DESIGN CRITERIA AND SPECIFICATIONS

FOR

GRAVITY SEWERS AND APPURTENANCES

TULLAHOMA UTILITIES AUTHORITY

SPECIFICATIONS NO. TUA-S-694 REVISION 7

NOVEMBER 2020

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GRAVITY SEWERS AND APPURTENANCES

SECTION 1 - GENERAL INFORMATION

1.01 DEFINITIONS

TUA - Tullahoma Utilities Authority, or Authorized Agent

City - City of Tullahoma, Coffee County, Tennessee

Developer - Owner of proposed development in which sewer lines are to be located.

Contractor - Contractor who is installing sewer lines in a proposed development. As provided by the laws of Tennessee, he must be properly licensed in Tennessee to perform gravity sewer work and must have shown competency in previous work.

Engineer - One who has prepared the construction plans for the installation of sewer lines in a proposed development. As provided by the laws of Tennessee, he must be a registered professional engineer in Tennessee and plans and specifications must bear his official seal. He must have demonstrated competency in design of gravity sewage systems

1.02 SCOPE OF REGULATIONS

These regulations shall apply to any person, developer, firm, business, or entity interested in and desiring to construct additional sewer lines or to extend sewer lines within the City of Tullahoma, Tennessee, or to construct additional lines or extend sewer lines in a way that affects the sewer service provided by the City.

1.03 REFERENCES

The Engineer and Developer should be familiar with the contents of the following documents prior to plans submission to TUA:

1. Rules of the Tennessee Department of Environment and Conservation, Chapter 0400-40-02, Regulations for Plans, Submittal, and Approval; Control of Construction; Control of Operation.

2. "Design Criteria for Review of Sewage Works Construction Plans and Documents", latest revision, State of Tennessee, Department of Environment and Conservation, Division of Water Resources.

3. Subdivision Regulations for the City of Tullahoma, Tennessee, available from City of Tullahoma.

1.04 DESIGN FEATURES

Sewer system design features shall generally conform to good municipal practice and to requirements of the Tennessee Department of Environment and Conservation.

The following criteria will generally apply:

Per Capita Wastewater Flow	100 GPCD
Peak Flow Factors	
Lateral Sewers	4.0 fps
Interceptor Sewers	2.5 fps
Minimum velocity at design flow	2.0 fps
Maximum velocity at design flow	15.0 fps
Basis of Hydraulic Design:	
Chezy's Formula with "n" =	0.013
Minimum Size Diameter	
Collector	8"
Service	6"

Pumping Stations shall, where possible, be designed to utilize equipment similar to that already utilized by TUA. Design discharge velocities shall be such as to create self-cleansing conditions in the force main. Suitable air release valves shall be utilized at all points in the force main where there is an accumulation of air or gases released from the sewage.

Pumping facilities will be required to have full standby capacity, alarm system, emergency bypass connection, flow meters in some cases and elapsed time meters for all pumps in all cases, water supply and backflow prevention device for maintenance and other items as determined in reviews for individual installation. Spare parts, such as seals, contactors, floats, etc., shall be provided by the Developer, to be determined by TUA on a case-by-case basis. Pump stations must be provided with all-weather roads for access for maintenance vehicles. The developer shall provide one day (8 hours) of training by the pump manufacturer for TUA's operation and maintenance personnel. Three copies of complete Operation/Maintenance manuals shall be provided for pump station prior to final acceptance.

A SCADA telemetry system is to be provided and installed with pumping stations as required by TUA. The SCADA system will consist of a Sixnet, Mini 1PM controller and an APC 420 Smart UPS. Programming of the controller will normally be provided by TUA. TUA will also provide and install the radio telemetry communications components unless otherwise directed. The correct wiring diagram of the SCADA equipment will be supplied by TUA. Level controls shall utilize a "Bird Cage" submersible water level sensor as manufactured by Blue Ribbon Corporation or an alternate sensor system specified by TUA. All controls shall be fully surge protected for both power and data. A surge protection system will be specified by TUA. Control panels shall be sized for the complete installation of all pump controls and SCADA equipment. Manufacturer shall inspect the installation and operation of all equipment and provide to TUA a written certification that the facilities are properly installed and operating in accordance with the

requirements of the manufacturer. Shop drawings for pump stations must be submitted to and approved by TUA in writing (after approval by the Engineer) prior to actual purchase of the pump station equipment. Preliminary discussions concerning pump station design are encouraged before preparation of preliminary plans so specific design requirements can be established.

Sewers Stream Crossings or drainage ways shall be Ductile Iron and designed to cross the stream or drainage way as nearly perpendicular to the stream flow as possible. Steps shall be taken to minimize adverse effects during stream crossings by employing best management practices. Required permitting (such as ARAP, TVA, US Army COE, etc.) shall be secured prior to commencement of work.

Sufficient cover for the sewer line shall be provided to protect the line. In general, cover minimums shall be as follows:

1. One foot of concrete when sewer is located in rock;

2. Three feet when sewer is in the stabilized stream or drainage channel; and

3. Seven feet when sewer is in a shifting stream channel.

Sewers located along streams or drainage ways are to be located outside of the stream bed and sufficiently removed from the normal flow channel to minimize damage to the streamside tree and vegetation root systems. Appurtenances (i.e., manholes, etc.) shall be located and constructed such that they do not interfere with the free discharge of flood flows of the stream or drainage way.

Pipe Material shall be as designated on approved construction drawings and shall conform to applicable specifications included in Section 2 of these Standard Specifications. The Engineer shall designate pipe materials on all construction drawings.

Separation of Water Mains and Sewers shall be maintained in accordance with the following guidelines:

For parallel installations, line separation is to be at least 10 feet edge to edge. If this cannot be obtained, the bottom of the water line shall be at least 18 inches above the top of the sewer. If this condition is also unobtainable, the sewer line is to be constructed of materials and have a joint design equivalent to water main standards as approved by TUA and shall be pressure tested to 50 psi to assure water tightness.

Where the water line crosses house sewers, storm sewers, or sanitary sewers, a separation of at least 18 inches shall be provided between the bottom of the water line and the top of the sewer. If this separation cannot be obtained, sewers within 10 feet of the water line shall be constructed of materials and have a joint design equivalent to water main standards as approved by TUA. Such sewer lines shall be pressure tested to 50 psi to assure water tightness. Water mains passing under sewers shall be protected (in addition to the above sewer line construction) by

providing: at least 18 inches between the bottom of the sewer and the top of the water line; adequate structural support of the sewer line to prevent excessive joint deflection or damage to the water line; centering of the water line section to result in water line joints being removed from the sewer line to the maximum possible extent. No water line shall pass through or come into contact with any part of a sewer or manhole.

Easements - When sanitary sewers are constructed outside a public right-of-way, easements must be provided using the following:

Sewer Depth (feet)	Easement Width Required (minimum)
0 - 12	20 feet
12 - 20	30 feet

No sewer allowed deeper than 20 feet without special approval by TUA. Also, any sewer over 12 feet deep shall be constructed using DUCTILE IRON PIPE unless otherwise approved by TUA.

Special Construction Requirements - Special provisions and requirements shall be required when sewers are constructed along or across streams or drainage ways.

During construction activities for a project, the Contractor shall be prohibited by clauses in the project specifications, or by reference to these specifications, from any unnecessary disturbances or uprooting of trees and/or vegetation along the stream or drainage way bank or vicinity, dumping of soil and debris into or along the stream or drainage way, changing course of the stream or drainage way, or pumping silt-laden water into the stream or drainage way.

The proposed work shall be carried out in such a manner as to prevent violations of water quality standards stated in 0400-40-03-.03 of the Rules of the Tennessee Department of Environment and Conservation.

At minimum, temporary erosion control measures such as silt fences, staked hay bales or siltation ponds shall be used to prevent or retard erosion from the construction activity from entering streams or drainage ways in the vicinity of the construction. The erosion control measures shall be in place prior to beginning clearing and/or any other construction activity.

The erosion control measure(s) used to protect the water quality of the nearby streams and/or drainage ways shall be maintained throughout the construction period. These control devices shall not be removed until, in the opinion of TUA, they are no longer required. Generally, this will be at the completion of the required restoration work for the project.

Special design requirements shall be employed to prevent stream drainage from sinking at the crossing and following along the sewer pipe bedding. This can be accomplished with an in-trench impounding structure of compacted clay. Other proposals will be considered.

1.05 PERMITS

Before beginning of any construction, the Developer or his agents shall obtain all necessary permits as required by law. Such permits include but are not limited to those from State and City storm water control agencies, State and County Highway Departments, the City Public Works Department and appropriate underground utility location services.

1.06 NOTIFICATION OF CONSTRUCTION

Before construction starts, a preconstruction conference shall be held with the Developer, Contractor, TUA, and other agents as appropriate present. After this conference, the work may begin and shall be accomplished in accordance with the approved plans and specifications by a properly licensed contractor.

1.07 INSPECTION

All projects shall be subject to inspection during and upon completion of construction by authorized representatives of TUA. Presence or absence of the inspector during the construction does not relieve the Developer and/or Contractor from adherence to approved plans and specifications.

The work shall at all times be subject to the inspection by authorized representatives of TUA and materials and/or workmanship found not meeting requirements of approved plans and specifications shall be immediately brought into conformity with said plans and specifications.

An authorized representative of TUA shall make a final inspection of the project after completion to determine acceptability of the work. Before this final inspection can be made, the Developer shall notify TUA in writing that the work has been completed in accordance with approved plans and specifications. If a sewer installation is not put into use within a nine month period after the completion of testing, the entire system must be retested.

1.08 FINAL ACCEPTANCE

When facilities qualify as public facilities, TUA will accept ownership of the completed facilities when the work has passed the final inspection, proper acquisition documents are completed, and acceptable Record Drawings are submitted to TUA. The Record Drawings shall be completed by the Engineer responsible for the project and shall show final locations of sewer lines, manholes, valves and fittings for force mains, services, and any other items pertinent to the system. Service line location and measurements shall be from the next downstream manhole with an indication of the length of service and depth of the end of the service. For sewer service lines not perpendicular to the main, locate the end of the service from two (2) property corners.

A “Mylar” set, three (3) print sets, and an electronic copy of the Record Drawings shall be submitted to TUA before final acceptance of the work is made. The Record Drawings shall have on them a certification of accuracy signed by the project Engineer.

Final acceptance by TUA will be made in writing upon satisfactory completion of the project including final inspection, submittal of "Record" Drawings and completion of acquisition documents. The Developer shall guarantee the work for a period of one year from the date of final acceptance and shall immediately correct any deficiencies in the work due to materials and/or workmanship which occur during the guarantee period. The date of final acceptance shall be that date on which the Developer has fulfilled all conditions necessary for final acceptance.

SECTION 2 - MATERIALS

2.01 GENERAL

All materials to be incorporated in the project shall be first quality, new and undamaged material conforming to all applicable portions of these specifications.

2.02 CONCRETE

Cement - Cement shall be Portland cement and shall conform to "Standard Specifications for Portland Cement", Type 1, ASTM Designation C150, latest revision. Cement shall be furnished in undamaged 94 pound, one cubic foot sacks, and shall show no evidence of lumping.

Concrete Fine Aggregate - Fine aggregate shall be clean, hard uncoated natural sand conforming to ASTM Designation C33, latest revision, "Standard Specifications for Concrete Aggregate".

Concrete Course Aggregate - Course aggregate shall consist of clean, hard, dense particles of stone or gravel conforming to ASTM Designation C33, latest revision, "Standard Specifications for Concrete Aggregate". Aggregate shall be well graded between 1-1/2" and #4 sieve sizes.

Water - Water used in mixing concrete shall be clean and free from organic matter, pollutants and other foreign materials.

Ready-Mix Concrete - Ready-mix concrete shall conform to ASTM Designation C94, latest revision, "Specifications for Ready-Mix Concrete".

Class "A" Concrete - Class A concrete shall have a minimum compressive strength of 4000 pounds per square inch in 28 days and shall contain not less than 6 sacks of cement per cubic yard.

Class "B" Concrete - Class B concrete shall have a minimum compressive strength of 2000 pounds per square inch in 28 days and shall contain not less than 4-1/2 sacks of cement per cubic yards.

Concrete Additive - XYPEX® Admix C-1000 shall be added to all concrete structures. The manufacturer's recommend addition rate for Concentrate C-1000 is 3% by weight of the cement.
Metal Reinforcing - Reinforcing bars shall be intermediate grade steel conforming to ASTM Designation A15, latest revision, "Standard Specifications for Billet Steel Bars for Concrete

Reinforcement". Bars shall be deformed with a cross sectional area at all points equal to that of plain bars of equal nominal size.

2.03 CRUSHED STONE

Crushed stone for bedding or backfill shall be Tennessee Department of Transportation (TDOT), Bureau for Highways, Standard Size No. 67 and shall meet TDOT Standards for road surfacing.

2.04 PEA GRAVEL

Pea gravel for shaping cradle bedding shall be #4 to #1/2" size Ohio River, or approved local gravel of similar character.

2.05 MANHOLE FRAMES AND COVERS

Manhole castings shall conform to ASTM Designation A48, latest revision, Class 20 and shall be free from scale, lumps, blisters, sand holes and defects of every nature which would impair their use. Castings shall be well cleaned, with a smooth tough asphaltic coating. Covers shall be well cleaned, with a smooth tough asphaltic coating. Covers shall be of the solid indented type with the words "SANITARY SEWER" cast in raised letters thereon. Bearing Surfaces of frames and covers shall be machined to provide a solid bearing and prevent rocking. Pattern drawings and weights of castings shall be submitted for approval of TUA.

Manhole frames and covers shall be equal to those listed below for particular applications.

TRAFFIC	John Bouchard No. 1155
NON-TRAFFIC	Same as traffic type specified above.
WATERTIGHT	To be used where manhole casting is subject to flood or submergence by surface runoff. John Bouchard No. 1123

Exceptions to the above shall be noted on Construction Drawings.

2.06 MANHOLE STEPS

Manhole steps are neither required nor permitted.

2.07 PRECAST MANHOLES

Precast manholes shall conform to the latest revision of ASTM C-478. Drawings of manhole sections proposed for use on this project must be submitted to TUA for approval prior to use. Manholes shall be cast with XYPEX® Admix C-1000 in the concrete for waterproofing and corrosion protection. The manufacturer's recommended addition rate for Concentrate C-1000 is 3% by weight of the cement.

Manhole sections showing evidence of cracking, crazing, honeycombing, crumbling or excessive roughness will not be acceptable. Sections with improper cut-outs, misalignments or other defects shall not be utilized in the project.

Precast manhole panel (monolithic) bases may be used. Drawings of the monolithic bases proposed for use on this project must be submitted to TUA for approval prior to use. Bases shall have a minimum thickness of 8 inches with a minimum thickness of 2 inches allowed at the invert of the downstream pipe for the construction of the invert.

Manhole sections shall be steam or water cured and shall not be delivered to job site until at least 7 days old. Each section shall be marked in a permanent manner with date of manufacture, manufacturer's mark, and manhole location or manhole number. Manhole sections to receive pipes shall be furnished with appropriate cut-outs with resilient connectors for installation of pipe. Joints of manhole sections shall be of tongue and groove type.

On precast manhole sidewall an approved flexible plastic gasket equal to RAM-NEK shall be applied to the joint surface to placement of next manhole section. The placement of this gasket shall also be required under all manhole castings and adjustment rings for castings, both on inside and outside edges.

Testing and Inspection of precast manhole sections shall be done in accordance with ASTM C-478 by an independent testing laboratory suitable to TUA. Compression tests shall be run on specimens obtained from each day's production: a minimum of 2 cylinders or cores per day's run but no less than the maximum number designated by ASTM C-478. The absorption test shall be run on a minimum of 2 randomly selected manhole sections per each day's production.

2.08 MONOLITHIC POURED-IN-PLACE MANHOLES

Concrete shall be Class D design mix. Also, for each day's pour two test cylinders should be made and tested in compliance with ASTM 172, ASTM C31 and ASTM C39. These cylinders shall be done by a testing laboratory selected, employed and paid for by the Contractor.

The Contractor shall submit to TUA his choice of a testing laboratory for their approval. The Contractor shall instruct the testing laboratory to forward copies of the test reports to TUA.

The maximum depth of manholes shall not exceed twenty feet. The minimum wall thickness for 4'-0" inside diameter manholes shall be 6 inches. The minimum wall thickness for 5' and 6' in size diameter manholes shall be 8 inches.

The base concrete shall be Class D as stated above, vibrated on firm sub-grade foundation or suitable crushed stone bedding. The base shall have a minimum diameter 8 inches greater than the outside diameter of the manhole and a minimum thickness, including the area under the pipe, as follows:

0' to 8' Manhole 8"

8’ to 12’ Manhole 10”
12’ to 20’ Manhole 12”

All water shall be removed from the form before and during the placement of the concrete. The first placement of base concrete shall consist of approximately 1/2 cubic yard of concrete deposited evenly around the walls and vibrated until there is a minimum slope of 60 degrees from the bottom of the forms to the bearing surface both inside and outside of the manhole. When this is complete and before additional is added, the concrete must be carefully vibrated on each side of each pipe.

Additional concrete must be deposited in evenly distributed layers of 18 inches with each layer vibrated to bond to the preceding layer. The wall spacers must be raised as the placements are made with the area from which the spacer is withdrawn being carefully vibrated.

Should a cold joint become necessary, a formed groove and reinforcing dowels (#5 bars 36 inches long at 12 inch centers) will be required in the top of the first placement for shear protection. Immediately before the second placement is made, the surface of the cold joint shall be thoroughly cleaned and wetted with a layer of mortar being deposited on the surface.

The forms may be removed 24 hours after placement. At this time a membrane curing compound with a fugitive dye included will be applied by power spraying to the outside of the manhole. The Contractor must submit manufacturer’s descriptive details for curing compounds for approval.

The monolithic manholes shall be backfilled to the same level simultaneously all around. The manholes shall not be backfilled until they reach 75% of the specified design strength. A select gravel backfill material shall be placed adjacent to the manholes in areas where swelling clays exist.

A resilient pipe connector shall be utilized to connect pipe to manhole sidewall.

Eccentric manhole cones shall be furnished and installed for 5 and 6 foot diameter manholes on precast or poured-in-place manholes. Concentric manholes cones may be installed on 5 and 6 foot diameter manholes if transition sections are used from 5 or 6 foot diameter to 4 foot diameter at approximately 60 inches above pipes. Details of proposed manhole construction shall be submitted to TUA for approval.

Manholes shall be cast with XYPEX® Admix C-1000 in the concrete for waterproofing and corrosion protection. The manufacturer’s recommended addition rate for Concentrate C-1000 is 3% by weight of the cement.

2.09 RESILIENT CONNECTORS

All connections of pipes to manholes sidewalls shall be made with resilient connectors. Openings in the manhole sidewall shall be so constructed such that it is an integral part of the sidewall and to provide for the required size and location of the pipe to connect to the manhole.

The sidewall opening shall be manufactured to allow for lateral and vertical movement, as well as angular adjustments through 20 degrees. The resilient connector shall be Kor-N-Seal as manufactured by NPC, Inc., or approved equal. The resilient connector shall meet all physical and performance requirements as set forth by ASTM C-923. Any exposed metal, such as tightening bands, shall be made entirely of corrosion resistant stainless steel. The void between the pipe and connector shall be filled with the "Cavity-O-Ring" annular space filler as manufactured by NPC, Inc., or approved equal.

2.10 DUCTILE IRON SEWER PIPE

1. Material

   Ductile iron sewer pipe shall conform to ASA Spec. A21.51 for ductile iron pipe centrifugally cast in metal or sand lined molds. Laying lengths shall be 16 feet or longer, except for special construction conditions. Pipe shall have bituminous coating outside, cement lining inside - ASA 21.4, and bituminous coating inside. Pipe shall be made with 60-42-10 grade ductile iron, or stronger. Unless noted otherwise on Drawings, thickness Class 50 pipe shall be used for gravity lines.

2. Drawings

   Unless otherwise indicated on the construction Drawings, ductile iron pipe may utilize slip-on joints equal to Tyton or Fastite. Joints used must be approved by TUA.

3. Testing and Inspection

   Testing and inspection shall be accomplished at the factory in accordance with ASA A21.51. An independent testing laboratory approved by TUA shall perform tests and furnish TUA with two (2) copies of all test reports. Tests to include: hydrostatic test (500 PSI - 10 Sec.); tensile test and impact test with one sample to be taken during each period of approximately three (3) hours. (See Section 2.13)

4. Marking

   The weight, class, manufacturer's mark, year of manufacture and letters "DI" or "DUCTILE" shall be cast or stamped on pipe.

2.11 POLYVINYL CHLORIDE (PVC) SEWER PIPE

1. Materials

   PVC sewer pipe shall be SDR 35, or heavier, manufactured in accordance with ASTM D3034, latest revision, for type PSM sewer pipe and fittings, 6" through 15" and ASTM F679 (wall thickness T-1), pipe sizes 18" through 27". Pipe shall be furnished in lengths not to exceed 13 feet. Pipe shall be furnished with integral bells; gaskets and lubricants shall be furnished by the pipe manufacturer. Pipe and fittings shall be made of PVC plastic having a cell classification of 12454-B or 12454-C as defined in ASTM D-1784.

   Pipe manufacturer shall be approved by TUA before use on any project.

2. Joints

Joints shall be compression type utilizing an elastomeric gasket providing a positive seal against ground water and root intrusion as well as sewage leakage and shall be in accordance with ASTM D3212. Gaskets shall comply with physical requirements specified in ASTM F447, latest revision. Lubricant shall be furnished with gasket and entirely compatible with gasket and pipe material.

Joints shall show no signs of leakage when tested as follows (supersedes ASTM D3034): Typical joint assembly shall be subjected to internal hydrostatic pressure of 10.8 psig for 10 minutes without leakage; assembly shall also be subjected to internal vacuum of twenty-two (22) inches of mercury or external pressure of 10.8 psig for ten (10) minutes without leakage. The above internal pressure and vacuum or external pressure tests shall be run on a typical joint assembly in concentric alignment and in a position of angular deflection to at least three (3). Joint design shall be approved by TUA before use on any project.

3. Testing and Inspection

Testing and inspection of all pipe shall be done at the factory with a certified copy of test results furnished to TUA before any pipe is installed.

For projects using less than 2000 feet of sewer (not including service lines) such testing shall be done by the manufacturer. For larger projects, testing shall be done by an independent testing laboratory approved by TUA (unless this requirement is waived in writing by TUA, in which case testing shall be done as if for projects using less than 2000 feet of sewers.)

Tests shall be done in accordance with ASTM D-3034 or ASTM F-679 and shall include: Pipe and Fitting Dimensions; Pipe Flattening; Impact Resistance; Pipe Stiffness; Joint Tightness (see Part 2); and Extrusion Quality. At least 1% of the production of each size furnished for this project shall be tested.

4. Marking

Each pipe section shall be marked with the following information:

4” to 15” Pipe Sizes:

Manufacturer’s name or trademark; nominal pipe size; PVC cell classification; Legend “Type PSM DR 35 PVC Sewer Pipe”; ASTM D3034.

18” to 27” Pipe Sizes:

Manufacturer’s name or trademark; nominal pipe size; PVC cell classification; Legend “PS 46 PVC Sewer Pipe”; ASTM F679.

5. Installation

Installation of PVC sewer pipe shall follow requirements of Section 3.

2.12 CONCRETE PIPE AND OTHER PIPE MATERIALS

Generally, use of pipe materials other than PVC, Ductile Iron, and Concrete shall not be permitted. If the Contractor or Engineer desires to use other pipe materials, TUA must be approached early in the design phase of the project. The decision of TUA on the use of other pipe materials shall be final.

2.13 FITTINGS AND COUPLINGS

Unless otherwise indicated or directed by TUA, fittings shall be of the same material as the pipe line in which they are to be installed. Fittings shall be furnished with joints of the same type used throughout the rest of the pipe line unless such joint shall not be available and TUA should approve a substitute type joint. Fittings shall be of the type indicated on the drawings and shall be the manufacturer's standard conforming to all applicable standard specifications and dimensional tolerances appropriate for the material of construction.

2.14 SPECIAL NOTE ON TESTING AND INSPECTION

The requirement that materials testing be done by an independent testing laboratory approved by TUA is hereby waived unless specifically required by TUA as noted during plan review. Tests as indicated must be conducted, however, and TUA shall be furnished with test reports as indicated. The test reports shall be certified true by the manufacturer.

2.15 IDENTIFICATION TAPE

A metalized tape shall be installed in the ditch above the sewer main and service connections to allow location by a metal detecting device and to alert construction workers of the presence of a sewer line. The tape shall be color-coded and labeled to identify the line as a sewer line. The tape shall be at least six inches wide and shall be installed within 12-18 inches of finish grade. The tape shall be Line Guard Type III as manufactured by Line Tech or an approved equal.

SECTION 3 - CONSTRUCTION

3.01 GENERAL

The streets, roads, and easements in which lines will be placed shall be indicated on the plans. Any change from locations approved by TUA shall be approved by TUA before construction.

Where the excavation exceeds the required depth, the Contractor shall bring the excavation to proper grade through the use of an approved incompressible backfill material (generally crushed stone or fill concrete, depending upon the nature of the facility to be placed thereon). In the event unstable soil conditions are encountered at the bottom of the excavation, the Engineer will direct the Contractor to continue the excavation to firm soil or to provide pilings or other suitable special foundations, with such action subject to approval by TUA.

The Contractor shall take such precautions as may be necessary to avoid endangering personnel, pavement, adjacent utilities or structures through cave-ins, slides, settlements or other soil disturbances resulting from his operations.

Backfilling shall be carried out as expeditiously as possible, but shall not be undertaken until TUA's inspector has been given the opportunity to inspect the work. The Contractor must carry out all backfilling operations with due regard for: the protection of pipes, structures and appurtenances; the use of prescribed backfill materials; and procedures to obtain the desired degree of compaction.

All shade trees, telephone poles, power poles, etc., along the line of work shall be protected, and sufficient barricades, lanterns, etc., shall be provided for the protection of the public.

3.02 TRENCH EXCAVATION

3.02.1 General - Trenching must be done in a neat and workmanlike manner maintaining proper vertical and horizontal alignment. Alignment shall be maintained by the use of offset hubs and batter boards at maximum 50 foot intervals or with a laser device or with other methods approved by TUA. Cut sheets shall be submitted to TUA for approval prior to construction.

Trenching shall be neatly excavated to the alignment and depth required for the proper installation of pipe, bedding material and appurtenances. Trenches shall be opened up far enough ahead of pipe laying to reveal obstructions, but in general shall not include more than 300 feet of continuous open trench at any time. The Contractor will be required to follow up trenching operations promptly with pipe laying, backfill and clean-up, and in event of failure to do so, may be prohibited from opening additional trench until such work is completed. This requirement is particularly applicable to work being done in developed areas.

The Contractor shall plan his operations so as to cause a minimum of inconvenience to property owners and to traffic. No road, street or alley may be closed unless absolutely necessary, and then only if the following conditions are met:

1. Permit is secured from State, County, or Municipal authorities having jurisdiction.

2. Fire, Police, Public Works Departments are notified before roads are closed.

3. Suitable detours are provided and are clearly marked.

No driveways shall be cut or blocked without first notifying the occupant of the property. Every effort shall be made to schedule the blocking of drives to suit the occupant's convenience, and except in case of emergency, drives shall not be blocked for a period of more than eight (8) hours. The Contractor shall furnish and maintain barricades, signs, flashing lights, and other warning devices as necessary for the protection of public safety. Flagmen shall be provided as required on heavily traveled streets to avoid traffic jams or accidents.

Trench width shall be held to a minimum consistent with proper working space for assembly of pipe. Maximum trench width up to a point one foot above top of pipe shall be limited to the outside pipe diameter plus sixteen (16) inches. Boulders, large stone, shale and rock shall be removed to provide clearance of 6" below and on each side of the pipe. Trench walls shall be kept as nearly vertical as possible with due consideration to soil conditions encountered and when necessary, sheeting or bracing shall be provided to protect life and property. Where unstable soil conditions are encountered at the trench bottom, the Contractor shall remove such additional material and replace the excavated material with approved backfill, or otherwise provide stable bedding for pipe as approved by TUA.

The Contractor shall excavate by hand wherever necessary to protect existing structures or utilities from damage or to prevent over depth excavation in the trench subgrade.

Excavated material shall be stored safely away from edge of trench and in such a way as to avoid encroachment on private property.

3.02.2 Rock Excavation - Where rock is encountered the excavation shall be carried to a depth of 6" below the barrel of the pipe, or the bottom of the structure, and the excess excavation shall be backfilled with crushed stone, sand or other approved bedding material firmly compacted. Boulders and large stones, rock or shale shall be removed to provide a clearance of at least 6" below all parts of the pipe or fittings and to clear width of at least 6" on each side of pipe and appurtenances.
Where rock is encountered, the Contractor shall "mattress" the trench during blasting operations and shall use all precautions to protect adjacent property against damage resulting from his operations. Rock excavation in proximity to other pipes or structures shall be conducted with the utmost care to prevent damage to the existing structures and any such damage caused shall be promptly repaired at the Contractor's expense. Blasting operations shall not be conducted within 25' of finished sewer or water pipe and rock excavation shall be at least 25' ahead of pipe laying. Extreme care shall be exercised in blasting with signals of danger given and displaced before the firing of any charge. The Contractor shall, in all his acts, conform to and obey all rules and regulations for the protection of life and property that may be imposed by any public authorities or that may be made from time to time by the Engineer relative to the storing and handling of explosives and the blasting operations. No blasting shall be done at any time except by persons experienced in this line of work.

Where rock is encountered in the immediate vicinity of gas mains, telephone cables, building footings, gasoline tanks, or other hazardous areas the Contractor shall remove the rock by means other than blasting. Care shall be taken in blasting operations to see that pipe or other structures previously installed are not damaged by blasting.

3.02.3 Sheeting and Shoring - The Contractor shall provide such bracing, sheeting or shoring as may be necessary for the protection of life and property, or where such protection is specifically required by the Engineer because of potential danger to life, property or the completed structure. It is the responsibility of the Contractor, Engineer, and Developer to provide proper design and implementation of excavation protection systems in accordance with applicable OSHA standards. TUA will not assume responsibility of, nor will TUA inspect

excavation protection systems. Sheeting will be required where necessary to restrict the trench width to acceptable limits above the top of pipe.

Sheeting, shoring or bracing shall conform to applicable safety codes and shall be left in place until pipe is laid, checked, and backfilled to a safe level at or above top of pipe. The bracing or sheeting may then be removed in an approved manner unless the Engineer specifically directs that the sheeting be left in place. Where the sheeting is left in place, either at the direction of the Engineer or option of the Contractor, the sheeting shall be cut off at least 18" below the finished ground level.

Care shall be taken in removing sheeting to avoid weakening the trench, increasing the backfill load, or endangering adjacent property. Voids left by the removal of sheeting shall be filled in and compacted with suitable material using tamps intended for this purpose.

3.02.4 Surface Obstructions - All buildings, walls, fences, poles, bridges, railroads, trees, and other property or improvements encountered shall be carefully protected from all injury, and in the event that any of the foregoing are damaged or removed during the process of the work, they shall be repaired or replaced in a satisfactory manner. Special care must be exercised in trenching under or near railroads in order to avoid or minimize delays or injuries resulting therefrom. Where it is necessary to cross beneath railroad tracks, the Contractor shall make such installations in a casing of large diameter as approved by the Railroad Company and TUA.

3.02.5 Subsurface Obstructions - In excavating, backfilling, and laying pipe, care must be taken not to remove, disturb, or injure other pipes, conduits, or structures, without the approval of the owner(s) of said facilities. If necessary, the Contractor, at his own expense, shall sling, shore up and maintain such structures in operation and within a reasonable time shall repair any damage done thereto. Repairs to these facilities shall be made to the satisfaction of the owner(s) of said facilities.

The Contractor shall give sufficient notice to the interested utility of his intention to remove or disturb any other pipe, conduit, etc., and shall abide by their regulations governing such work. In the event subsurface structures are broken or damaged in the prosecution of the work, the Contractor shall immediately notify the proper authorities and shall be responsible for any damage to persons or property caused by such breaks.

When pipes or conduits providing service to adjoining buildings are broken during the progress of the work, the Contractor shall have them repaired at once. Delays, such as would result in buildings being without service overnight or for needlessly long periods during the day, will not be tolerated, and TUA reserves the right to make repairs at the Contractor's expense without notification. Should it become necessary to move the position of the pipe, conduit, or structure, it shall be done by the Contractor in strict accordance with instruction given by the utility involved.

3.03 INSTALLATION OF SEWER PIPE AND ACCESSORIES

3.03.1 General - The Contractor shall use only experienced people in the final assembly of pipe in the trench, and all pipe shall be laid in accordance with these Specifications and the recommended practice of the pipe manufacturer. Trench bottoms shall be carefully prepared, shall be free of water, and bedding as specified shall be in place.

Care shall be exercised to ensure that pipe of the proper strength or classification meeting the specifications in every respect is provided at the site of pipe laying operations. Recommended tools, equipment, lubricant and other accessories needed for proper assembly or installation of the pipe shall be provided at the site of the work. Any damage or defective pipe discovered during the pipe laying operations shall be discarded and removed from the site of the pipe laying operations.

Alignment and grade shall be carefully maintained during the laying operations. The method used for maintaining grade and alignment must be acceptable to TUA and must produce the desired results. The top of the bedding material must be brought to the exact grade and must be shaped so as to provide effective support for the bottom quadrant of the pipe except at the bells.

The Contractor shall exercise care in the storage and handling of pipe, both on the storage yard and at the site of laying operations. Suitable clamps, slings, or other lifting devices shall be provided for handling pipe and fittings. Pipe and fittings shall be inspected for defects and for dirt or other foreign material immediately before placing them in the trench. Suitable swabs shall be available at the site of laying operations, and any dirt or foreign material shall be removed from the pipe before it is lowered into the trench.

3.03.2 Bedding - It is desired that trench widths from a point one (1) foot above the top of the pipe down to the bottom of the trench be held to a minimum consistent with the provisions of necessary space for proper assembly of the pipe. In general, the trench width shall not exceed the nominal pipe diameter plus sixteen (16) inches.

A minimum of 6” of crushed stone bedding shall be placed in the bottom of the trench to provide continuous support of the bottom quadrant of the pipe. The Contractor shall bring the crushed stone bedding up to the required level to provide support to the bottom quadrant and shall then shape the bedding to receive the pipe. Bell-holes shall be dug so that the bottom of the bells will not support the pipe.

After the bedding has been shaped and the pipe has been installed, crushed stone backfill shall be carefully placed by hand and compacted on both sides of the pipe and up to a level 12” above the top of the pipe.

In addition to maximum trench width, the selection of pipe has been based on the use of 6” of crushed stone bedding to provide continuous support of the bottom quadrant of the pipe plus crushed stone backfill carefully placed and compacted on both sides of the pipe and up to a level of 12” above the top of the pipe. It is, therefore, essential that these conditions be observed in the installation of the pipe.

3.03.3 Pipelaying - After the pipe has been cleaned and inspected for defects and lowered into the trench, the mating surfaces of the compression joint shall be wiped clean and coated with lubricant of a type supplied by the pipe manufacturer. The pipe shall then be assembled with due care being taken to ensure that the spigot end of the pipe is shoved home and that the pipe is left in proper grade and alignment.

Whenever pipe laying operations are to be discontinued for a period of time exceeding two (2) hours, the end of the pipe shall be carefully secured to avoid displacement or misalignment of a tight fitting plug or stopper shall be placed in the line. Upon resumption of laying operations, the plug or stopper shall not be removed from the line until any water, mud or other debris has been removed to avoid entry into the completed section of the sewer.

Installation of sewer pipe shall conform to provisions of these specifications and recommendations of the pipe manufacturer. Installation instructions provided by the pipe manufacturer shall be available at all times at the location of the work.

The proper gaskets and lubricants shall be furnished by the pipe manufacturer and lubricants shall be delivered to the job site in properly labeled, unopened containers.

Wye branches or tees and other fittings shall be placed in the sewer line as shown on the Drawings or as directed by TUA as pipe laying progresses. The Contractor shall keep accurate records of their locations.

1. Laying Polyvinyl Chloride Pipe (PVC)

Installation of polyvinyl chloride pipe shall conform to ASTM 2321, latest revision. PVC pipe shall be laid on crushed stone bedding and shall be backfilled with compacted crushed stone around and above the pipe as outlined in 3.03.2 and in 3.06.1. The bedding material shall be shaped to provide continuous support for the PVC pipe throughout its length except at bells. Blocking shall not be used to bring the pipe to grade.

Whenever it is necessary to cut a joint of pipe in order to fit the trench conditions, the cut can be made with either hand or mechanical saws or plastic pipe cutters. The cut shall be square and perpendicular to the pipe axis. The cut end shall be beveled to as closely resemble the factory bevels as possible.

Assemble all joints in accordance with recommendations of the manufacturer.

2. Laying Ductile Iron Pipe

Where ductile iron pipe is shown, specified or directed by the Engineer, the pipe shall be of the type and class as indicated. Ductile iron pipe to be installed in trenches shall be laid on crushed stone bedding and shall be backfilled with compacted crushed stone around and above the pipe as specified for other pipe materials. The bedding materials shall be shaped to provide continuous support throughout its length except at bells.

Unless otherwise indicated, ductile iron pipe shall be laid with slip type compression joints, equal to the manufacturer's standard for pressure water pipe and assembly of the joints shall be in accordance with the manufacturer's recommendations using lubricant and accessories as provided by the pipe manufacturer.

Whenever it is necessary to cut a joint of pipe in order to fit the trench conditions, the cutting shall be done using the equipment as recommended by the manufacturer for the specific type of pipe involved. The cut shall be made so as to leave a smooth end at right angles to the axis of the bore and the end shall be beveled or finished as required to make the joint without risk of damage to the gasket.

On stream crossings, ravines, shallow cuts and other locations where pipe will not be laid on bedding placed on original subgrade the pipe shall be supported on concrete piers as detailed on the Drawings or as directed by the Engineer. Piers shall be of Class A concrete with reinforcing as shown. The tops of piers shall be carefully set at the exact elevation and shall be shaped so as to provide support for the bottom half of the pipe with allowance being made for the outside diameter of the pipe plus the thickness of a layer of tarred felt around the outside of the pipe. After the concrete has obtained satisfactory strength the ductile iron pipe may be installed across the piers using one or more layers of felt between the surface of the concrete and the outside diameter of the pipe. The Contractor may, at his option, install the pipe to exact grade and alignment using temporary support and then construct the permanent piers for the pipe, provided suitable precautions are taken to avoid any misalignment during the construction of the piers. Sewer laid on piers across ravines or streams shall be allowed only when it can be demonstrated that no other practical alternative exists. The impact of flood water and debris associated with these flood waters shall be considered in the design of these sewers. The bottom of the pipe on piers should be placed no lower than the elevation of the fifty (50) year flood plain.

3. <u>Connections to Structures</u>

Connections of pipes to manholes or other large structures shall be made using short lengths of pipe to avoid stressing the pipe at the point where it is placed in the wall of the structure. Pipes entering or leaving masonry or concrete walls shall have one flexible joint located not more than 6" outside the structure wall followed by a length of pipe not more than 2' in length with another flexible joint at the end of the 2' pipe length in such a way as to provide for limited lateral or vertical movement of the pipe line as well as limited deflection. Ordinary compression type joints of the types specified for gravity sewers shall be considered as having sufficient flexibility for this purpose. The supplier of the pipe for the sewer lines shall furnish with the pipe order the required number of specials and short lengths of pipe for the Contractor to install the required flexible connections without improvising.

The connection to a manhole shall be made utilizing a "Kor-N-Seal" connector, or approved equal, with the annular space filled with a "Cavity-O-Ring" filler, or approved equal. See Section 2.09 for complete specifications.

4. **<u>Connections to Existing System</u>**

No pipe shall be connected to the existing sewage system until all new upstream construction has been completed, is free of foreign materials and obvious defects have been corrected. New lines, then, must remain disconnected from the existing system by actual physical separation, by plugs of a type approved by TUA or by other means approved by TUA. A note on the construction plans stating this requirement shall be required for approval of the plans.

3.03.4 IDENTIFICATION TAPE

A metalized tape shall be installed in the ditch above the sewer main and service connections to allow location by a metal detecting device and to alert construction workers of the presence of a sewer line. The tape shall be color-coded and labeled to identify the line as a sewer line. The tape shall be at least six inches wide and shall be installed within 12-18 inches of finish grade. The tape shall be Line Guard Type III as manufactured by Line Tech or an approved equal.

3.04 MANHOLES

Consideration will be given to the use of either cast-in-place manholes or precast manholes. In the event the Contractor elects to use precast manholes, he shall submit details of the proposed manholes together with the name of the supplier to TUA for approval before any of the precast manholes are shipped to the job site. Precast manholes may be used with precast floors, or with structural concrete floors poured in place. Precast risers shall be furnished with openings for pipes entering and leaving the manhole. Individual riser sections shall be furnished for the exact conditions to be encountered in the field and shall be constructed so as to suit field conditions and to line up properly with the pipes in other riser sections. Misalignment of or improperly located holes for incoming pipes shall be cause for rejection of the manhole sections. Precast manhole sections shall be joined together in such a way as to present a smooth uniform joint which shall be structurally sound and watertight.

The manhole sidewall shall be of a length such that a maximum of three (3) precast manhole casting rings (12" total), shall be placed on the top of the unit to bring the casting to final grade.

Cast-in-place manholes shall be constructed on structural concrete slabs, with a second floor incorporating flow channels being provided after the pipes have been laid and the walls have been constructed. Flow channels shall consist of smooth uniform cross sections conforming to the cross section of the pipes so as to provide a minimum of turbulence and avoid deposition of solids. Flow channels shall have a depth of at least equal to one-half (1/2) the pipe diameter. The finished floor of the manhole shall have a slope approximately one-half inch (1/2") from wall to channel to provide for proper drainage, but at the same time, offer safe footing for workmen. Brick or pieces of brick may be used for fuller material in forming the flow channel and finished floor in the manholes provided no brick shall be left within one-inch (1") of the finished surface.

Manholes shall be cast with XYPEX® Admix C-1000 in the concrete for waterproofing and corrosion protection. The manufacturer's recommended addition rate for Concentrate C-1000 is 3% by weight of the cement.

Water-tight manholes and inserts shall be installed, if during a field review, it is determined that one is necessary to prevent surface runoff from entering the sewer. This requirement takes precedence over what is shown on the construction plans.

Care shall be taken in the construction of manholes as all manholes shall be subjected to and shall pass a vacuum test prior to acceptance. Manhole vacuum testing shall be accomplished prior to backfilling of the manhole.

3.05 SERVICE CONNECTIONS

Sewer service lines shall be provided as shown on the plans or as directed by TUA. Service connections shall consist of wyes with 6" branch connections, 6" bends, and 6" piping as required to complete the sewer service connection. Bends greater than 45 degrees are not permissible. Pipe and fitting joints shall be compression type as used on the main sewer. Service pipe and fittings shall be of the same material as used for the main sewer. Service pipe shall be laid on a slope of one-fourth inch (1/4") per foot or, where this grade is not available and TUA specifically approves, one-eighth inch (1/8") per foot may be used. Sewer service lines shall conform to details as shown on Standard Detailed Drawings and shall terminate one foot (1') inside the property line, or the public access easement (if service crosses this easement) with a clean-out kit installed, a 6" SDR 35 to 4" Schedule 40 adapter for residential services, plastic service box brought to final grade, and service line properly capped. The service end shall be capped with a tight compression plug braced to withstand pressure of an air pressure test. (See Standard Detail S-6 for particulars.)

In the event that it should be necessary to install a service connection where a wye has not been provided, saddles must be used and shall be attached to the main sewer by a cement grout or epoxy in such a way as to effect a permanent water tight joint. Service taps on PVC sewers shall consist of a PVC saddle, neoprene gasket, and two stainless steel bands.
Excavation, laying and backfilling for service lines shall conform to the applicable specifications.

Record Drawings submitted to TUA shall indicate the service locations in such a manner that they can be accurately located in the field using information shown on the drawings.

3.06 WATER MIGRATION DAMS

To prevent migration of water through the bedding and backfill, compacted earthen dams approximately five (5) feet thick shall be placed across the trench and around the pipe extending from side to side of the trench and from the excavated bottom of the trench to the top level of the initial Class I backfill. At minimum, the migration dams shall be placed approximately fifteen (15) feet from the connection of each line to a manhole and on all service lines at the face of the intersection of the main line trench and service line trench. In constructing the dams, the soil shall be placed in six-inch (6") layers and compacted to 90% Proctor density. Above the pipe zone as defined below, backfill may be suitable excavated material or, where called for on approved construction drawings, crushed stone, placed in layers generally not exceeding twelve inches (12") and vibrated in place.

3.07 BACKFILL

Where crushed stone backfill is required the crushed stone shall be No. 67 size as designated by Tennessee Department of Transportation (TDOT) Standards and shall meet all requirements of the TDOT Standards for crushed stone used in road surfacing.

Where crushed stone is not required but the excavated material is unsuitable for use in the backfill, the Contractor may use fine dry selected earth or clay as backfill material. Material containing excessive organic matter, stumps, roots, refuse or foreign matter or hard clay lumps that cannot readily be compacted will not be acceptable for use as backfill.

3.07.1 Backfill for Trenches - Backfill up to the spring line of the pipe shall be placed as pipe laying progresses in order to maintain proper grade and alignment. Additional backfill shall not be placed until after the pipe has been inspected by TUA's inspector and approved for backfill.

Backfill to spring line of pipe and to a depth of twelve inches (12") above the top of pipe (pipe zone) shall be crushed stone placed by hand and compacted. Additional backfill may be placed by means of front-end loaders, bulldozers or other suitable mechanical equipment subject to a nine-inch (9") limitation of maximum thickness of layers placed before compaction.

In highways, streets, drives or other paved or traveled areas, backfill above pipe zone as described above shall consist of carefully placed #67 crushed stone as designated by the Tennessee Dept of Transportation. Maximum depth of layers shall generally be nine-inches (9") before compaction but in no case shall exceed the effective depth of tamping equipment used.

Where trench is located in open country or on public right-of-way outside the ditch line where not subject to traffic, the backfill up to a point twelve inches (12") above the top of the pipe shall be placed as specified in the preceding paragraphs. Above this point the backfill may consist of excavated material placed so as to avoid excessive settlement of the trench provided such material is selected to exclude rocks larger than twelve inches (12") in any dimension. No rocks larger than one and one-half inch (1-1/2") may be used in the top six inches (6") of backfill material.

In wide deep trenches the Engineer may, at his discretion, permit the use of rock larger than twelve inches in the backfill, provided such rock is carefully placed in such a manner that the final position of the rock will not be within the vertical prism lying directly over the pipe or within nine inches (9") on either side of the pipe.

In locations not subject to traffic where excavated material is permitted in the backfill such material shall be brought up to the original ground level and shall then be mounded over to provide for additional settlement. Compaction of this backfill material will not be required, however, if the Contractor shall exercise care to confine the mound to the area immediately over the trench and shall be responsible for bringing in such additional fill material as may be required from time to time during the one-year warranty period to fill in areas where excessive settlement has occurred.

The Contractor shall be responsible for and shall protect all sewers, storm sewers and electric, telephone, water, or other pipes or conduits against danger or damage while the trenches are being backfilled and from future settlement of the backfill. Where such damage should occur as a result of the Contractor's operations, he shall repair such damage promptly.

The Contractor's attention is called to the fact that he will be held completely responsible for any damage to pavement, sidewalks, curbs, gutters, meter or valve boxes, street inlets, or other structure or appurtenances as a result of the Contractor's operations. It should be specifically noted that the Contractor shall be responsible for damage even though the character or nature of the original pavement or structure was such that it was not capable of carrying the load of the construction equipment regardless of the construction methods used.

3.07.2 Backfill at Manholes and Other Structures - Backfill around manholes located in highways, streets, or other traveled areas shall consist of carefully placed #67 crushed stone as specified under "Backfill for Trenches". Backfill around manholes, piers or other structures in locations not subject to traffic may consist of excavated material subject to the following restrictions.

1. No rock larger than twelve inches (12") in any dimension shall be placed within six inches (6") of the manhole walls, or pipes entering or leaving the manhole.

2. No rock larger than twelve inches (12") in any dimension shall be placed in the vertical prism above and extending nine inches (9") outside of the pipe lines.

3. Crushed stone shall be used under, around and up to a point twelve inches (12") over the tops of any pipes entering or leaving the manholes. This requirement shall include the inlet pipe for drop manholes.

4. Excavated material used for backfill shall be carefully placed in layers and compacted in such manner as to fill voids and prevent excessive settlement.

3.08 PAVEMENT REMOVAL

Where existing paved streets, roads, parking lots, drives, or sidewalks must be disturbed during construction of the project the Contractor shall take the necessary steps to minimize damage. Permanent type pavement shall be cut or sawed in a straight line before removal and care shall be taken during excavation to avoid damage to adjacent pavement. Where trucks or other heavy equipment must cross curbs or sidewalks, such areas shall be suitably protected.

3.09 PAVEMENT REPLACEMENT

In paved or improved roads, or where sidewalks, curbs, gutters, or driveways have been damaged by Contractor, and where replacement of surfaces or damaged items is required, items shall be repaired or replaced without any needless delay in the best workmanlike manner with same kind of materials as were removed or damaged in the construction operation. Underlying foundation

courses of roads, etc., finished surface, etc., shall conform to undisturbed portions of damaged items and shall in every respect be equal to quality, materials and workmanship in original, undisturbed item. Decision of TUA shall be final as to classification of any form of pavement or surfacing not specified on project plans or of any forms of pavement or surfacing where classification is at all doubtful. Should Contractor fail or refuse to repair any damage after receiving directions of TUA, TUA may, after twenty-four (24) hours written notice, employ such force and furnish such materials as may be necessary to do the work with costs to be billed to Contractor.

Pavement replacement shall be performed in accordance with practices required by applicable local, State, and/or federal public works departments.

3.10 CLEAN-UP PROCEDURES AND REQUIREMENTS

The Contractor shall not remove from the line of work any earth excavated therefrom which may be suitable for backfilling or surfacing until the excavation has been refilled and surfaced.

As soon as backfilling of any excavation is completed and when in areas of existing development, the Contractor must at once begin the removal of all surplus dirt except that actually necessary to provide for the settlement of the filling unless otherwise provided in the special specifications. He shall also remove all the pipe and other material placed or left on the street by him except material needed for the replacement of paving, and the street shall be opened up and made passable for traffic. Following the above work, the repairing and complete restoration of the street surfaces, bridges, crossings, and all places affected by the work shall be done as promptly as possible.

All excavated material shall be cleared from adjacent street surfaces, gutters, sidewalks, parkways, railroads, grass plots, yards, etc., and the whole work shall be left in tidy and acceptable conditions. Contractor will be required to re-grass lawns or neutral grounds where trenches are excavated in these locations or where Contractor has damaged lawns or neutral ground by his operations.

SECTION 4 - TESTING

4.01 GENERAL

Upon completion of construction the Contractor shall hydraulically clean the sewers to remove all sand, dirt, brick, and other foreign materials and shall conduct his own inspection to locate any defects and determine when the sewers are ready for testing and final inspection by TUA. All apparent defects shall be corrected by the Contractor before testing or final inspection is requested.

No sewer line shall be allowed to discharge into the existing sewage system until said line is free of foreign materials and obvious defects have been corrected. New lines, then, must remain

disconnected from the existing system by actual physical separation, by plugs of type approved by TUA, or by other means approved by TUA.

All testing of sewers and appurtenances as set forth in these specifications shall be witnessed by a representative of TUA. It is the Developer's and Contractor's responsibility to notify TUA when testing is to be performed. Testing performed without TUA's representative present will not be accepted and shall be re-tested with TUA's representative present prior to final acceptance.

If a sewer installation is not put into use within a nine month period after the completion of testing, the entire system must be retested.

4.02 VISUAL INSPECTION

TUA will make the necessary visual inspections to verify the quality of workmanship. Such inspections shall include examination of manholes, "lamping" or "flashing" sewer lines and observation of clean-up, pavement replacement. Any defects such as misalignment of sewers, visible leaks, obstructions, cracked or broken pipe, or failure to restore the surface to a satisfactory condition must be corrected before acceptance.

4.03 LEAKAGE TESTS

All sewers shall be Air Pressure tested and described below. In addition, sewer lines shall be installed such that infiltration shall not average more than 25 gallons per day per inch of nominal diameter per mile of sewer. These requirements may be applied to any single section of line between two manholes. In order to test such infiltration, TUA may require that the Contractor plug the open ends of all lines at the manhole so that measurements may be made at each section of the sewer line. The infiltration limits set forth above must be met during the worst climate and soil saturation conditions.

In lieu of infiltration tests, TUA may require exfiltration tests. The test shall be performed by applying one foot of water head pressure above the invert at the upstream manhole. The test shall have a duration of one hour and the permissible limits for exfiltration shall be 25 gallons per day per inch of nominal diameter per mile of sewer. These requirements may be applied to any single section of line between two manholes. Water required for the exfiltration test shall be furnished by the Contractor.

Air Pressure Test - Equipment shall be top quality and in good condition. Plugs should have a sealing length equal to or greater than the diameter of pipe being tested. External bracing of the plugs should not be required in order for the plug to hold against internal air pressure. The test equipment shall include accurate pressure gages to monitor test pressure, safety relief valve(s), and quick-release air bleed valve(s).

1. The procedure for air pressure testing shall conform to ASTM C828, unless modified herein.

2. After backfilling and cleaning the line (including flushing, if necessary) making sure all service plugs are adequately braced against internal pipe pressure, and checking air test equipment including pipe plugs (suitably braced against internal pipe pressure, if necessary), the sewer line section to be tested shall be pressurized to 4 psig (pounds per square inch-gage) greater than the average back pressure of any ground water that may be over the pipe (2.31 ft. of water - 1 psig). At least two (2) minutes shall be allowed for air pressure to stabilize. After the stabilization period and with 3.5 psig minimum pressure in pipeline, air supply shall be disconnected and the time observed which results in a 1 psig pressure drop.

3. The portion of line being tested shall be termed "Acceptable" if the time required for the pressure to decrease from 3.5 psig to 2.5 psig (greater than average back pressure of any ground water over pipe) is not less than that stated in the following table:

PIPE DIA. Inches	TIME Sec/100 ft.	ALLOWABLE AIR LOSS Ft. 3/min.
6	42	2.0
8	72	2.0
10	90	2.5
12	108	3.0
15	126	4.0
18	144	5.0
21	180	5.5
24	216	6.0
27	252	6.5
30	288	7.0

4. If the pipe is tested in a "dry" condition and fails to meet the test, specifications allow for the pipe to be wetted and tested in that condition. Initial testing may be in the "dry" or "wet" condition at the Contractor's option.

5. Observe safety precautions during test. Caution all workers to remain clear of test plugs which can blow out under considerable force at any time the line is pressurized.

The Contractor shall furnish all labor, tools, equipment and materials for the test. The tests must be scheduled at a time acceptable to TUA.

4.04 DEFLECTION TESTING

TUA may require the Contractor to perform random deflection tests of PVC pipe prior to final acceptance. Should three successive test locations be unsatisfactory, then the Contractor shall deflection test the entire sewer system. All locations with excessive deflection shall be excavated and repaired by re-bedding or replacement of the pipe.

Deflection testing for PVC pipe shall be made by passing a properly sized go/no-go mandrel provided by the contractor and approved by TUA through the pipe section to be tested with the pipe in place and backfilled. The mandrel size shall be 95% of the actual pipe diameter used. This deflection acceptance test shall be made after backfill consolidation has occurred.

4.05 MANHOLE VACUUM TEST

All manholes shall be subjected to and shall pass a vacuum test of at least 10" Hg. prior to acceptance by TUA. The Contractor shall be responsible for providing the equipment required for testing, including the manhole sealing apparatus, gauges, pump, plugs, and operating personnel. The equipment shall be top quality, and in good condition.

Each manhole shall be tested for acceptance after backfilling. It is recommended that the manhole also be tested before backfilling to facilitate repair if leaks are found. The lift holes shall be plugged with an approved non-shrink grout. The pipes entering the manhole shall be plugged, taking care to securely brace the plugs to prevent them from being drawn into the manhole.

With the vacuum tester set in place on top of the cone section of the manhole:

1. Inflate the compression band seal in accordance with the manufacturer's recommendations.

2. Connect the vacuum pump to the outlet port with the valve open and draw a vacuum of 10 inches of mercury (Hg.).

3. Close the valve and shut off vacuum pump.

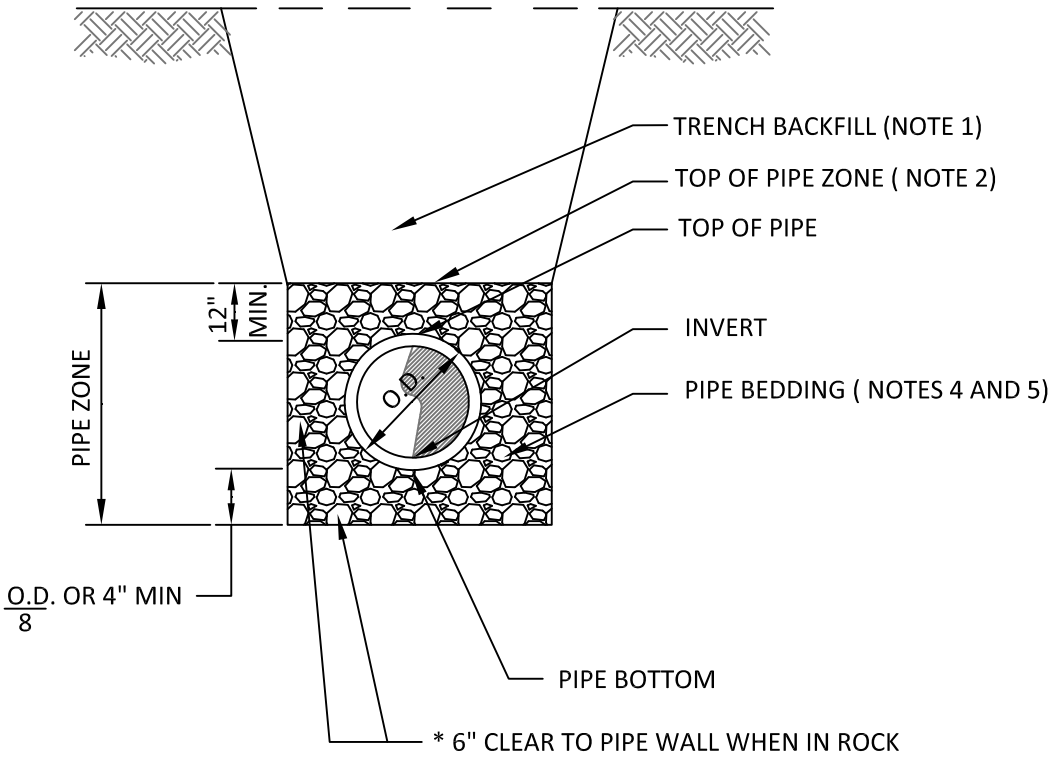
4. Measure the time elapsed for the vacuum to drop to nine (9) inches Hg.

5. The manhole shall pass if the time for the vacuum to drop to nine (9) inches Hg. is greater than or equal to one (1) minute for standard 48" diameter manholes, or two (2) minutes for 60" and 72" diameter manholes.

If the manhole fails the vacuum test, necessary repairs shall be made with an approved non-shrink grout while the vacuum is being drawn. Retest as above until a satisfactory test is obtained.

NOTES:

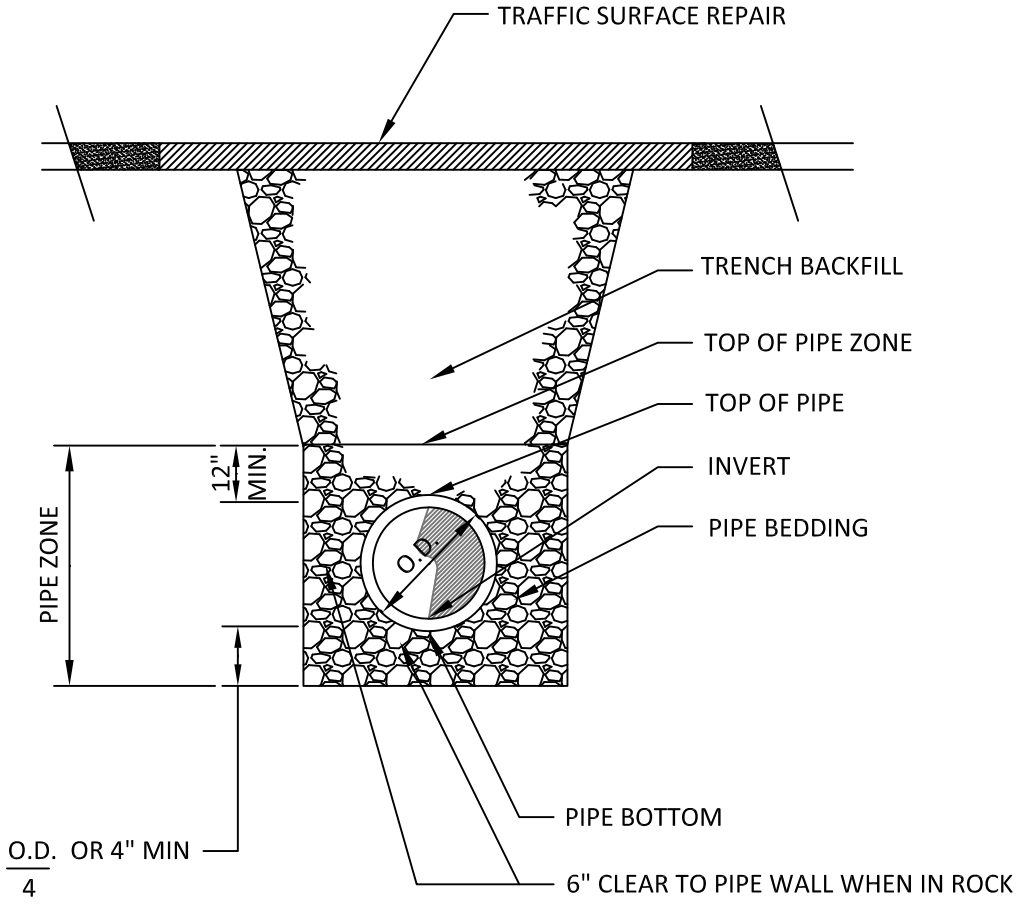
1. SEE STANDARD SPECIFICATIONS FOR BACKFILL REQUIREMENTS.
2. "PIPE ZONE" EXTENDS TO 12" ABOVE THE TOP OF PIPE AND BACKFILL IS TO BE CRUSHED STONE, GRAVEL OR OTHER GRANULAR MATERIAL AS APPROVED BY THE THE ENGINEER.
3. LIMIT TRENCH WIDTH AT TOP OF PIPE ZONE TO O.D. + 16" UNLESS OTHERWISE PERMITTED BY ENGINEER.
4. PIPE BEDDING IS TO BE CRUSHED STONE, GRAVEL OR OTHERWISE APPROVED GRANULAR MATERIAL BY THE ENGINEER. DEPTH UNDER BOTTOM OF PIPE IS TO BE 1/8 O.D. OF PIPE OR 4", WHICHEVER IS GREATER.*
5. PIPE IS TO BE CONTINUOUSLY SUPPORTED ALONG LENGTH OF PIPE BARREL EXCEPT AT BELLS. HOLES ARE SUCH THAT NO BEARING LOAD IS TAKEN OUT BY THE BELL.



TUA	TULLAHOMA UTILITIES AUTHORITY		
	TYPICAL SEWER INSTALLATION S-1		
	DRAWN BY: M.K.E.	DATE: 11-13-2009 REVISED 11-20-2020 by LGT	NOT TO SCALE

NOTE:

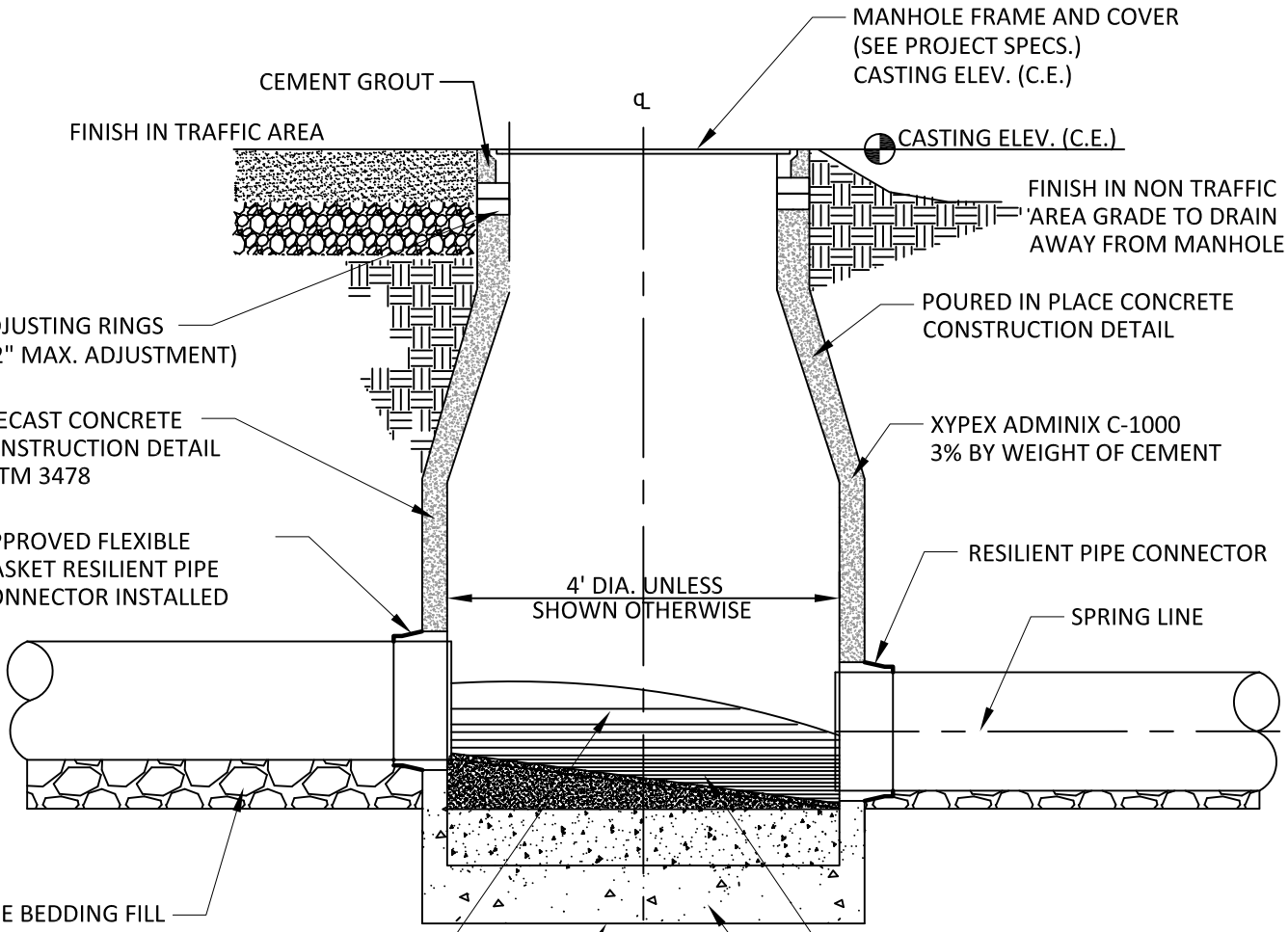
SEE PROJECT SPECIFICATIONS FOR TRENCHING, BEDDING, PIPELAYING, BACKFILLING, TRAFFIC SURFACE REPAIR, AND OTHER PERTINENT REQUIREMENTS IN TRAFFIC AREAS.



TUA	TULLAHOMA UTILITIES AUTHORITY		
	SEWER LINE INSTALLATION IN TRAFFIC AREAS S-2		
	DRAWN BY: M.K.E.	DATE: 11-19-2009 REVISED 11-20-2020 by LGT	NOT TO SCALE

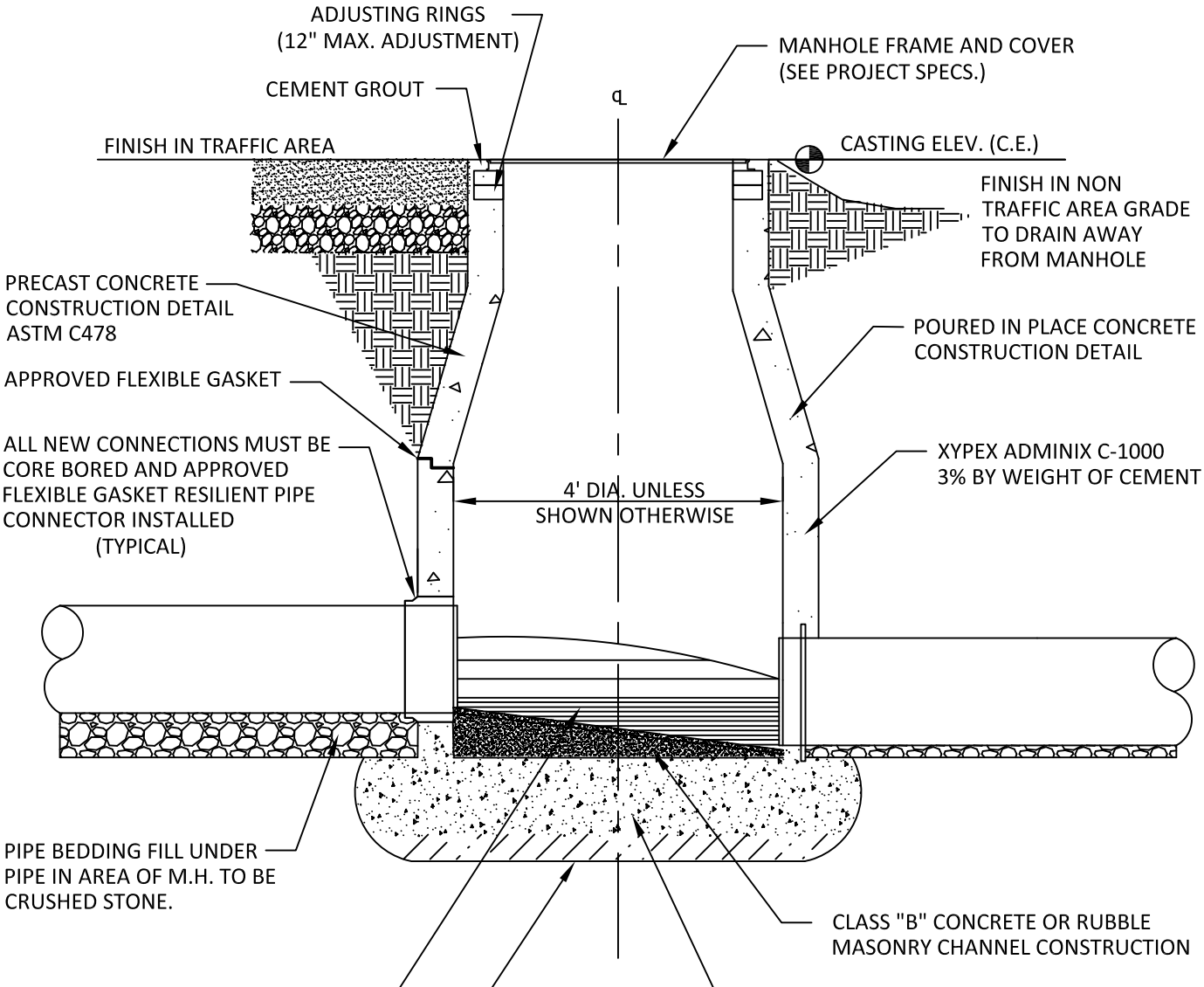
NOTE: MANHOLE DIAMETER SIZING SHALL BE AS FOLLOWS:

LINE SIZE	MANHOLE DIAMETER
12" AND LESS	4' DIA.
15" THRU 24"	5' DIA. OR AS DIRECTED

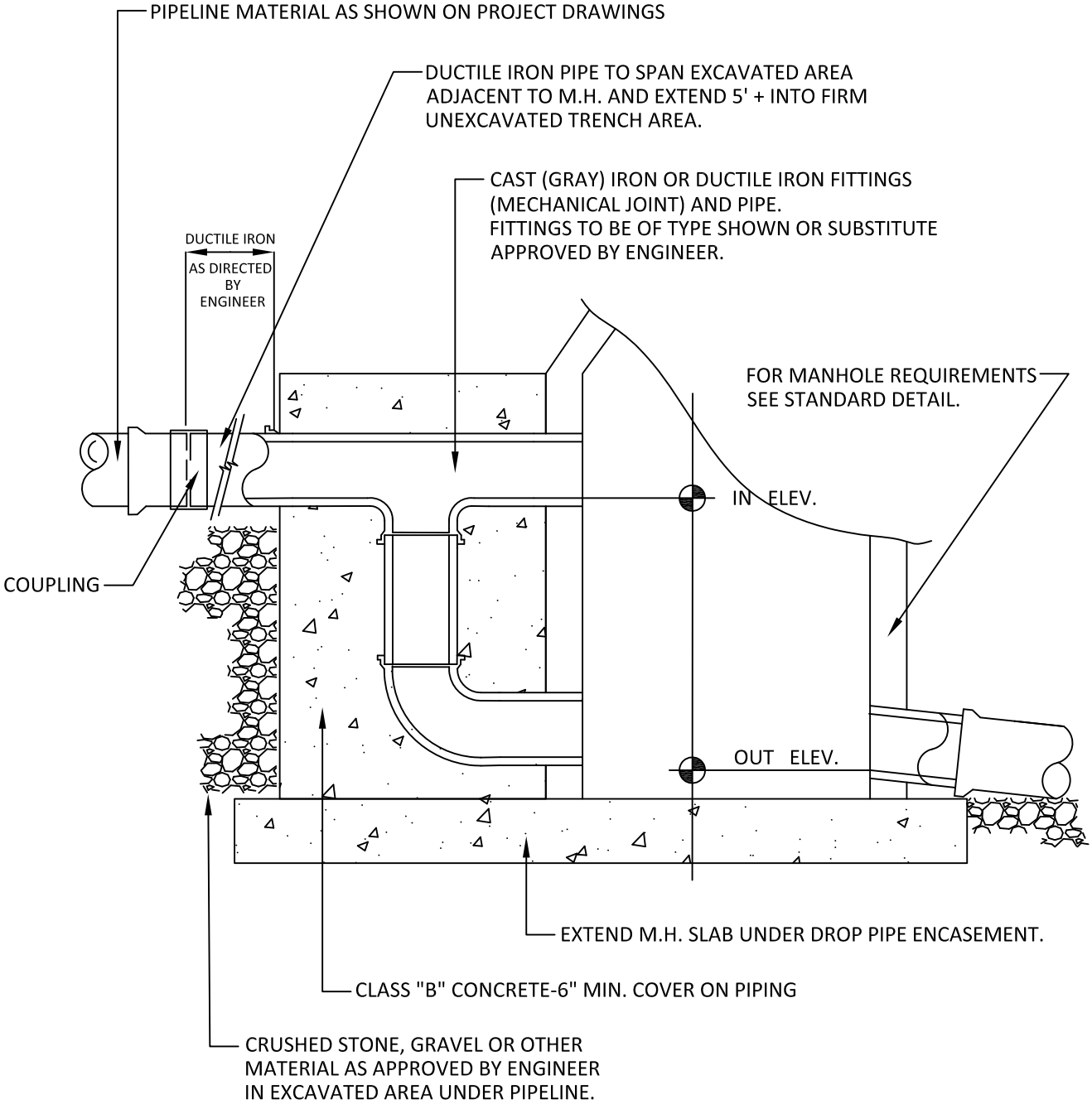


EACH MANHOLE SHALL HAVE A DESIGN DROP OF AT LEAST 0.1 FOOT AT THE MANHOLE CENTERLINE.

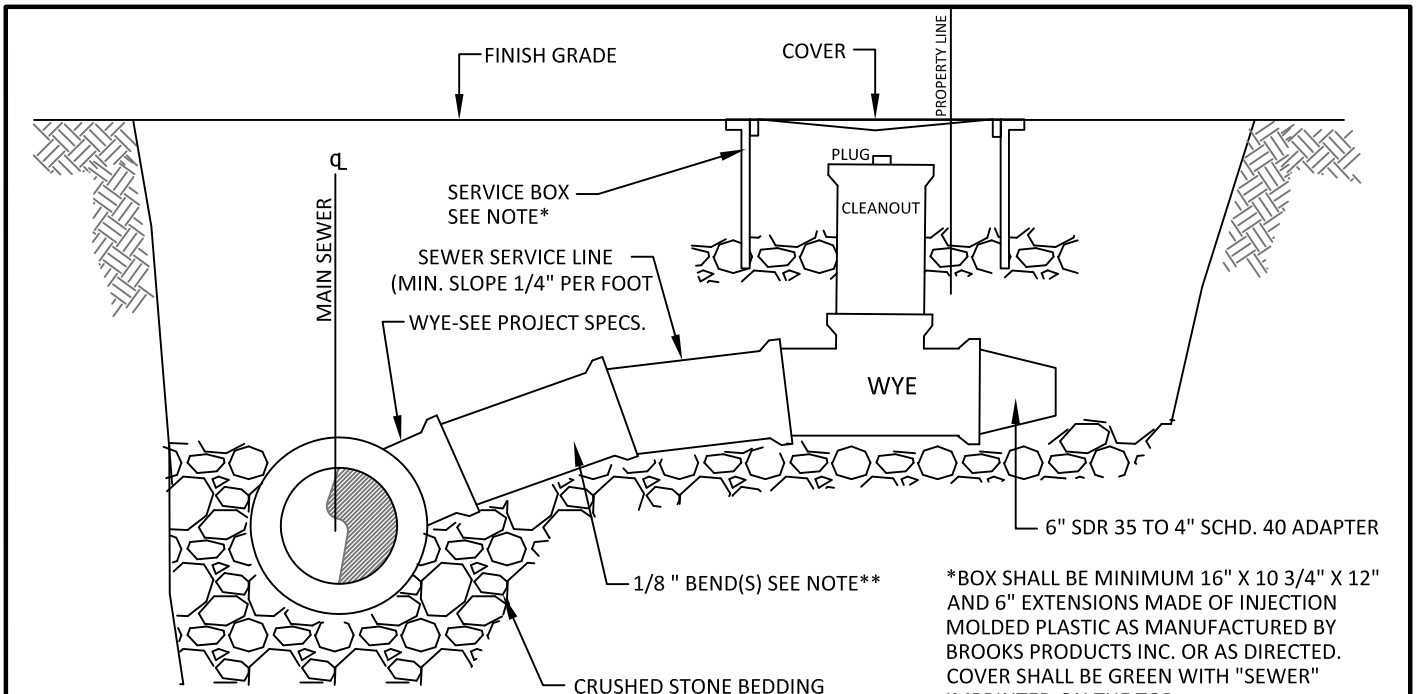
TUA	TULLAHOMA UTILITIES AUTHORITY		
	STANDARD MANHOLE S-3		
	DRAWN BY: M.K.E.	DATE: 11-16-2009 REVISED 11-23-20 by LGT	NOT TO SCALE



TUA	TULLAHOMA UTILITIES AUTHORITY		
	CONNECTION TO EXISTING MANHOLE S-4 (PRECAST & POURED IN PLACE CONSTRUCTION)		
	DRAWN BY: M.K.E.	DATE: 11-16-2009 REVISED 11-24-2020 BY LGT	NOT TO SCALE



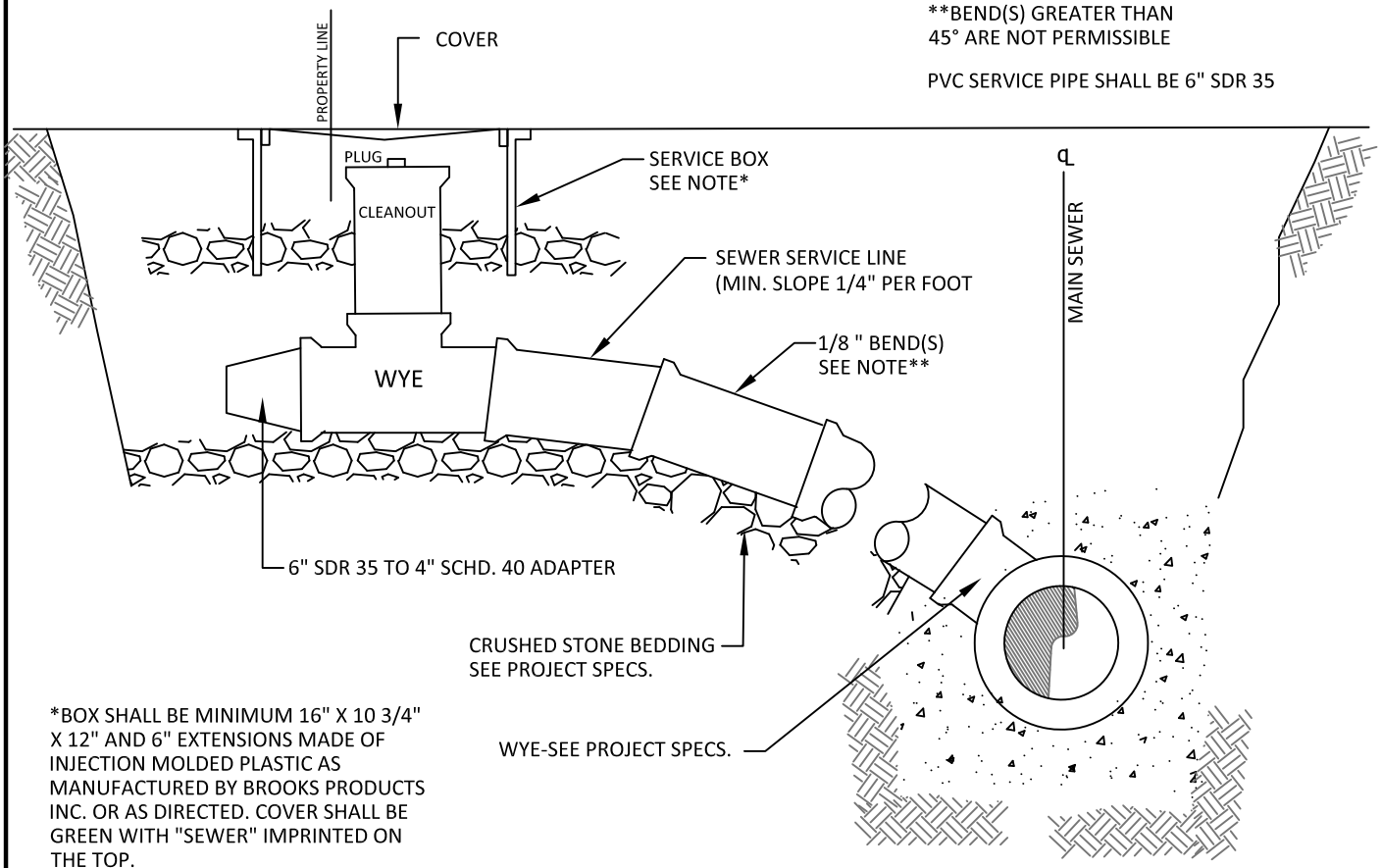
TUA	TULLAHOMA UTILITIES AUTHORITY		
	DROP MANHOLE REQUIREMENTS S-5		
	DRAWN BY: M.K.E.	DATE: 11-18-2009 REVISED: 11-30-2020 by LGT	NOT TO SCALE



*BOX SHALL BE MINIMUM 16" X 10 3/4" X 12" AND 6" EXTENSIONS MADE OF INJECTION MOLDED PLASTIC AS MANUFACTURED BY BROOKS PRODUCTS INC. OR AS DIRECTED. COVER SHALL BE GREEN WITH "SEWER" IMPRINTED ON THE TOP.

**BEND(S) GREATER THAN 45° ARE NOT PERMISSIBLE

PVC SERVICE PIPE SHALL BE 6" SDR 35



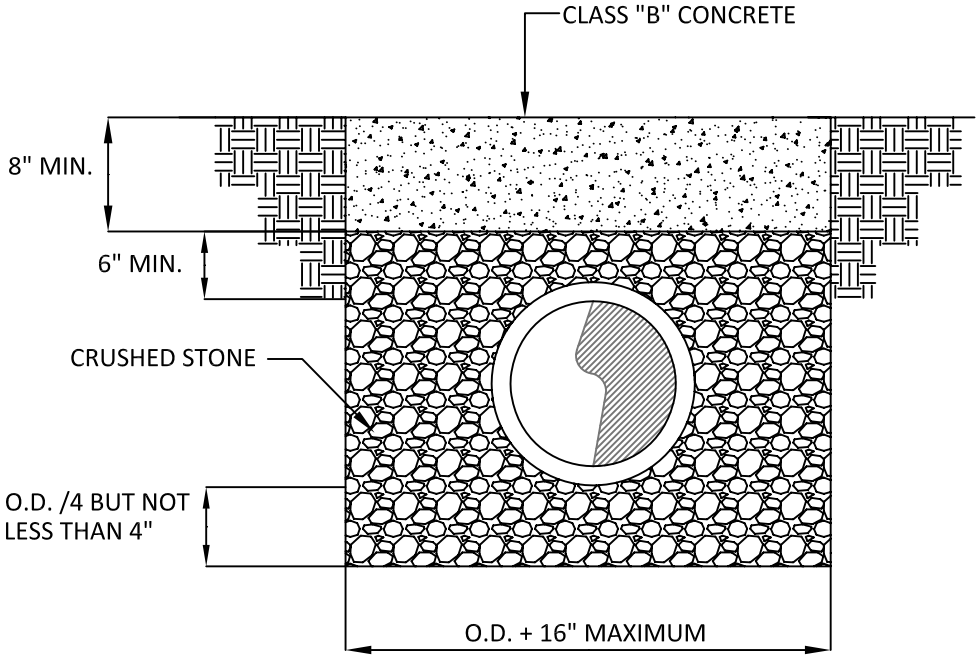
*BOX SHALL BE MINIMUM 16" X 10 3/4" X 12" AND 6" EXTENSIONS MADE OF INJECTION MOLDED PLASTIC AS MANUFACTURED BY BROOKS PRODUCTS INC. OR AS DIRECTED. COVER SHALL BE GREEN WITH "SEWER" IMPRINTED ON THE TOP.

**BEND(S) GREATER THAN 45° ARE NOT PERMISSIBLE

PVC SERVICE PIPE SHALL BE 6" SDR 35

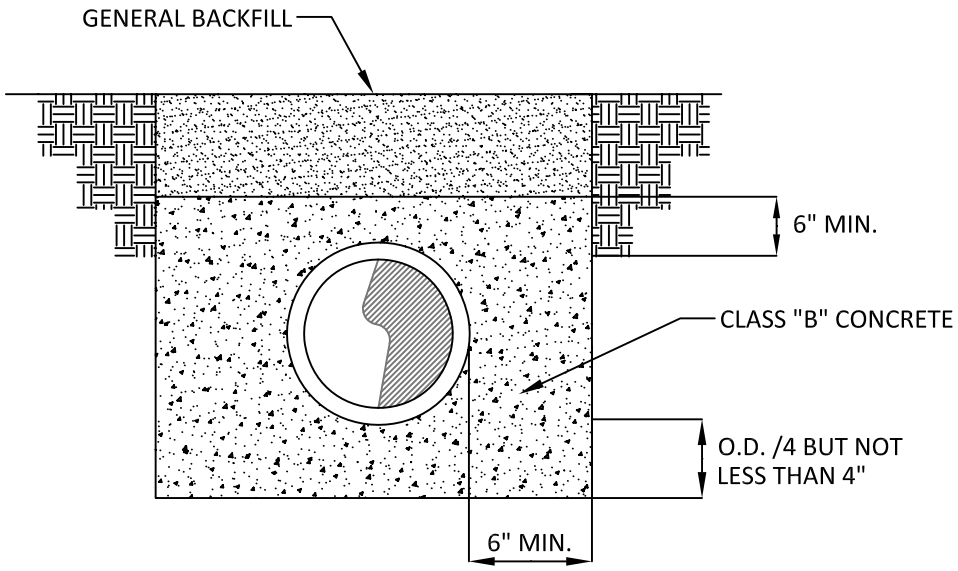
TUA	TULLAHOMA UTILITIES AUTHORITY		
	DEEP AND NORMAL DEPTH SEWER SERVICES S-6		
	DRAWN BY: M.K.E.	DATE: 11-13-2009 REVISED 12-01-2020 by LGT	NOT TO SCALE

CONCRETE CAP



NOTE: TO BE USED WHERE NOTE ON DRAWINGS REQUIRES PIPE TO BE ENCASED OR CAPPED WITH CONCRETE OR WHERE THE ENGINEER DIRECTS CONCRETE TO BE POURED

CONCRETE ENCASEMENT



TUA	TULLAHOMA UTILITIES AUTHORITY		
	CONCRETE CAP & ENCASEMENT DETAILS S-7		
	DRAWN BY: M.K.E.	DATE: 11-18-2009 REVISED: 12-01-2020 by LGT	NOT TO SCALE