPROOF GREASE FILLED CONNECTIONS AT JUNCTIONS. TRACER WIRE SYSTEM SHALL BE TESTED FOR FUNCTIONALITY PRIOR TO ACCEPTANCE. TRACER WIRE SHALL NOT BE USED FOR GRAVITY SEWER LINES.
10) PROVIDE CHECK DAMS AT 50'–0" O.C. MINIMUM, UNLESS OTHERWISE DIRECTED BY WMD.

HISTORIC FRANKLIN TENNESSEE

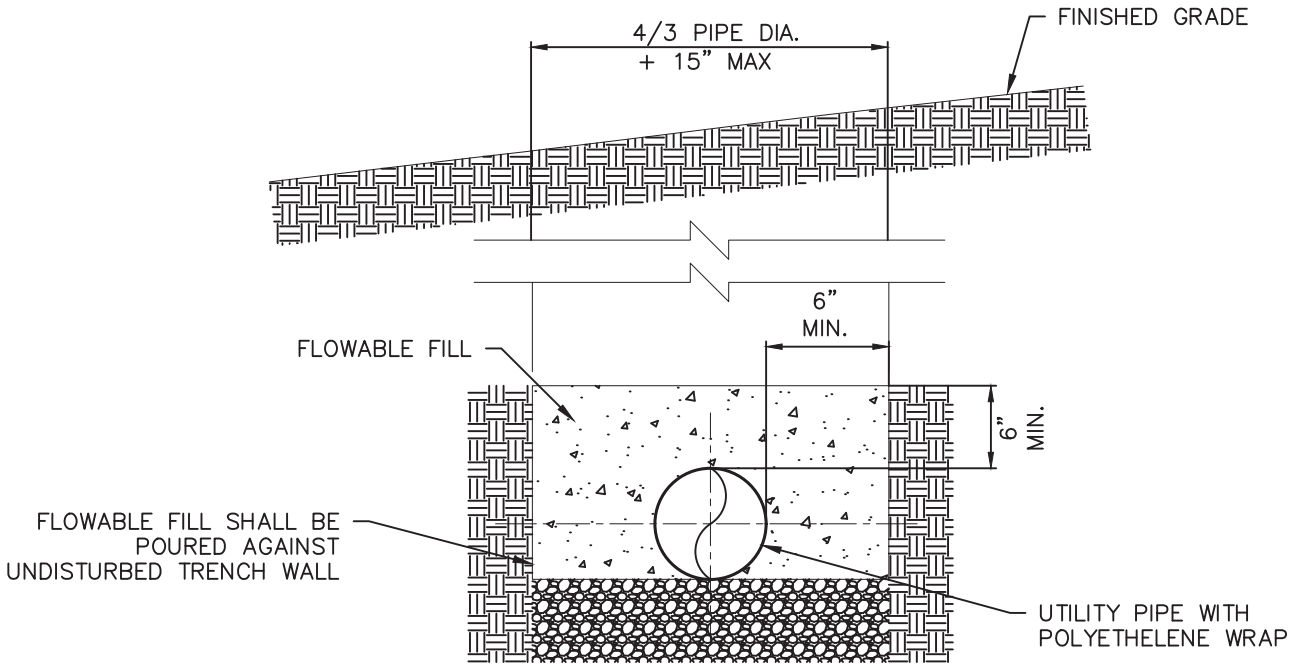
UTILITY BEDDING AND BACKFILL DETAIL

DWG. NO. **G-8**

CITY OF FRANKLIN	WATER MANAGEMENT DIRECTOR:	DATE: 10/16/2019
NOT TO SCALE		



CONCRETE PROTECTION FOR EXISTING UTILITY LINES



CONCRETE ENCASEMENT FOR NEW UTILITY LINES

NOTES:

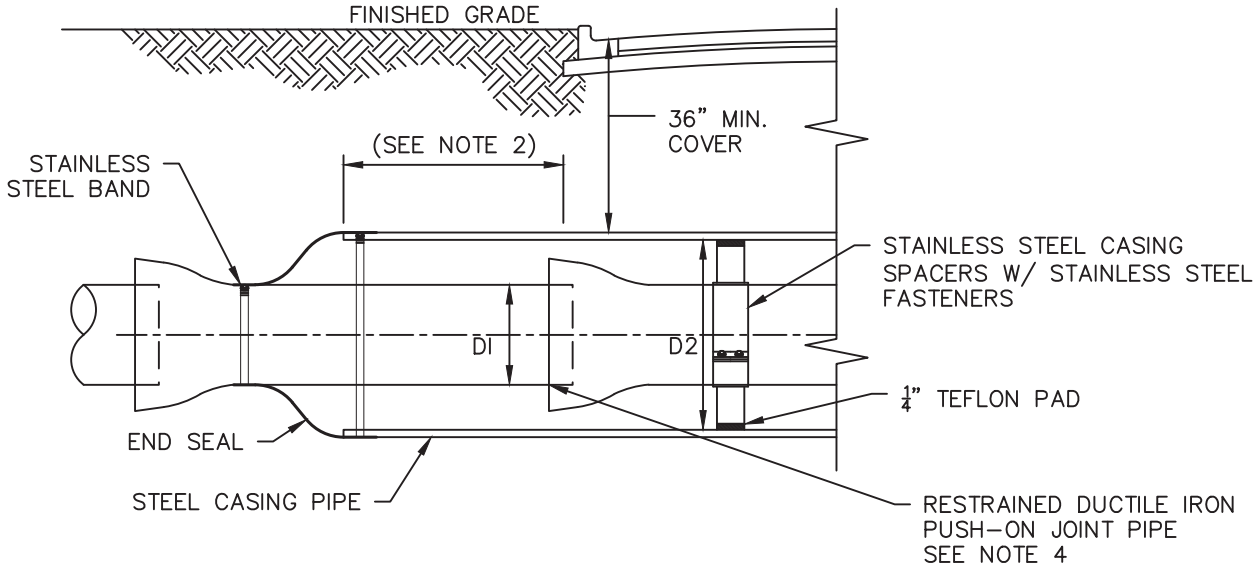
1) FLOWABLE FILL (CLSM) COMPRESSION STRENGTH = 200 PSI MAX.
2) FLOWABLE FILL TO BE PLACED 16 HOURS BEFORE BACKFILLING TRENCH
3) PRIOR TO ENCASING DUCTILE IRON PIPE IN FLOWABLE FILL, WRAP PIPE WITH 4-MIL HDCL (HIGH-DENSITY, CROSS LAMINATED) POLYETHYLENE OR 8-MIL LLD (LINEAR LOW-DENSITY) POLYETHELENE.

HISTORIC FRANKLIN TENNESSEE

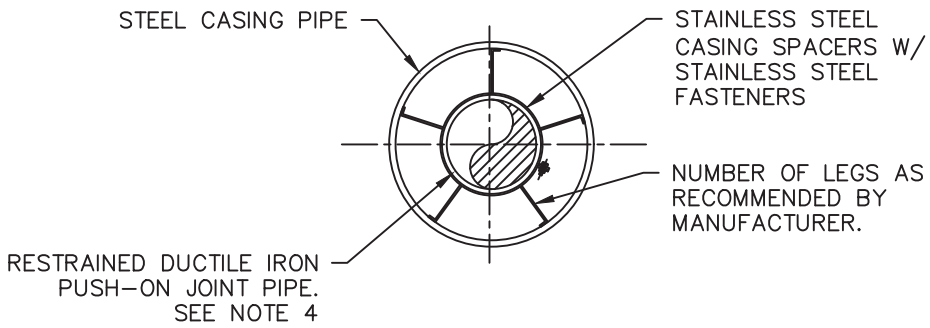
CONCRETE PROTECTION FOR BURIED UTILITIES

DWG. NO. **G-9**

CITY OF FRANKLIN	WATER MANAGEMENT DIRECTOR:	DATE: 10/16/2019
NOT TO SCALE		



ELEVATION



SECTION

NOTES:

1. WHEN CONSTRUCTION IS WITHIN TDOT OR RAILROAD JURISDICTION, ADDITIONAL REQUIREMENTS OF EACH AGENCY SHALL BE MET.
2. CASING SHALL EXTEND A MIN. OF 10' BEYOND EDGE OF PAVEMENT OR R.O.W., WHICHEVER IS FURTHER.
3. A MINIMUM OF 3 CASING SPACERS PER 20 LINEAR FEET OF INSTALLED CARRIER PIPE SHALL BE PROVIDED.
4. CARRIER PIPE SHALL BE RESTRAINED JOINT.

CARRIER PIPE AND CASING PIPE SIZES (MIN.)										
CARRIER PIPE NOM. DIA (DI)	2	4	6	8	10	12	14	16	20	24
CASING PIPE NOM. DIA. (D2)	6	14	16	18	22	24	30	30	36	48
WALL THICKNESS (IN.) R.O.W.	0.250	0.250	0.250	0.250	0.250	0.250	0.312	0.312	0.375	0.500
WALL THICKNESS (IN.) RAILROAD	0.250	0.250	0.250	0.312	0.375	0.375	0.500	0.500	0.563	0.625

HISTORIC FRANKLIN TENNESSEE

BORE AND JACK CASING

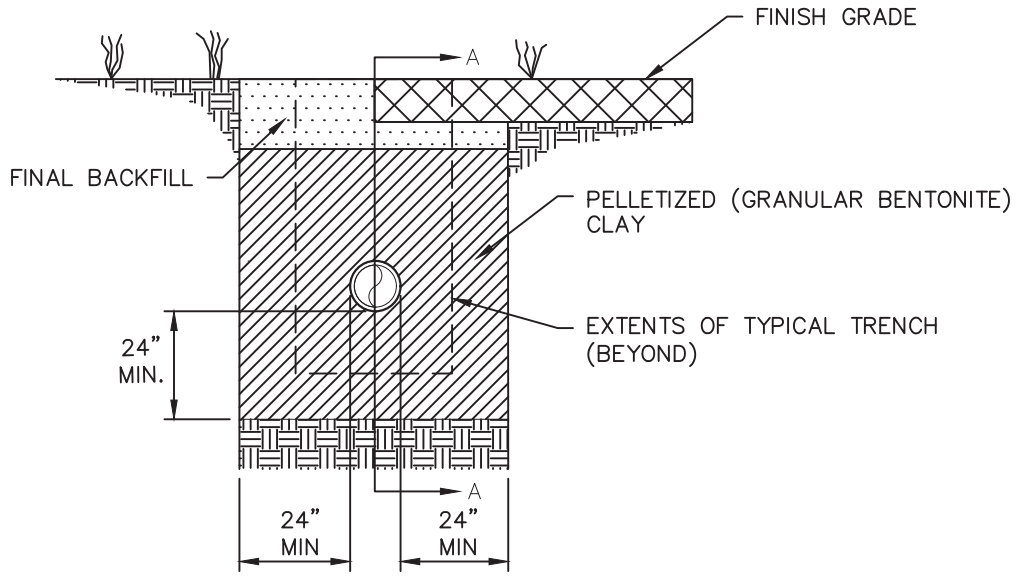
DWG. NO. **G-10**

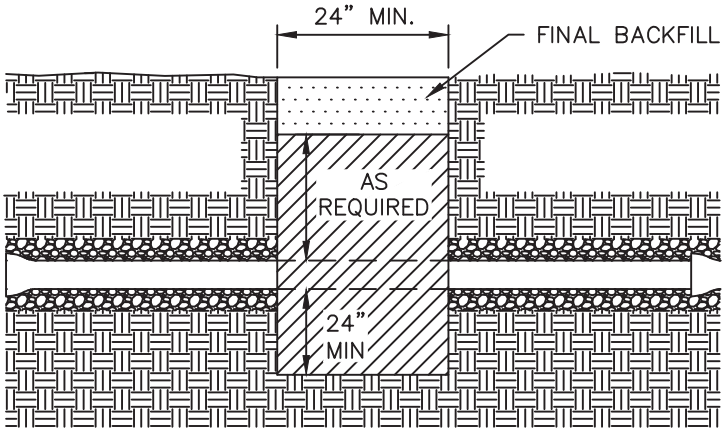
CITY OF FRANKLIN

NOT TO SCALE

WATER MANAGEMENT DIRECTOR:

DATE: 10/16/2019





SECTION A–A

NOTES:

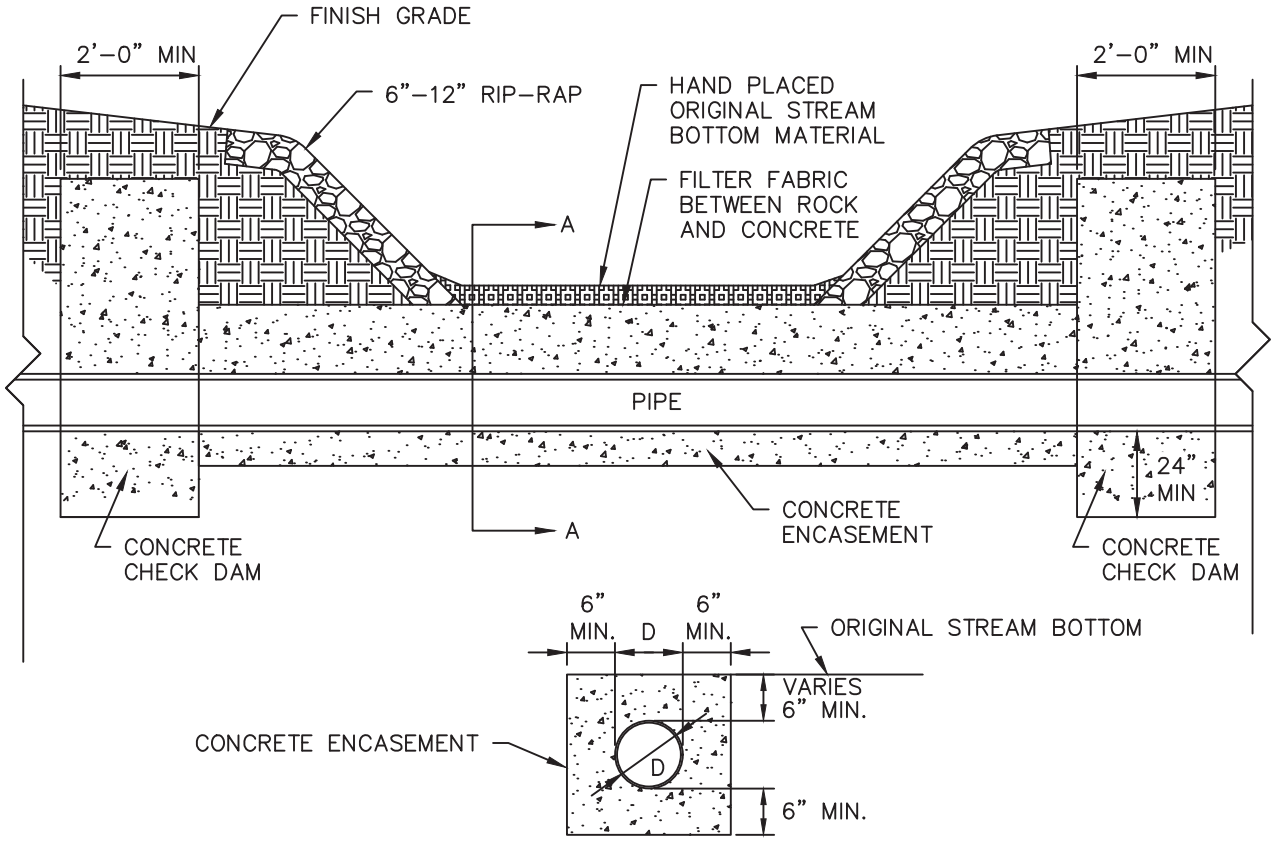
1) 24" KEYWAY TO BE CUT IN DIRT EXCAVATION (BOTTOM AND SIDES). IN ROCK EXCAVATION, REMOVE FRACTURED AND SHOT ROCK IN ROCK TRENCH, AND EXTEND PELLETIZED BENTONITE CLAY TO CLEAN, SOLID ROCK SURFACE (BOTTOM AND SIDES).

HISTORIC FRANKLIN TENNESSEE

CHECK DAM FOR UTILITY LINES

DWG. NO. **G-11**

CITY OF FRANKLIN	WATER MANAGEMENT DIRECTOR:	DATE: 10/16/2019
NOT TO SCALE		



SECTION A–A

NOTES:

1) NO BLASTING IS PERMITTED IN THE EXCAVATION OF TRENCHES THAT LIE WITHIN 50 FEET OF A STREAM OR WETLAND, INCLUDING ALL STREAM CROSSINGS.
2) CROSSINGS SHALL INTERSECT THE STREAM CHANNEL AS CLOSE TO 90 DEGREES (PERPENDICULAR) TO THE STREAM AS POSSIBLE.
3) CONCRETE STRENGTH f'c = 3,000 PSI AT 28 DAYS.
4) ENCASEMENT WIDTH TO BE POURED THE WIDTH OF TRENCH WITH A MINIMUM OF 6" ON EACH SIDE OF PIPE. PROVIDE STAINLESS STEEL HOLD-DOWNS TO PREVENT PIPE FROM FLOATING DURING CONCRETE PLACEMENT.
5) CHECK DAMS TO HAVE A 24" POURED KEYWAY IN DIRT EXCAVATION (BOTTOM AND SIDES). IN ROCK EXCAVATION, REMOVE FRACTURED AND SHOT ROCK IN TRENCH, AND EXTEND CHECK DAM TO CLEAN, SOLID ROCK SURFACE (BOTTOM AND SIDES).
6) CROSSINGS THAT UTILIZE HORIZONTAL DIRECTIONAL DRILLING MAY BE USED INSTEAD OF OPEN CUT WITH WMD APPROVAL.
   A. BORE ENTRY/EXIT LOCATIONS ARE TO BE AT LEAST 50 FEET FROM THE STREAM BANK.
   B. BORE DEPTH BELOW STREAM BED TO BE SUFFICIENT TO PREVENT RELEASE OF DRILLING FLUID.
   C. A SITE-SPECIFIC CONTINGENCY AND CONTAINMENT PLAN FOR INADVERTENT RELEASE OF DRILLING FLUID MUST BE ESTABLISHED PRIOR TO COMMENCEMENT OF WORK.

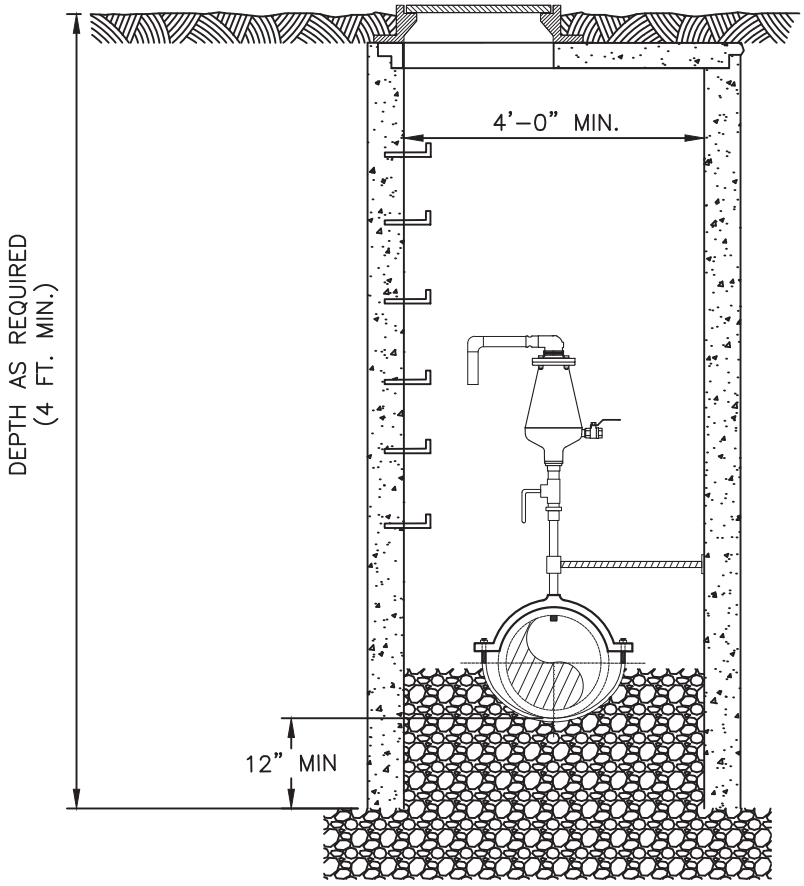
HISTORIC FRANKLIN TENNESSEE

UTILITY STREAM CROSSINGS

DWG. NO. **G-12**

CITY OF FRANKLIN	WATER MANAGEMENT DIRECTOR:	DATE: 10/16/2019
NOT TO SCALE		

DETAIL TO BE REVISED



NOTES:

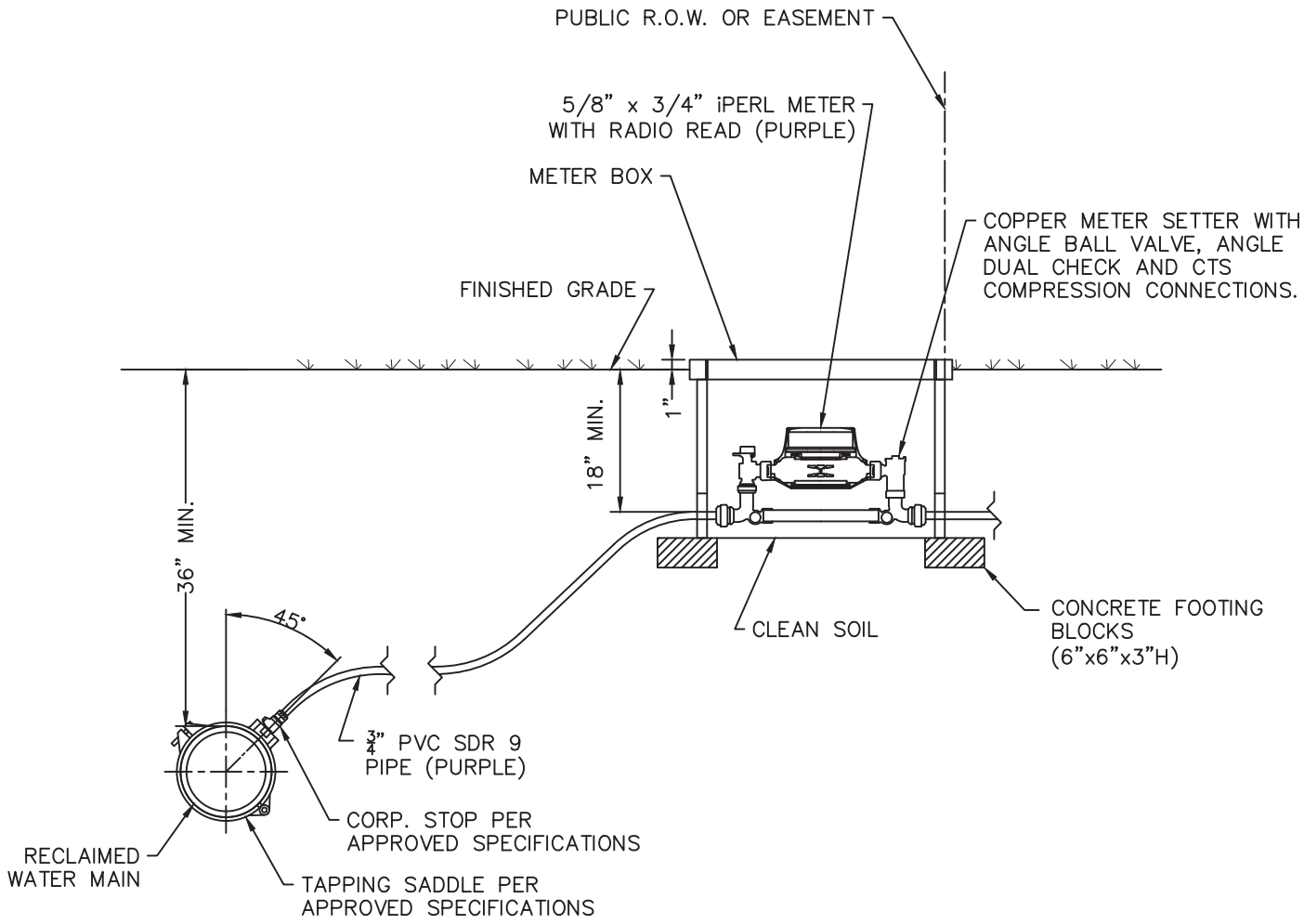
1) VALVE IS TO BE SIZED FOR CONDITIONS.
2) VALVE SHALL BE A.R.I. USA INC. D–040 OR APPROVED EQUAL FOR WATER MAINS.
3) VALVE SHALL BE A.R.I. USA INC. D–020, S–020, S–022 OR APPROVED EQUAL FOR SEWAGE FORCE MAINS AND RECLAIMED WATER MAINS.
4) IF ASSEMBLY IS TO BE INSTALLED IN TRAFFIC AREA, BOX AND COVER TO BE TRAFFIC BEARING AS APPROVED BY THE CITY OF FRANKLIN.

HISTORIC FRANKLIN TENNESSEE

COMBINATION AIR VALVE ASSEMBLY FOR PRESSURE MAINS

DWG. NO. **G-13**

CITY OF FRANKLIN	WATER MANAGEMENT DIRECTOR:	DATE: 10/16/2019
NOT TO SCALE		



METER SIZE	SIGMA HDPE RAVEN METER BOX	McDONALD COPPER METER SETTER
¾"	RMB132418-SW-W 13"X24"X18"	770-2-WD-QQ 33

NOTES:

1) MINIMUM TRENCH WIDTH ON SERVICE SHALL BE 2 FEET.
2) INSTALL THE METER BOX AS NEAR THE PROPERTY LINE AS POSSIBLE WITHIN THE PUBLIC RIGHT-OF-WAY OR PUBLIC EASEMENT. METER BOX SHALL BE SET PLUMB APPROXIMATELY 1" ABOVE PROPOSED GRADE AND SUCH THAT SURFACE DRAINAGE WILL NOT ENTER IT.
3) METER BOX AND SETTER TO BE FURNISHED AND INSTALLED BY CONTRACTOR.
4) METER TO BE FURNISHED AND INSTALLED BY THE CITY OF FRANKLIN.
5) MINIMUM SERVICE LINE COVER SHALL BE 36" BELOW FINISHED GRADE UNDER ROADWAYS, 30" IN UNPAVED AREAS, AND 18" AT SERVICE BOX.
6) IF ASSEMBLY IS TO BE INSTALLED IN TRAFFIC AREA, BOX AND COVER TO BE TRAFFIC BEARING AS APPROVED BY THE CITY OF FRANKLIN.

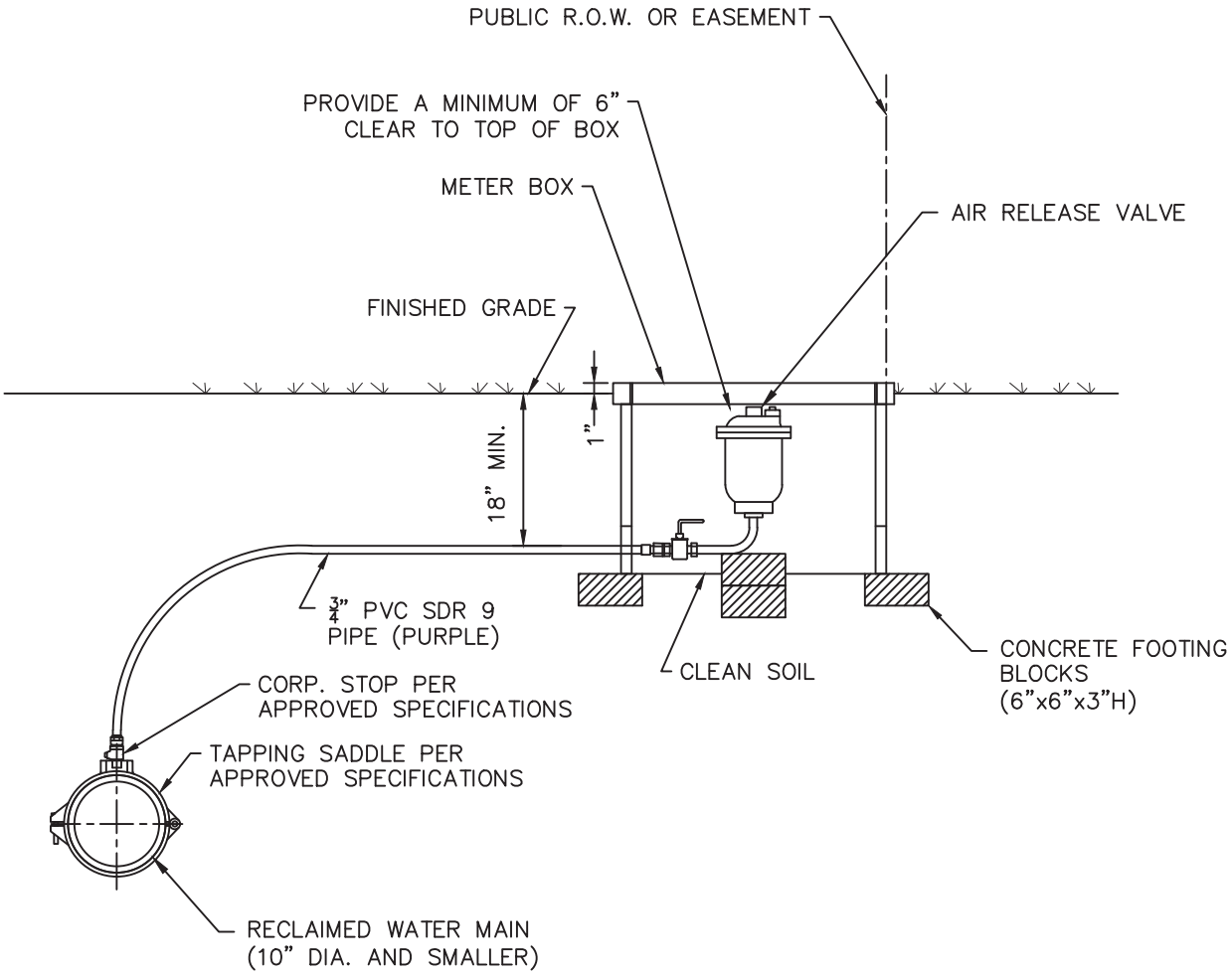
HISTORIC FRANKLIN TENNESSEE

3/4" RECLAIMED WATER SERVICE ASSEMBLY

DWG. NO. **RW-1**

CITY OF FRANKLIN	WATER MANAGEMENT DIRECTOR:	DATE: 10/16/2019
NOT TO SCALE		

DETAIL TO BE REVISED



METER SIZE	SIGMA HDPE RAVEN METER BOX	McDONALD COPPER METER SETTER
–	RMB173018–SW–W 17"X30"X18"	–

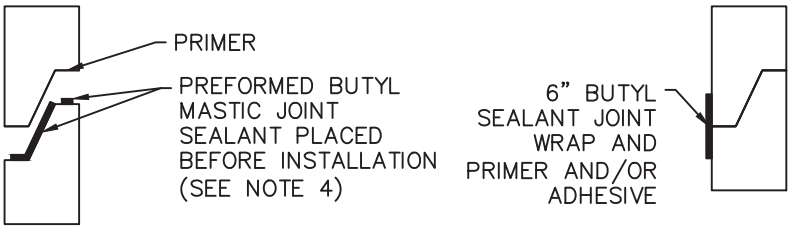
NOTES:

1) VALVE IS TO BE SIZED FOR CONDITIONS.
2) AIR RELEASE VALVES SHALL BE A.R.I. USA INC. D–020, S–020, S–022 OR APPROVED EQUAL.
3) IF ASSEMBLY IS TO BE INSTALLED IN TRAFFIC AREA, BOX AND COVER TO BE TRAFFIC BEARING AS APPROVED BY CITY OF FRANKLIN.

HISTORIC FRANKLIN TENNESSEE

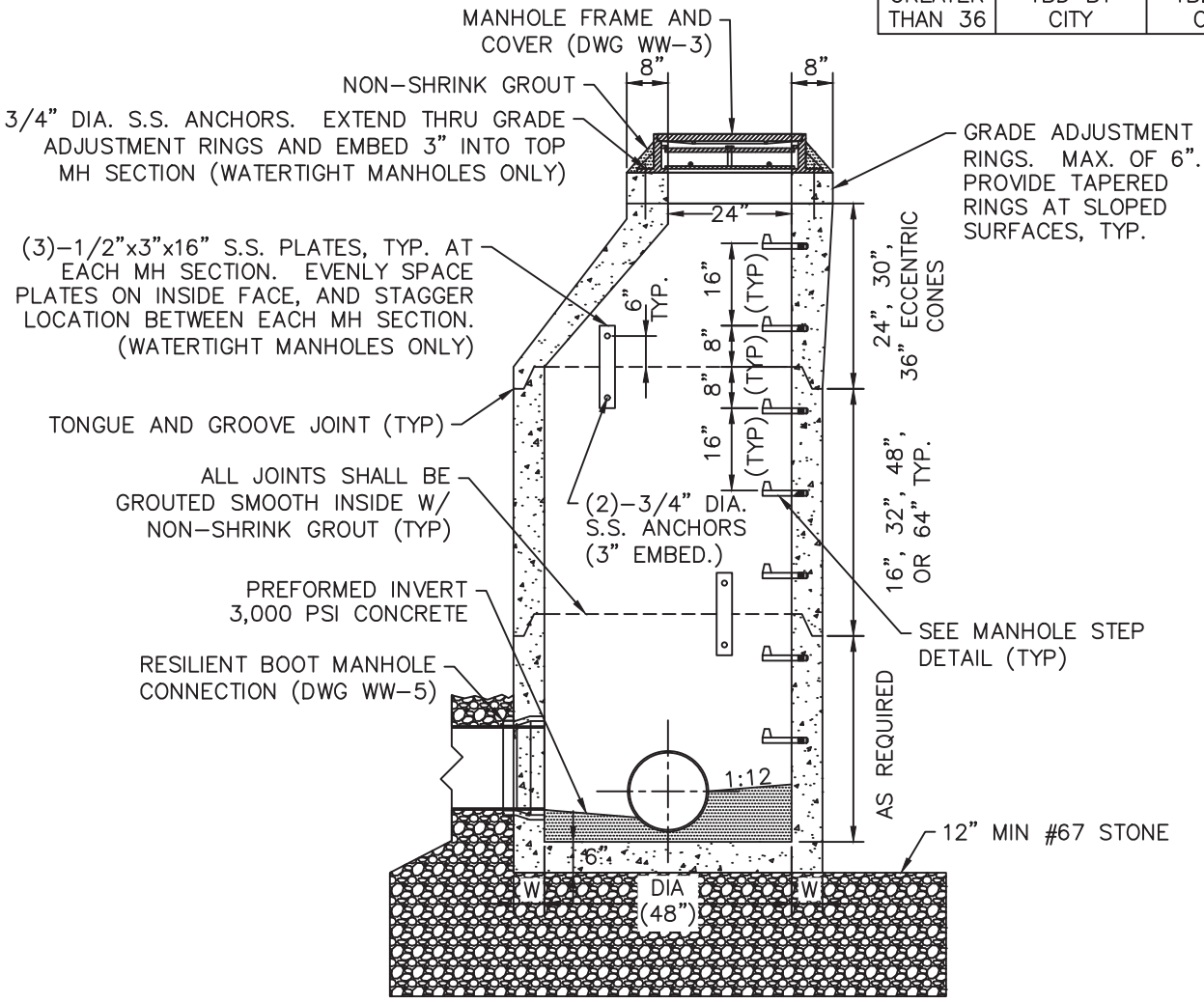
AIR RELEASE ASSEMBLY FOR RECLAIMED WATER MAINS

CITY OF FRANKLIN	WATER MANAGEMENT DIRECTOR:	DATE: 10/16/2019	DWG. NO. RW-2
NOT TO SCALE			



REGARDLESS OF APPROVED PLANS, THE FOLLOWING SIZES SHALL BE REQUIRED:

SEWER MAIN (IN)	INSIDE DIA. OF MH (INCHES)	MIN WALL THICKNESS W
8"–15"	48"	5"
18"–24"	60"	6"
24"–36"	72"	7"
GREATER THAN 36	TBD BY CITY	TBD BY CITY



48" MANHOLE

NOTES:

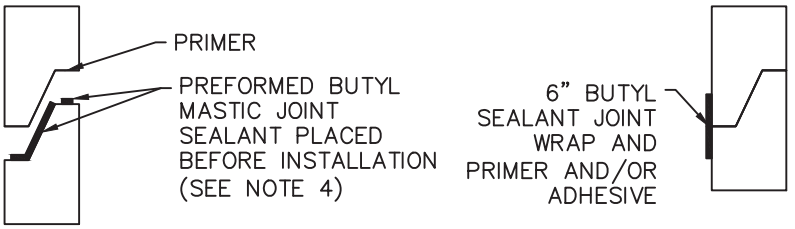
1) STRUCTURE SHALL CONFORM TO ASTM C478, LATEST REVISION.
2) CONCRETE – f'c = 4,000 PSI MIN.
3) REBAR – ASTM A615 GRADE 60 AND ASTM A1064
4) LOADS – AASHTO H–20 LOAD RATED WITH 30% IMPACT
5) EXISTING MANHOLES SHALL BE CORE DRILLED FOR SEWER CONNECTION.
6) ALL PRECAST MANHOLES SHALL CONTAIN XYPEX ADMIXTURE OR APPROVED EQUAL.
7) COMPRESS MANHOLE RISERS TOGETHER PERMITTING VISUAL INSPECTION OF SEALANT. SEALANT SHALL PROTRUDE FROM JOINT CIRCUMFERENCE FOR ACCEPTANCE. WHERE MASTIC DOES NOT PROTRUDE, EITHER INSIDE OR OUTSIDE, INJECT JOINT WITH CONSEAL CS–231, CONTROLLED EXPANSION WATERSTOP.

HISTORIC FRANKLIN TENNESSEE

48" DIAMETER PRECAST MANHOLE

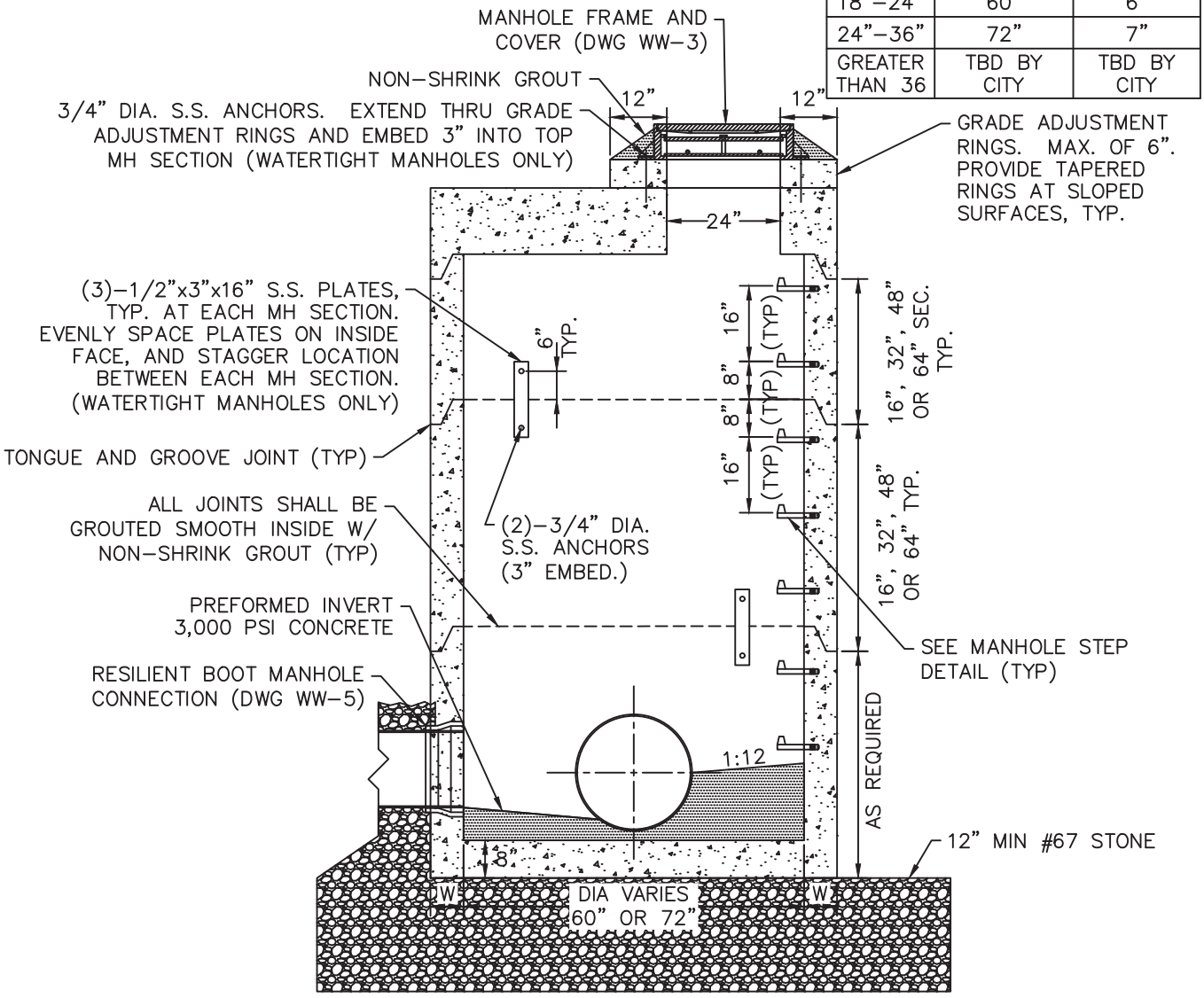
DWG. NO. **WW-1**

CITY OF FRANKLIN	WATER MANAGEMENT DIRECTOR:	DATE: 10/16/2019
NOT TO SCALE		



REGARDLESS OF APPROVED PLANS, THE FOLLOWING SIZES SHALL BE REQUIRED:

SEWER MAIN (IN)	INSIDE DIA. OF MH (INCHES)	MIN WALL THICKNESS W
8"–15"	48"	5"
18"–24"	60"	6"
24"–36"	72"	7"
GREATER THAN 36	TBD BY CITY	TBD BY CITY



60" OR 72" MANHOLE

THE USE OF FLAT–TOP MANHOLES SHALL BE APPROVED BY COF WATER MANAGEMENT

NOTES:

1) STRUCTURE SHALL CONFORM TO ASTM C478, LATEST REVISION.
2) CONCRETE – f'c = 4,000 PSI MIN.
3) REBAR – ASTM A615 GRADE 60 AND ASTM A1064
4) LOADS – AASHTO H–20 LOAD RATED WITH 30% IMPACT
5) EXISTING MANHOLES SHALL BE CORE DRILLED FOR SEWER CONNECTION.
6) ALL PRECAST MANHOLES SHALL CONTAIN XYPEX ADMIXTURE OR APPROVED EQUAL.
7) COMPRESS MANHOLE RISERS TOGETHER PERMITTING VISUAL INSPECTION OF SEALANT. SEALANT SHALL PROTRUDE FROM JOINT CIRCUMFERENCE FOR ACCEPTANCE. WHERE MASTIC DOES NOT PROTRUDE, EITHER INSIDE OR OUTSIDE, INJECT JOINT WITH CONSEAL CS–231, CONTROLLED EXPANSION WATERSTOP.

HISTORIC FRANKLIN TENNESSEE

60" AND 72" DIAMETER PRECAST MANHOLES

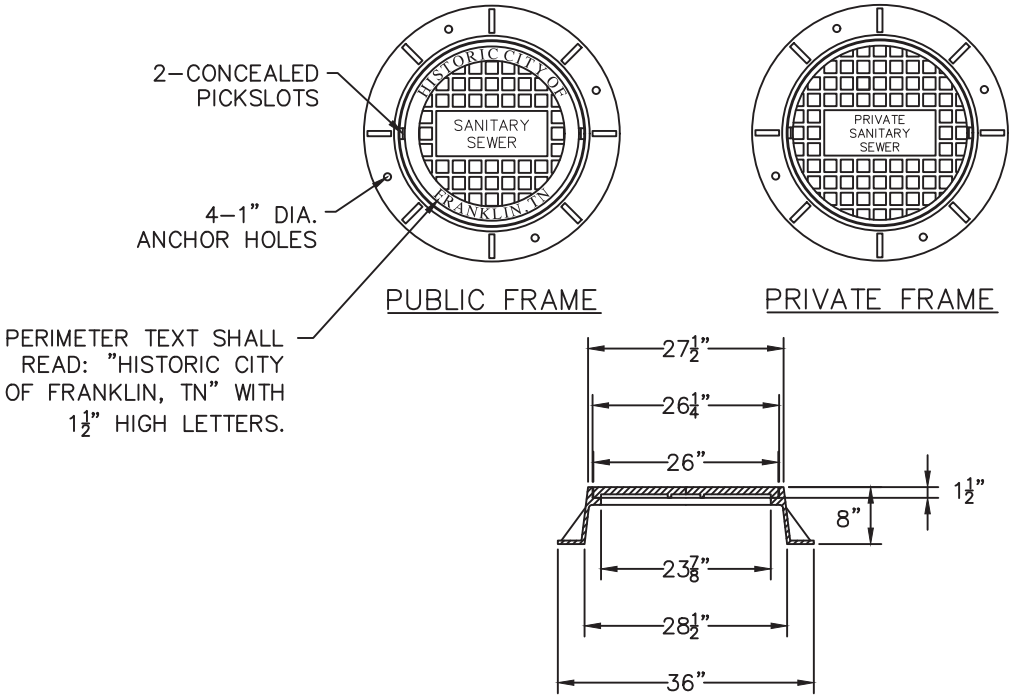
DWG. NO. **WW-2**

CITY OF FRANKLIN

NOT TO SCALE

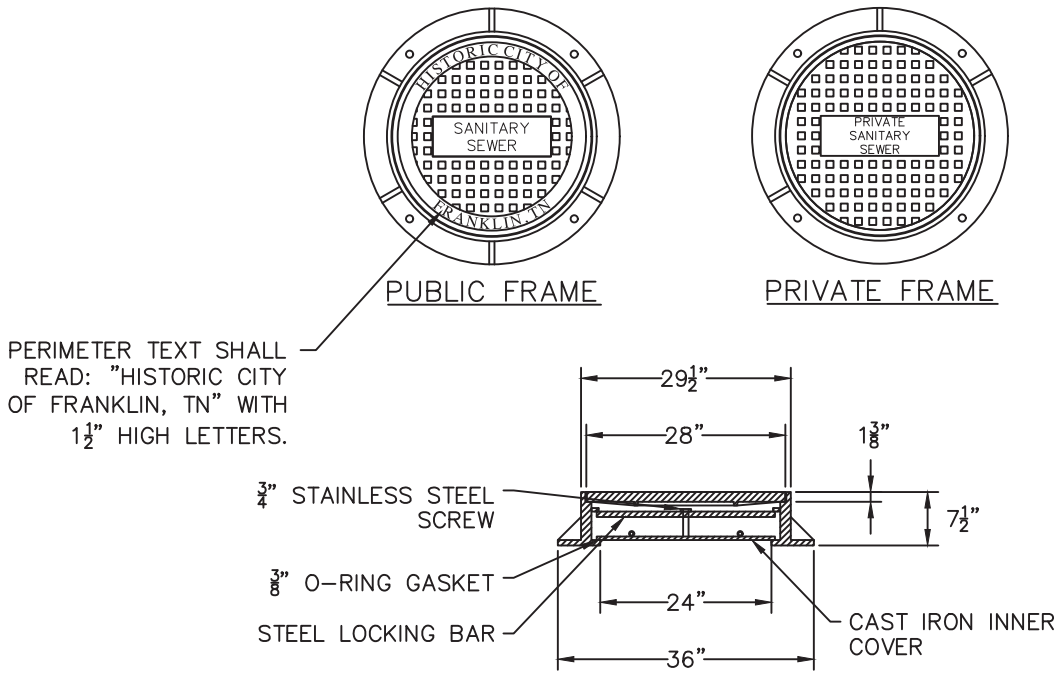
WATER MANAGEMENT DIRECTOR:

DATE: 10/16/2019



STANDARD

NOTE:
JOHN BOUCHARD & SONS CASTING #1152 MODIFIED OR APPROVED EQUAL.



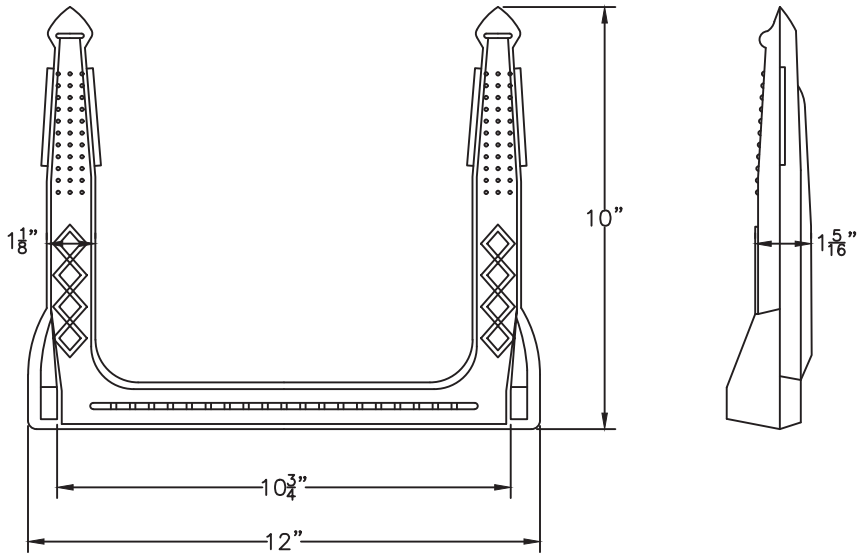
WATERTIGHT

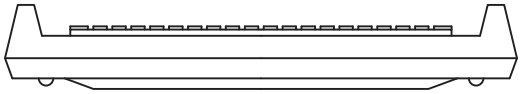
NOTE:
JOHN BOUCHARD & SONS CASTING #1123 MODIFIED OR APPROVED EQUAL.

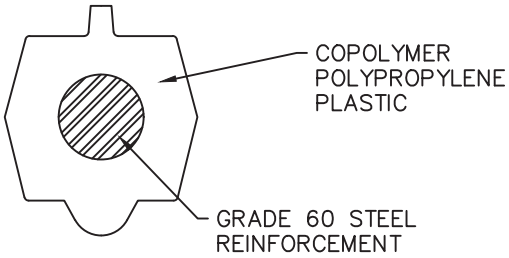
HISTORIC FRANKLIN TENNESSEE

MANHOLE FRAME AND COVER

CITY OF FRANKLIN	WATER MANAGEMENT DIRECTOR:	DATE: 10/16/2019	DWG. NO. WW-3
NOT TO SCALE			







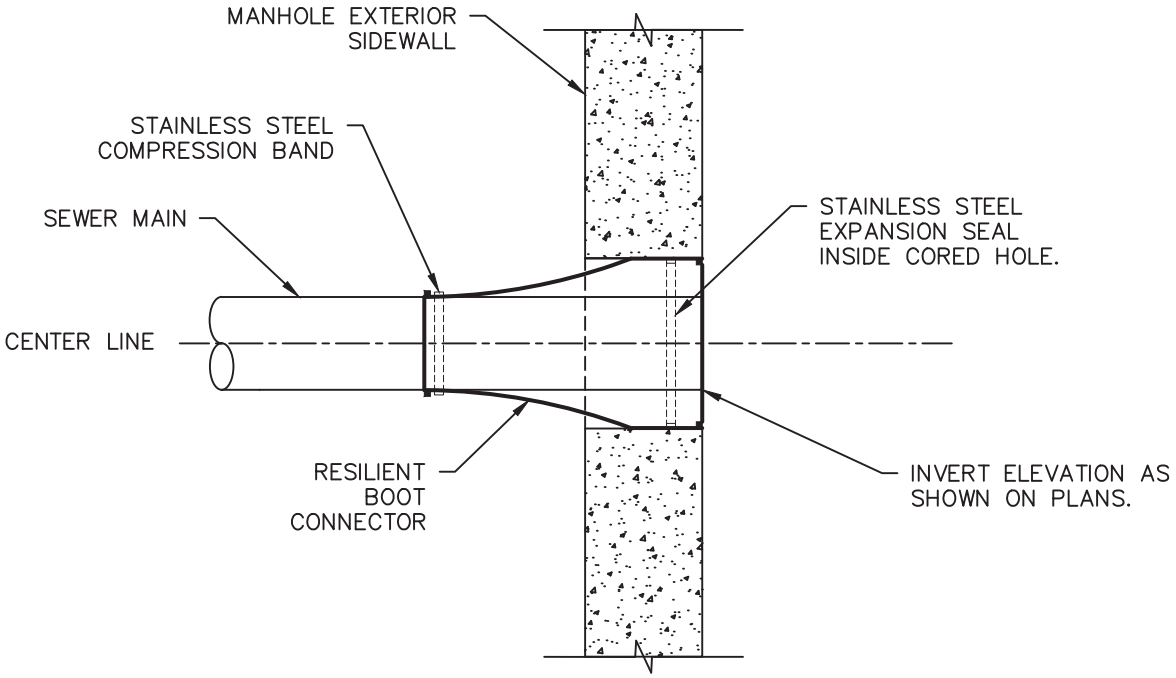
SECTION A

NOTE:
MANHOLE FRAME AND COVER SHALL ALIGN WITH THE STEPS OVER THE BENCH OF THE INVERT CHANNEL.

HISTORIC FRANKLIN TENNESSEE

MANHOLE AND VAULT STEPS

CITY OF FRANKLIN	WATER MANAGEMENT DIRECTOR:	DATE: 10/16/2019	DWG. NO. WW-4
NOT TO SCALE			



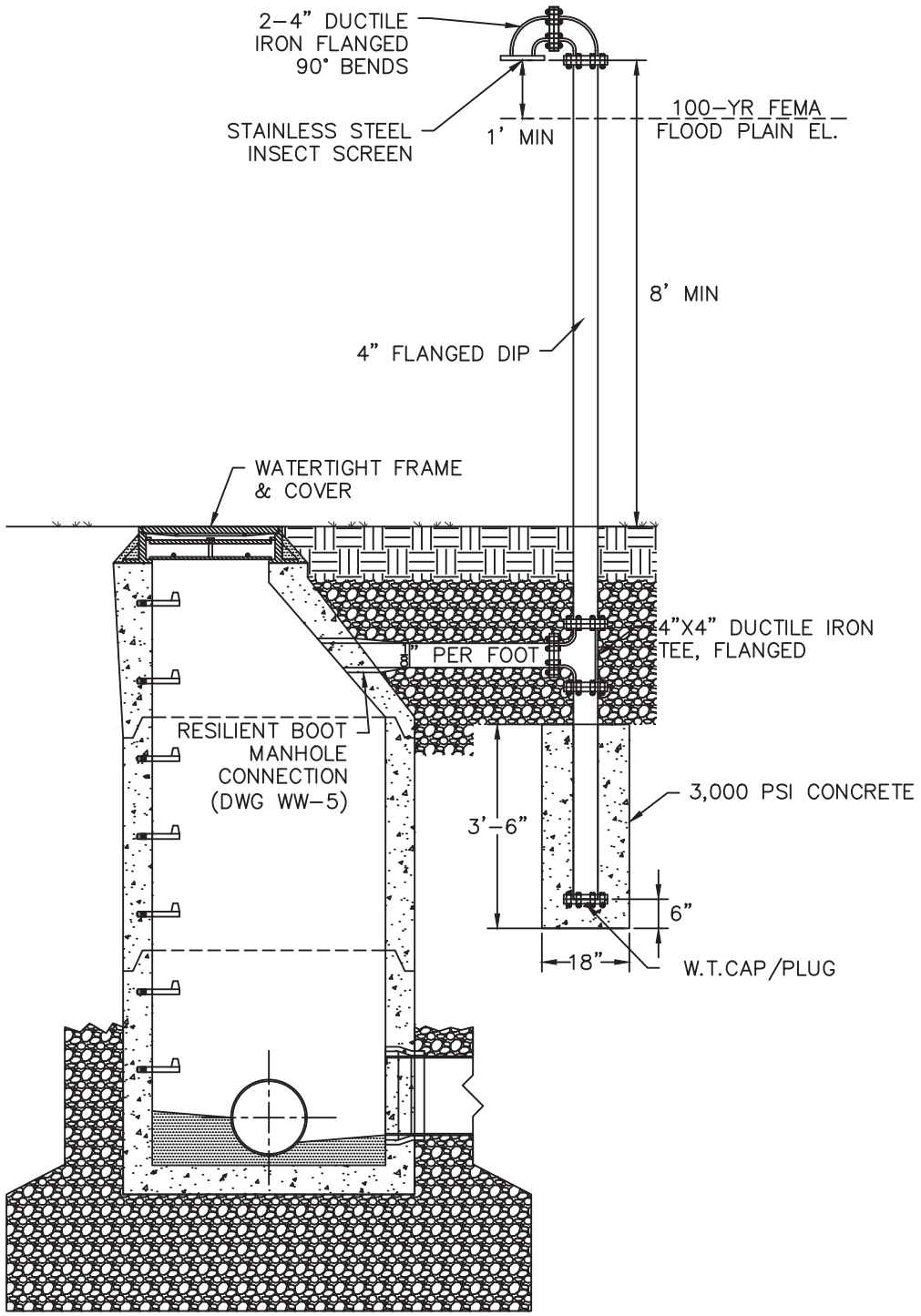
HISTORIC FRANKLIN TENNESSEE

RESILIENT BOOT MANHOLE CONNECTION

DWG. NO.

WW-5

CITY OF FRANKLIN	WATER MANAGEMENT DIRECTOR:	DATE: 10/16/2019
NOT TO SCALE		



WATERTIGHT MANHOLE

NOTES:

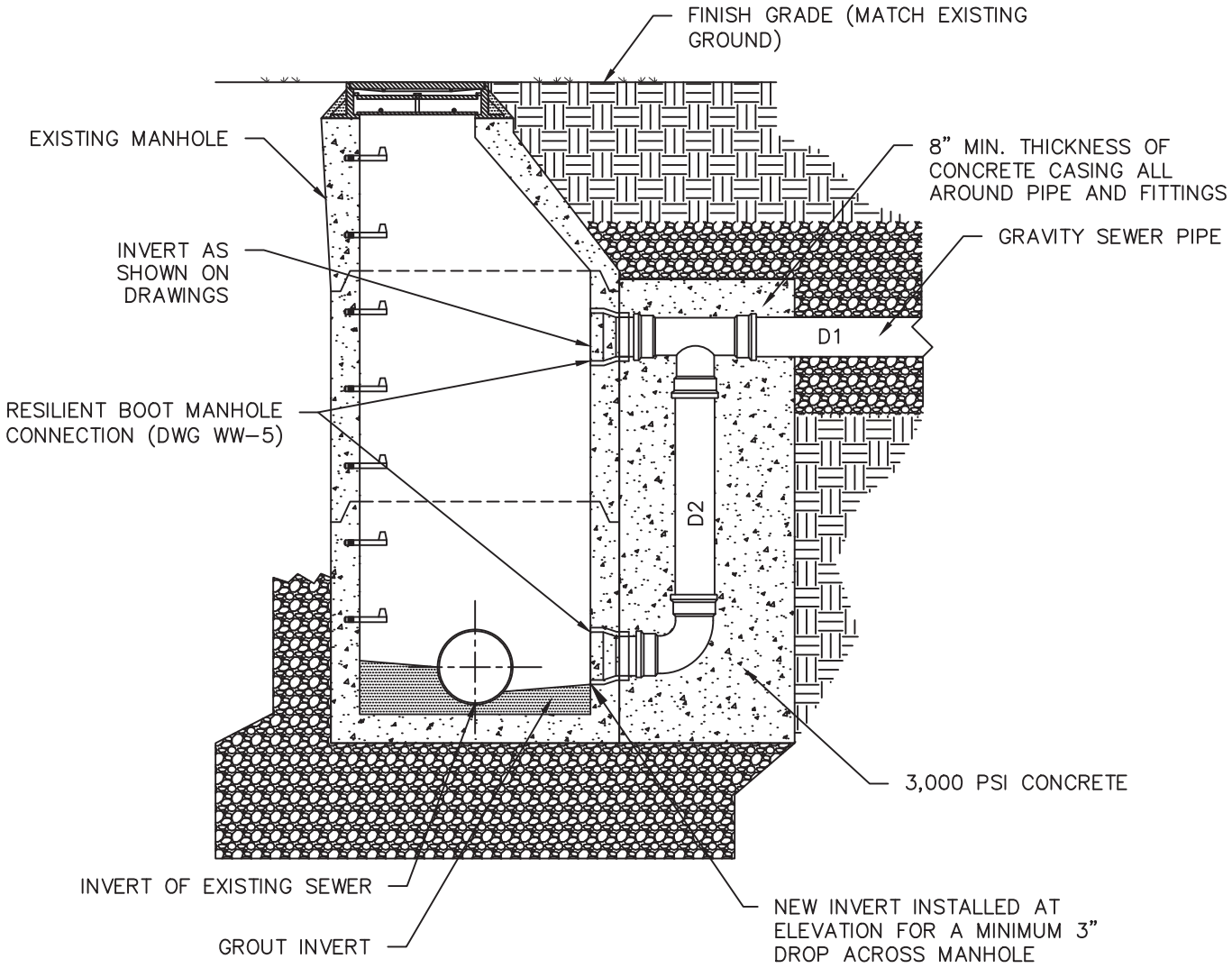
1) VENT PIPE TO BE PAINTED WITH ONE COAT OF RED LEAD PRIMER, AND TWO COATS OF TNEMEC SERIES 66 GREEN ENAMEL (4–6 MILS DFT).
2) TOP OF VENT TO BE MINIMUM OF 8'–0" ABOVE GRADE OR HIGHER IF ELEVATION IS SHOWN ON PLANS.
3) VENT PIPE TO BE INSTALLED IN PRECAST HOLE IN CONE PROVIDED BY MANUFACTURER.

HISTORIC FRANKLIN TENNESSEE

MANHOLE VENT

CITY OF FRANKLIN	WATER MANAGEMENT DIRECTOR:	DATE: 10/16/2019	DWG. NO. WW-6
NOT TO SCALE			

D1	D2
8"	8"
10"	8"
12"	10"
15"	12"
18"	12"
>18"	CONTACT CITY



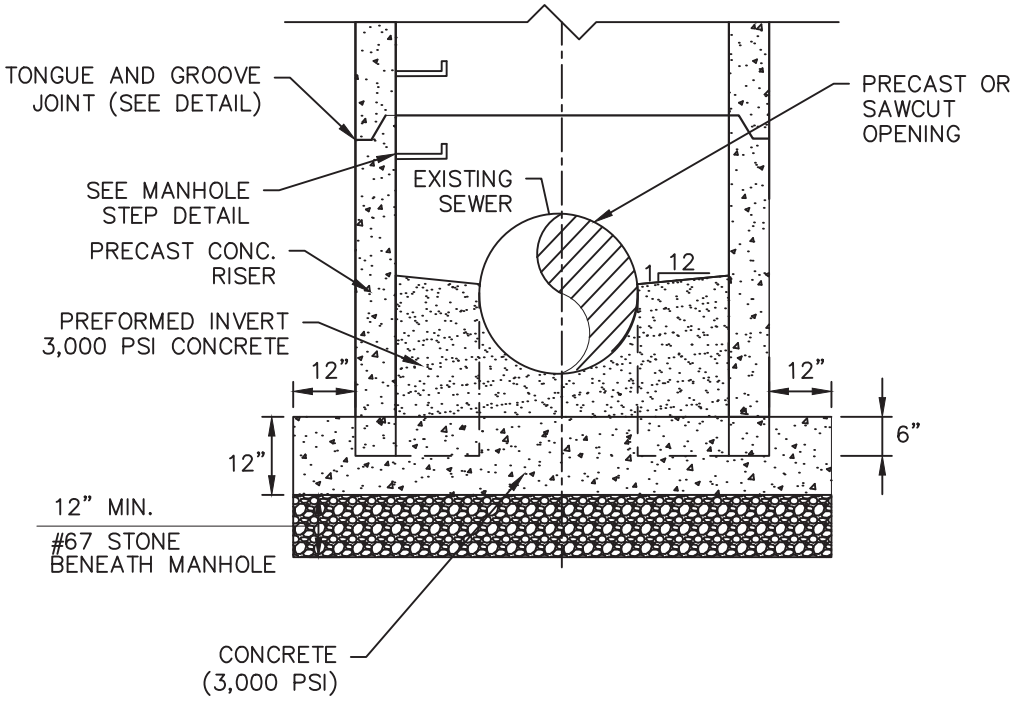
NOTE:
D2 PIPE MATERIAL SHALL BE CONSISTENT WITH D1 PIPE MATERIAL.

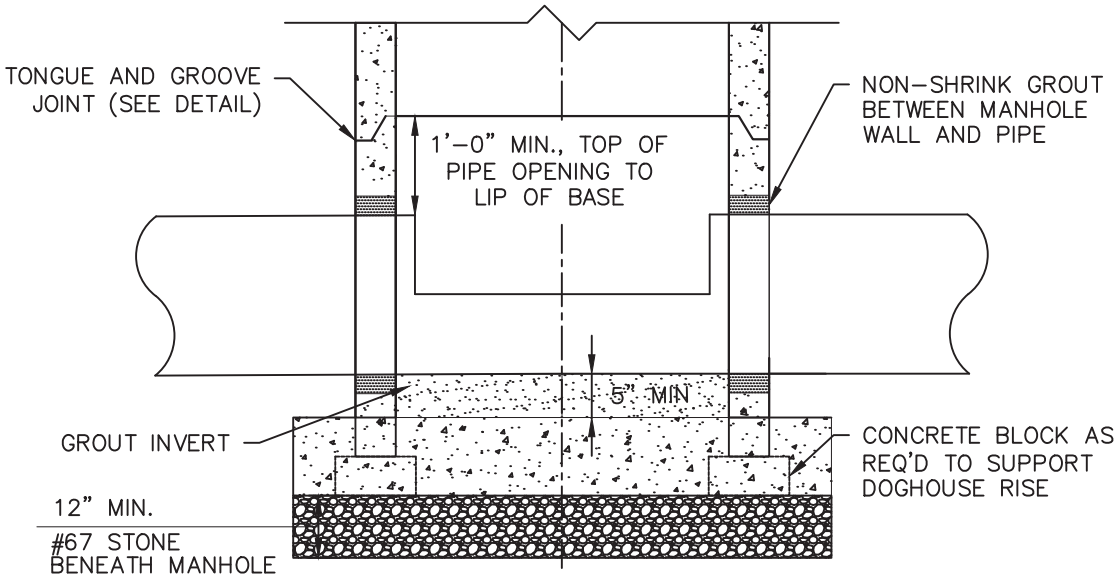
HISTORIC FRANKLIN TENNESSEE

DROP CONNECTION TO EXISTING MANHOLE

DWG. NO.
WW-7

CITY OF FRANKLIN	WATER MANAGEMENT DIRECTOR:	DATE: 10/16/2019
NOT TO SCALE		





NOTES:

1) ALL PRECAST ELEMENTS SHALL CONFORM TO ASTM C478.
2) ALL PRECAST MANHOLES SHALL CONTAIN XYPEX ADMIXTURE ACCORDING TO SPECIFICATIONS.

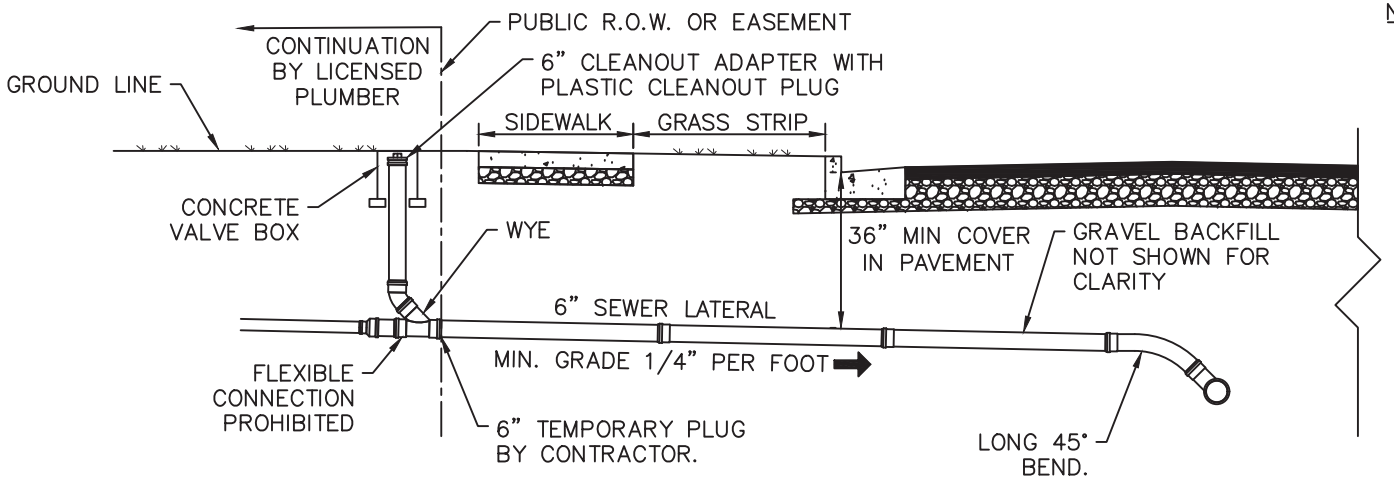
HISTORIC FRANKLIN TENNESSEE

DOGHOUSE MANHOLE OVER EXISTING SEWER

DWG. NO.

WW-8

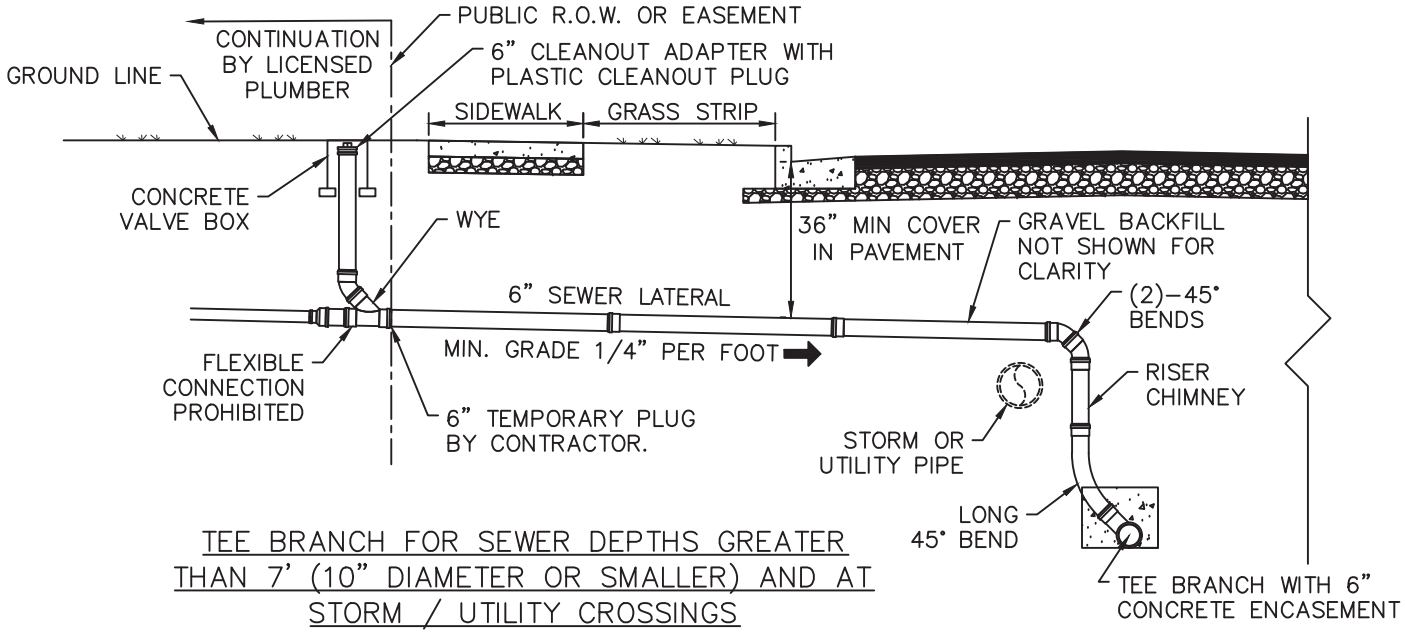
CITY OF FRANKLIN	WATER MANAGEMENT DIRECTOR:	DATE: 10/16/2019
NOT TO SCALE		



TYPICAL TEE BRANCH

NOTES:

1) 6" SEWER LATERALS SHALL BE THE SAME MATERIAL AS THE PUBLIC MAIN.
2) SERVICE LINES SHALL BE LOCATED 10' FROM THE WATER SERVICE LINE AND OUT OF THE WAY OF DRIVEWAYS, LANDSCAPING, HEADWALLS, ETC.
3) CLEANOUTS SHALL BE IN A CONCRETE VALVE BOX (SEE DETAIL)
4) THE MINIMUM COVER FOR A WASTEWATER LATERAL IS 18 INCHES IN UNPAVED AREAS AND 36 INCHES UNDER PAVEMENT.



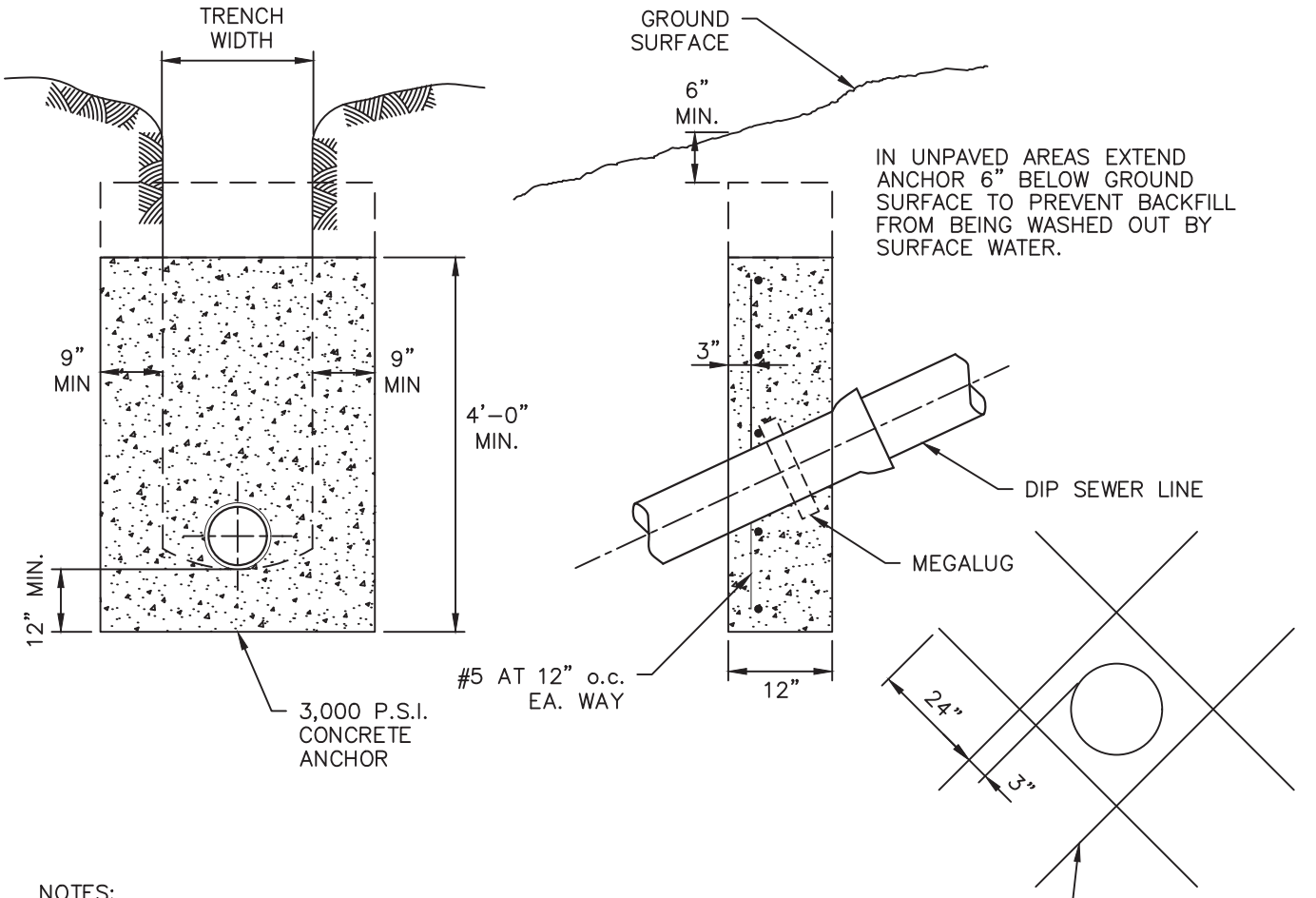
TEE BRANCH FOR SEWER DEPTHS GREATER THAN 7' (10" DIAMETER OR SMALLER) AND AT STORM / UTILITY CROSSINGS

HISTORIC FRANKLIN TENNESSEE

SANITARY SEWER LATERALS

DWG. NO. **WW-9**

CITY OF FRANKLIN	WATER MANAGEMENT DIRECTOR:	DATE: 10/16/2019
NOT TO SCALE		



NOTES:

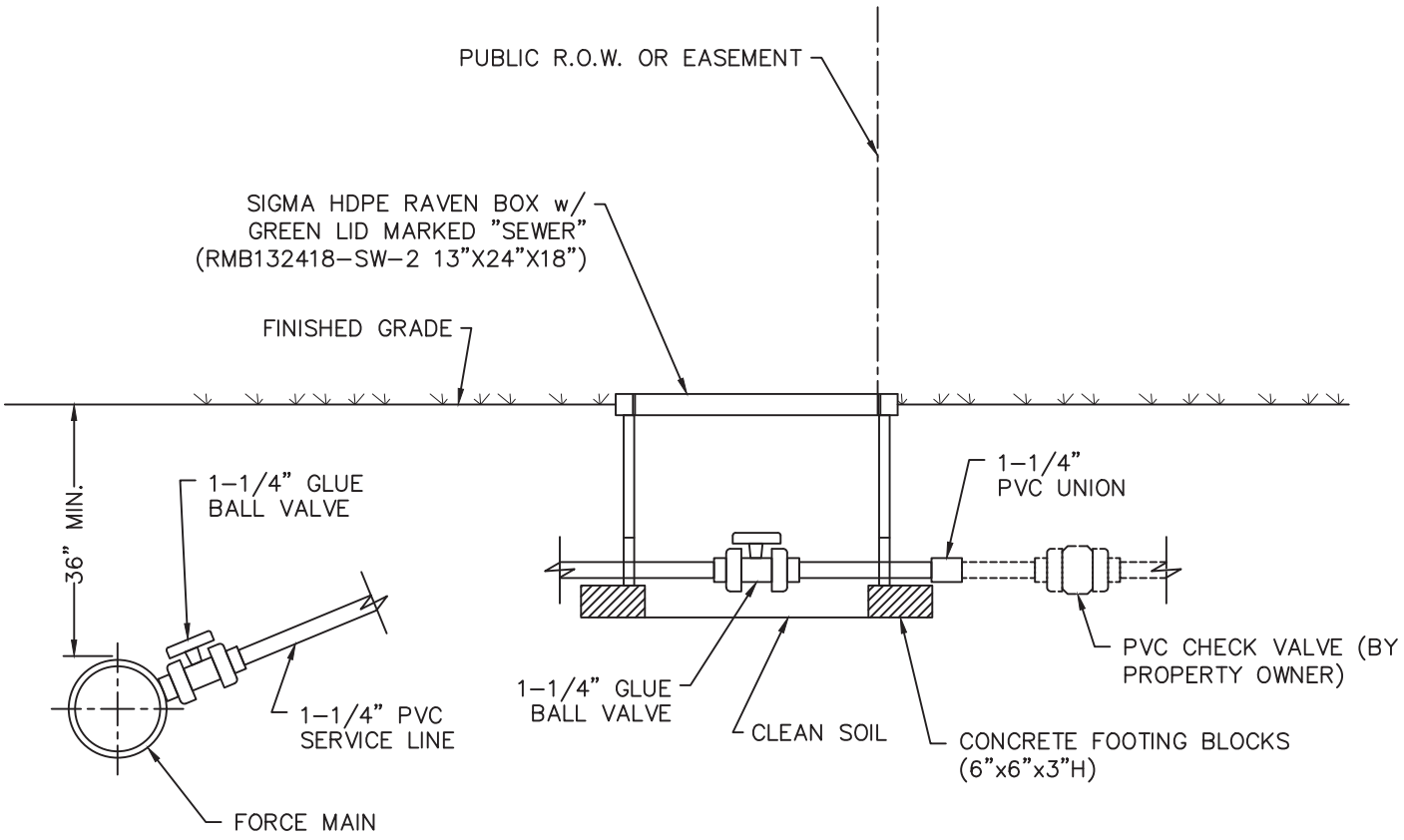
1) NO ANCHOR REQUIRED ON GRADES LESS THAN 18% UNLESS NOTED.
2) PIPE MATERIAL TO BE DIP FOR PIPE ON GRADES 18% OR GREATER.
3) PROVIDE ANCHOR 36'-0" CENTER TO CENTER ON GRADES BETWEEN 18% AND 25%.
4) PROVIDE ANCHOR 24'-0" CENTER TO CENTER ON GRADES BETWEEN 25% AND 35%.
5) PROVIDE ANCHOR 16'-0" CENTER TO CENTER ON GRADES 35% AND GREATER.
6) PROVIDE A MID-SPAN MEGALUG PIPE RESTRAINT CENTERED IN EACH CONCRETE ANCHOR.
7) CONTRACTOR MAY SUBMIT ALTERNATE DESIGN UTILIZING ROCK BOLTS TO KEY ANCHOR TO ROCK TRENCH.
8) FOR CONDITIONS OTHER THAN SHOWN HEREON, ANCHORS SHALL BE PROVIDED AS DESIGNED BY THE ENGINEER-OF-RECORD.

HISTORIC FRANKLIN TENNESSEE

CONCRETE ANCHORS FOR SEWER ON STEEP GRADES

CITY OF FRANKLIN	WATER MANAGEMENT DIRECTOR:	DATE: 10/16/2019	DWG. NO. WW-10
NOT TO SCALE			

NOTES: HDPE METER BOX IS NOT TRAFFIC RATED. BOXES IN DRIVEWAYS, PARKING LOTS, AND OFF-ROADWAY APPLICATIONS SUBJECT TO OCCASIONAL TRAFFIC SHALL BE QUAZITE BOX (PG1324BB18) AND COVER (PG1324HH00-SEWER). BOXES IN DIRECT ROADWAY APPLICATIONS SHALL BE AASHTO H-20 LOAD RATED WITH 30% IMPACT AND APPROVED BY THE WATER MANAGEMENT DEPARTMENT. PROFESSIONAL ENGINEER SEAL SHALL BE REQUIRED.



NOTES:

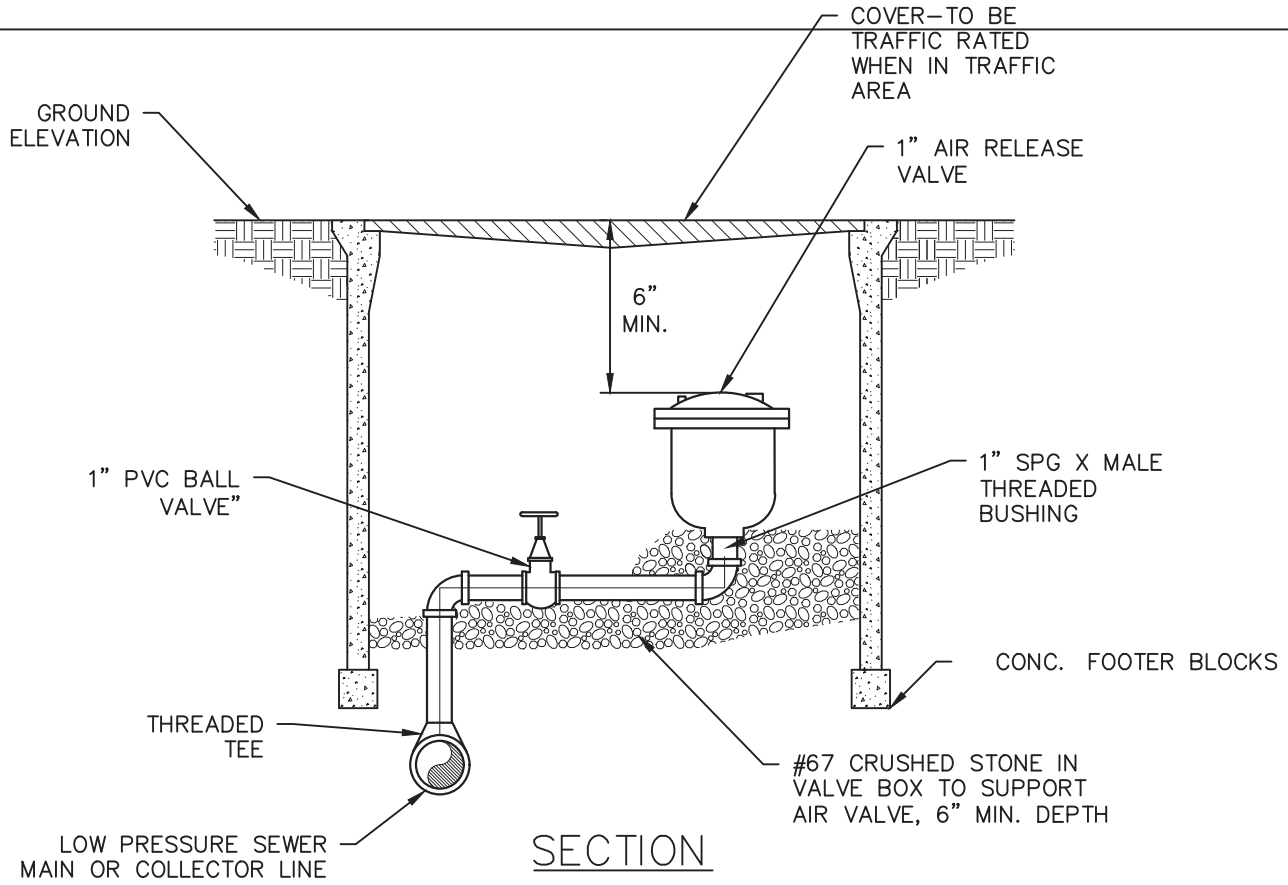
1) MINIMUM TRENCH WIDTH ON SERVICE SHALL BE 2 FEET.
2) INSTALL THE SERVICE BOX AS NEAR THE PROPERTY LINE AS POSSIBLE WITHIN THE PUBLIC RIGHT-OF-WAY OR PUBLIC EASEMENT. BOX SHALL BE SET PLUMB APPROXIMATELY 1" ABOVE PROPOSED GRADE AND SUCH THAT SURFACE DRAINAGE WILL NOT ENTER IT.
3) MINIMUM SERVICE LINE COVER SHALL BE 36" BELOW FINISHED GRADE UNDER ROADWAYS, 30" IN UNPAVED AREAS, AND 18" AT SERVICE BOX.

HISTORIC FRANKLIN TENNESSEE

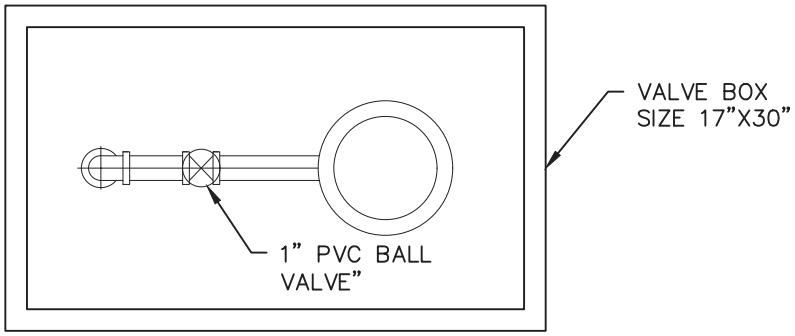
LATERAL SERVICE CONNECTION TO LOW PRESSURE SANITARY SEWER MAIN

CITY OF FRANKLIN	WATER MANAGEMENT DIRECTOR:	DATE: 10/16/2019	DWG. NO. WW-11
NOT TO SCALE			

DETAIL TO BE REVISED



SECTION



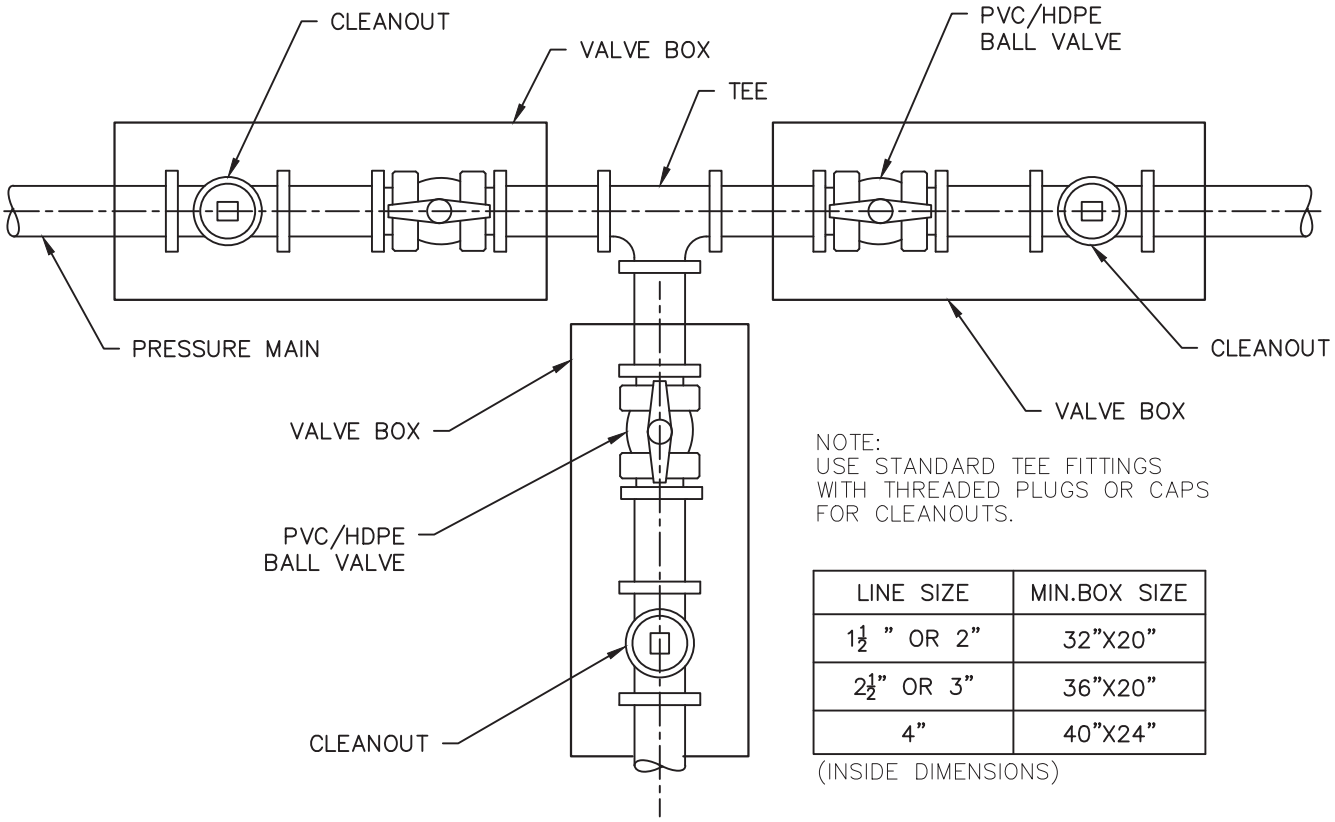
PLAN VIEW

NOTES:

1) VALVE IS TO BE SIZED FOR CONDITIONS.
2) AIR RELEASE VALVES TO BE SHALL BE A.R.I. USA INC. D–020, S–020, S–022 OR APPROVED EQUAL.
3) IF ASSEMBLY IS TO BE INSTALLED IN TRAFFIC AREA, BOX AND COVER TO BE TRAFFIC BEARING AS APPROVED BY CITY OF FRANKLIN.

HISTORIC FRANKLIN TENNESSEE

1" AUTO AIR RELEASE VALVE ON LOW PRESSURE SANITARY SEWER MAIN			DWG. NO. **WW-12**
CITY OF FRANKLIN	WATER MANAGEMENT DIRECTOR:	DATE: 10/16/2019	
NOT TO SCALE			

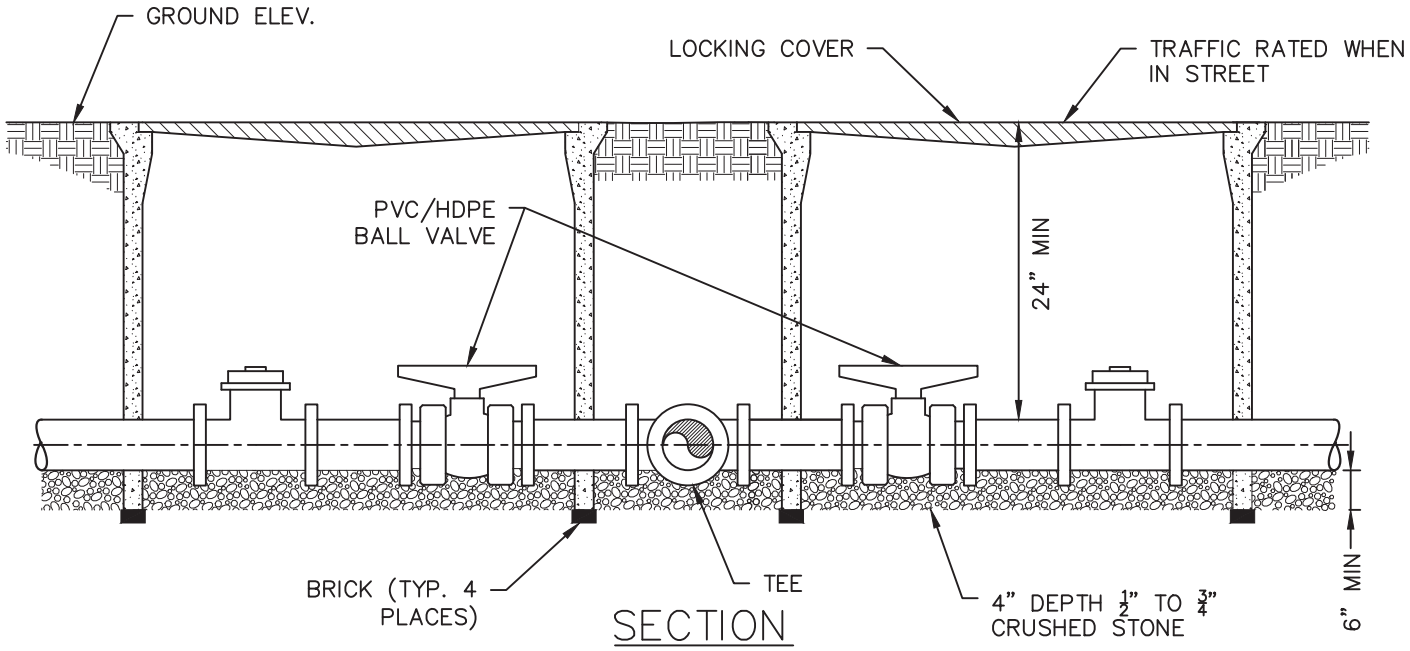


NOTE:
USE STANDARD TEE FITTINGS
WITH THREADED PLUGS OR CAPS
FOR CLEANOUTS.

LINE SIZE	MIN.BOX SIZE
1½ " OR 2"	32"X20"
2½" OR 3"	36"X20"
4"	40"X24"

(INSIDE DIMENSIONS)

PLAN



SECTION

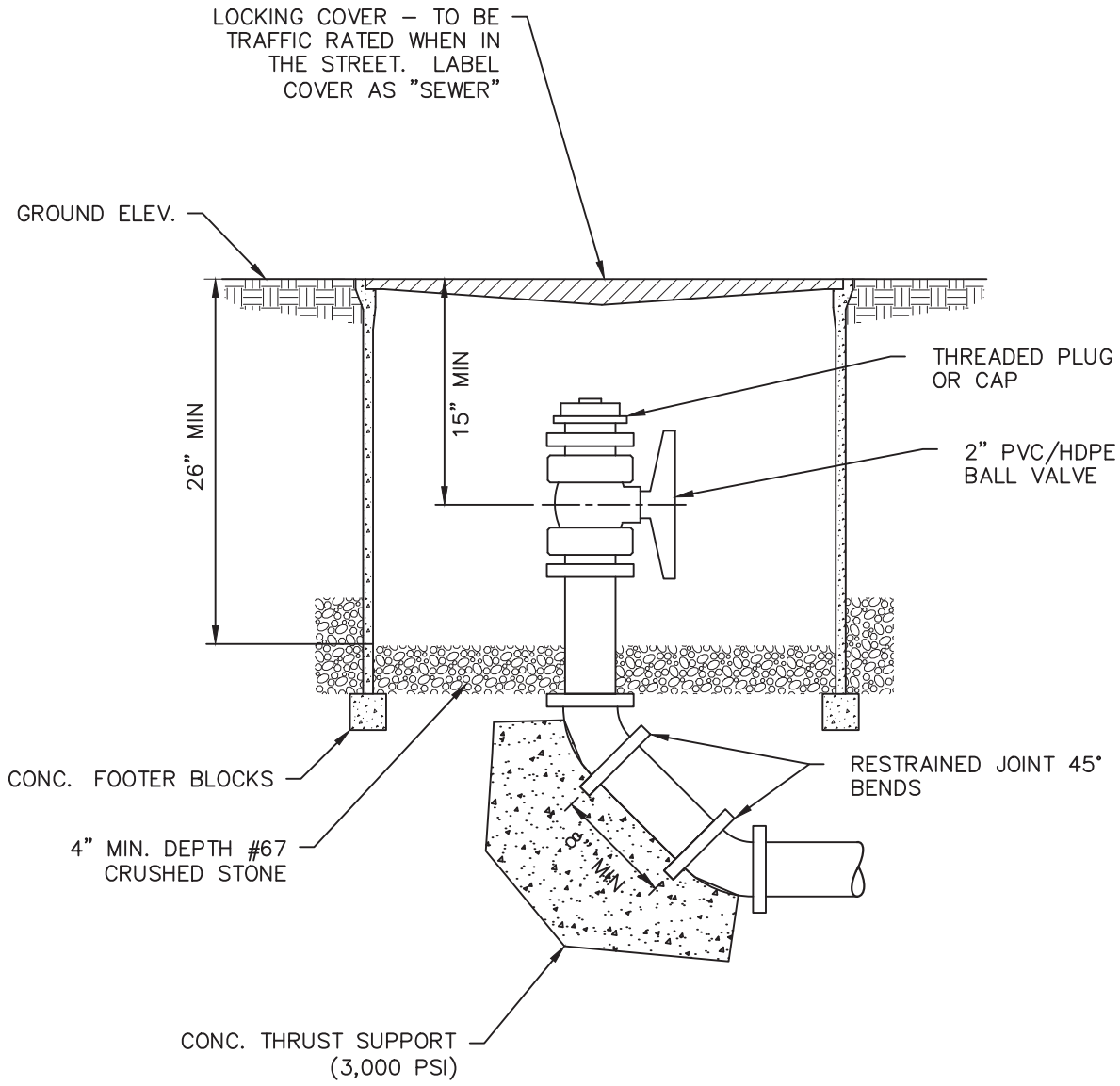
NOTE: IF ASSEMBLY IS TO BE INSTALLED IN TRAFFIC AREA, BOX AND COVER TO BE TRAFFIC BEARING AS APPROVED BY THE CITY OF FRANKLIN.

HISTORIC FRANKLIN TENNESSEE

VALVE BOX & CLEANOUT ARRANGEMENT AT LOW PRESSURE MAIN JUNCTION

DWG. NO. **WW-13**

CITY OF FRANKLIN	WATER MANAGEMENT DIRECTOR:	DATE: 10/16/2019
NOT TO SCALE		



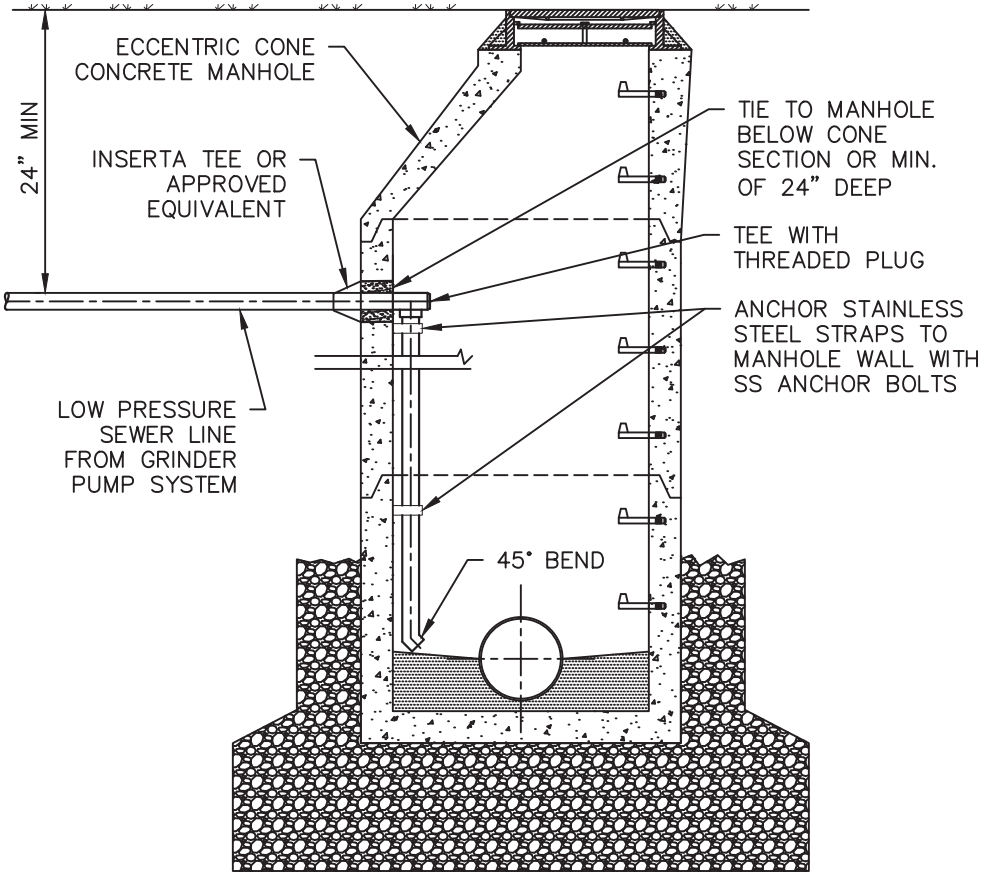
NOTE: IF ASSEMBLY IS TO BE INSTALLED IN TRAFFIC AREA, BOX AND COVER TO BE TRAFFIC BEARING AS APPROVED BY THE CITY OF FRANKLIN.

HISTORIC FRANKLIN TENNESSEE

LOW PRESSURE SANITARY SEWER END OF LINE FLUSHING ASSEMBLY

DWG. NO. **WW-14**

CITY OF FRANKLIN	WATER MANAGEMENT DIRECTOR:	DATE: 10/16/2019
NOT TO SCALE		



NOTES:

1) CONCRETE MANHOLES AT FORCE MAIN CONNECTION TO GRAVITY SEWER SHALL BE LINED BY PRODUCT AND INSTALLER APPROVED BY THE COF WATER MANAGEMENT DEPARTMENT.

HISTORIC FRANKLIN TENNESSEE

LOW PRESSURE SANITARY SEWER CONNECTION TO MANHOLE

CITY OF FRANKLIN	WATER MANAGEMENT DIRECTOR:	DATE: 10/16/2019	DWG. NO. WW-15
NOT TO SCALE			