

WPN15-0393

WASTEWATER COLLECTION - CONSTRUCTION SPECIFICATIONS

June 2015 Edition

SEWER ONLY

**THE CITY OF ALCOA, TENNESSEE
PUBLIC WORKS & ENGINEERING DEPARTMENT
WATER AND SEWER SERVICES**

TN DEPT OF ENVIRONMENT
AND CONSERVATION
JUN 16 2015
DIV OF WATER RESOURCE
RECEIVED



CITY OF ALCOA

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

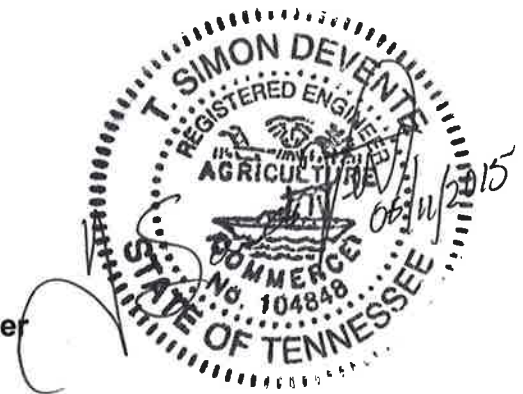
JUL 15 2015

THIS APPROVAL IS VALID FOR ONE YEAR
THE 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 DESIGN GOAL FOR THE COMMISSIONER.

BY *Adrian Bahar* EPS I
TITLE

APPROVAL EXPIRES
JUL 15 2018
TENNESSEE DEPARTMENT OF ENVIRONMENT & CONSERVATION
DIVISION OF WATER RESOURCES

**Simon deVente, P.E.
Assistant Director/Chief Engineer**



FOREWORD

These specifications have been compiled to assist in the orderly design and construction of Alcoa's wastewater collection system. Combined with the construction specifications for the water and street & drainage systems, documented procedures have been established that will benefit City of Alcoa staff, City Commission, Regional Planning Commission, and other City committees in the construction, operation, and maintenance of the City's infrastructure system. Just as important, these specifications provide a framework for developers, engineers, and others who are involved with the construction of street, drainage, water and sanitary sewer system improvements in private developments.

Any further reference to "the City" shall mean the 'City of Alcoa Public Works & Engineering Department'

The development of these specifications was a combined effort. The basis for the wastewater collection system construction standards are the Tennessee Department of Environment and Conservation Regulations and Guidelines. City staff reviewed and modified the requirements to closely fit the practices desired for the City service area. Key staff members involved in that work were:

- Simon deVente, P.E., Assistant Director/Chief Engineer
- **Shane Snoderly, Civil Engineer II**
- Kenneth Hendrix, Public Works Inspector II
- Junior Neeley, Lead Worker
- Danny Ogle, Utility Lead Worker
- Mark Ross, Construction Services Supervisor
- Randy Slagle, Utility Lead Worker
- Kenneth D. Wiggins, P.E., Public Works & Engineering Director

The assembly of comments and suggestions from each of these individuals resulted in these Wastewater Collection – Construction Specifications for the City of Alcoa Public Works & Engineering Department.

REFERENCE INDEX

The purpose of this Reference Index is to catalog by name and address those agencies, associations and others who are referred to in these Standards by their initials.

AASHTO	American Assn. of State Highway and Transportation Officials 444 N. Capitol St., NW http://www.transportation.org/	Washington, DC 20001
ANSI	American National Standards Institute 1819 L Street, NW, Suite 600 http://www.ansi.org/	Washington, DC 20036
ASTM	American Society for Testing and Materials 1916 Race Street http://www.astm.org/	Philadelphia, PA 19103
AWWA	American Water Works Assn. 6666 W. Quincy Ave., http://www.awwa.org	Denver, CO 80235
DIPRA	Ductile Iron Pipe Research Association 245 Riverchase Parkway, E., Suite 0 http://dipra.org/	Birmingham, AL 35244-1856
HI	Hydraulic Institute 30200 Detroit Road http://www.pumps.org/	Cleveland, OH 44145
NFPA	National Fire Protection Association 1 Batterymarch Park http://www.nfpa.org/	Quincy, MA 02169-7471
NSF	National Sanitation Foundation Testing Laboratory, Inc. P.O Box 1468 http://www.nsf.org/	University of Michigan Ann Arbor, MI 48106
TDEC-DWR	Tennessee Department of Environment and Conservation Division of Water Resources Tennessee Tower – 2 nd Floor http://www.tennessee.gov/environment/water/	312 Rosa Parks Ave. Nashville, TN 37243-1534
UL	Underwriters Laboratories, Inc. 333 Pfingsten Road http://ul.com/	Northbrook, IL 60062-2096

SECTION 2
WASTEWATER COLLECTION SYSTEM
TABLE OF CONTENTS

Forward.....	2
Reference Index.....	3
Table of Contents.....	4
2.0 <u>SYSTEM DESIGN</u>	
2.0.1 - Pre-Design Conference	6
2.0.2 - Design Basis.....	6
2.0.3 - Design Factors.....	6
2.0.4 - Plans and Specification Approvals	7
2.1 <u>DETAILS OF DESIGN OF WASTEWATER COLLECTION LINES</u>	
2.1.1 - Minimum Size	9
2.1.2 – Depth	9
2.1.3 – Slope.....	9
2.1.4 – Alignment	9
2.1.5 - Increasing Size	9
2.1.6 - Surface Water Crossings.....	10
2.1.7 - High Velocity Protection.....	10
2.1.8 - Pipe Bedding	10
2.1.9 - Joints and Infiltration.....	10
2.1.10 - Manholes	10
2.1.11 - Protection of Water Supplies	11
2.1.12 - Force Mains.....	12
2.1.13 - Wastewater Lift Stations	12
2.1.14 - Low Pressure Sanitary Sewer Collection Systems.....	13
2.1.15 – Easements	14
2.2 <u>PRODUCTS</u>	
2.2.1 – General	15
2.2.2 - Pipe – Gravity	15
2.2.3 - Pipe – Pressurized Main	16
2.2.4 - Concrete Materials.....	17
2.2.5 - Manholes	17
2.2.6 - Air Release Valves	22
2.2.7 - Valves – Pressurized Main (Force Main)	22
2.2.8 - Clean Outs / Flushing Stations - Pressurized Main (Force in)	22
2.2.9 - Grinder Pump Units – Low Pressure Sewer Systems	22
2.2.10 - Pipe Casing & Bores	23
2.3 <u>CONSTRUCTION OF WASTEWATER COLLECTION LINES</u>	
2.3.1 - Pre-Construction Activities	24
2.3.2 - Soil Erosion Control	25
2.3.3 - Preparation	26
2.3.4 - Installing Gravity Sanitary Sewers	27

2.3.5 - Installing / Repairing Sanitary Sewer Lines in Street, Highway, and Railroad Rights-of-Way.....	29
2.3.6 - Initial Proof Testing of Sanitary Sewers.....	29
2.3.7 - Final Testing.....	29
2.3.8 - Installing Manholes.....	30
2.3.9 - Vacuum Testing.....	32
2.3.10 - Sewer Service Assemblies.....	33
2.3.11 – Low Pressure Sanitary Sewer Placement & Testing.....	34
2.3.12 - Warranty Inspection.....	34
2.4 <u>STANDARDS FLEXIBILITY</u>	
2.4.1 - Interpretations of these Standards and Design Criteria.....	35
2.4.2 - Right of Appeal.....	35
<u>Appendix A.1</u> - Table for Design Basis for New Sanitary Sewer	
<u>Appendix A.2</u> - TDEC Hydraulic Design Criteria Table	
<u>Appendix B</u> - Water & Wastewater Construction Specifications - List Of Cited Standards	

Standard Drawings

SECTION 2

WASTEWATER COLLECTION SYSTEM

2.0 SYSTEM DESIGN

2.0.1 Pre-Design Conference

Prior to the design of a wastewater collection system extension, the design **Engineer / Engineer of Record (here after referred to as "the Engineer")** should first confer with the City Planner (or the Planner of the appropriate Planning region) in regard to growth potential and density that may be expected in the general area of the extension being planned. A **pre-design** conference with the Alcoa Public Works & Engineering Department staff **shall** follow to discuss customer needs, system requirements and standards & specifications as well as any coordination or other issues related to the mains being extended. **In residential, commercial, and industrial developments, fittings and piping for sanitary sewer service connections shall be furnished and installed by the developer.** The engineer must be licensed to practice in the State of Tennessee by the Tennessee Department of Commerce and Insurance, Board of Architectural and Engineering Examiners.

2.0.2 Design Basis

- (a) Generally the sewers should be designed to carry, when running full, not less than the following daily per capita contributions of wastewater, exclusive of wastewater from industrial plants:
 - 1. Laterals and sub-main sewers: 400% of average design flow.
 - 2. Main, trunk & outfall sewers: 250% of average design flow.
- (b) In general, wastewater collection extensions shall be designed for the estimated ultimate tributary population.

2.0.3 Design Factors

- (a) In determining the required capacities of sanitary sewers, the following factors must be considered:
 - 1. Maximum hourly quantity of wastewater
 - 2. Additional maximum wastewater from industrial plants
 - 3. Ground water infiltration.
- (b) Typical design flows for various facilities are tabulated in Appendix 1. The flows shown are assumed to include nominal infiltration, but an additional allowance should be made where conditions are unfavorable. However, actual flows shall be used when available.

2.0.4 Plans and Specifications Approval

- (a) Submittal of construction plans, hydraulic calculations and construction specifications for a proposed extension must be submitted accordingly:
1. Hydraulic calculations must be submitted for all receiving lines as provided in Chapter 2 of the TDEC Division of Water Resources, see Appendix 2-A;
 2. Initially to the Alcoa Public Works & Engineering Department for approval;
 3. Then to the Tennessee Department of Environment and Conservation, Division of Water Pollution Control, for approval;
 4. Plans must be submitted to TDEC within 30 days of City of Alcoa approval; a copy of the TDEC-WPC approval letter and two (2) stamped approved sets of drawings must be submitted to the City; and
 5. Approval shall expire twelve (12) months from the date of the TDEC approval date.

Upon completion of the project and prior to sale(s) of individual service(s) and/or obtaining a Certificate of Occupancy (C.O.), the design engineer shall prepare detailed plans to reflect as constructed As-Built. As-Built plans shall be submitted to the City:

1. Two sets on reproducible sheets (e.g. Mylar),
2. In digital format, AutoCAD (dwg or dxf format) and in PDF format, compatible with the City's mapping system,
3. Four (4) copies of applicable Operations & Maintenance manuals must be delivered prior to or with the as-builts, and
4. All applicable easement drawings and documents, recorded at the Blount County Register of Deeds office.

Hand revised or cloud revision construction sheets will not be accepted as As-Builts.

- (b) Each plan sheet shall bear an appropriate title block showing the name of the project, location, owner, engineer, date, scale in feet, true north where applicable, sheet number and revision data. The title block must be located at the bottom or right hand side of the sheet, readable from the bottom or right hand side.

Each sheet shall contain a blank area at least 4-inches by 6-inches near the title block for imprinting the official "Approved for Construction" stamps of the Tennessee Department of Environment and Conservation and the Public Works Department of the City of Alcoa. Plans shall be clear and legible and shall conform to the requirements of the Alcoa Public Works & Engineering Department's Standards. Plans shall be on sheets 24-inches by 36-inches.

- (c) Plans of Sewers:

Plans shall comply with Rules of the Tennessee Board of Examiners for Land Surveyors Chapter 0820-03 "Standard of Practice" and shall include information as provided in Section 0820-03-.07 (2) "Topographic Surveys". A plot plan of the existing and proposed sewers shall be submitted for projects involving substantial additions to the existing sewer system. The plan shall show the location, size and direction of flow of all existing and proposed sewers. Hydraulic calculations are required for all lines in the project.

All lines receiving discharge from the project shall be shown to be adequate. A vicinity map must accompany all sewer line extensions. For projects involving multiple sewer lines, include a project map showing the overall layout of the entire project.

- (d) Plan Details: Detail plans shall be submitted. Plans and profiles are required for all wastewater lines. Profiles should have a horizontal scale of not more than 50 feet to the inch. The vertical scale of profiles shall not be more than 10 feet to the inch. The plan view should be drawn to a corresponding horizontal scale. Plans and profiles should be drawn on the same sheet and must contain the following:
1. Scaling for plan & profile drawings should be 1:20 or 1:30 in congested areas and 1:40 or 1:50 in non-congested areas for the plan view. The profile area should have a scaling ratio of 10 horizontal to 1 vertical.
 2. Location of streets and sewers; line of ground surface; size, material and type of pipe for the main and service lines; length between manholes; invert and surface elevation at each manhole; location and size of service lines and taps; and grade of sewer between each two adjacent manholes. All manholes shall be numbered on the plans and correspondingly numbered on the profiles.
 3. Stationing of the sewer line at 100-foot intervals and locations of all appurtenances by stationing shall be shown on the plan and profile. Where there is any question of the sewer being sufficiently deep to serve any residence or other source, the elevation and location of the basement floor or other low point source shall be plotted on the profile of the sewer which is to serve the house or source in question.
 4. Whenever possible, sewer service lines shall discharge into a manhole.
 5. Locations of all special features such as inverted siphons, concrete encasements, elevated sewers, etc.
 6. Structures both above and below ground which might interfere with the proposed construction, particularly water mains, gas mains, storm drains, etc.
 7. Easements, lot and right-of-way lines and corners to be in place at the completion of the project. Provide lot numbers, street names and proposed edge-of-pavement.
 8. Other utilities shall be drawn on the sheet except for clarification or reference and shall be a reduced line weight and/or grey scale color from the design utility.
 9. Permanent Bench Mark based on USGS Datum referenced to Tennessee NAD 83 Coordinate System. Additional Bench Marks will be required when the project area exceeds 2000 feet in length.

2.1 DETAILS OF DESIGNING OF WASTEWATER COLLECTION LINES

2.1.1 Minimum Size

No sewer main shall be less than 8 inches in diameter. No service line shall be less than 6 inches in diameter.

2.1.2 Depth

In general, sewers should be deep enough to drain basements and to prevent freezing; where practical, a minimum depth of 5 feet should be maintained.

Maximum depth of bury or cover will be determined by pipe material, conditions of bury and future use subject to manufacturer's limits of bury.

2.1.3 Slope

All sewers shall be so designed and constructed to give mean velocities, when flowing half full, of not less than 2.0 feet per second. The minimum recommended slopes for 8-inch through 12-inch sewer mains are shown below. However, these slopes should be used only when required. All sewers shall be laid with uniform slope between manholes.

SEWER SIZE	RECOMMENDED MIN. SLOPES
8-inch	0.522 ft. / 100 ft.
10-inch	0.387 ft. / 100 ft.
12-inch	0.304 ft. / 100 ft.

Sewers larger than 12-inch diameter shall be designed in compliance with the latest TDEC-DWR standards. Where existing sanitary lines installed prior to 1985 and are being replaced as part of a line rehabilitation project, slopes for these lines should meet minimum TDEC-DWR standards.

2.1.4 Alignment

Sewers shall be designed with straight alignment between manholes.

2.1.5 Increasing Size

When a smaller sewer joins a larger one, the invert of the larger sewer should be lowered sufficiently to maintain the same energy gradient. An acceptable approximate method for securing these results is to place the 0.8 depth point of both sewers at the same elevation.

2.1.6 Surface Water Crossings

Surface water crossings, both under and over water, present special problems which should be discussed with the Alcoa Public Works & Engineering Department; the Tennessee Department of Environment and Conservation, Division Water Resources; and the U.S. Army Corps of Engineers before plans are prepared. Should permits be required, the Engineer of Record shall apply for the required permits and submit required fees.

2.1.7 High Velocity Protection

Ductile iron pipe shall be used when slopes are greater than:

SEWER SIZE	MAX. SLOPE
8-inch	18%
10-inch	13%
12-inch	9%

Sewers larger than 12-inch diameter shall be designed in compliance with the latest TDEC-WPC standards.

2.1.8 Pipe Bedding

All sewers shall be designed to prevent damage from superimposed loads. Proper allowance for loads on the sewer shall be made because of the width and depth of trench. As a general rule, ductile iron pipe or concrete encasement shall be used in vehicular traffic areas where cover is less than 4 feet, or in open areas where cover is less than 2-1/2 feet. Ductile iron pipe shall be required when sewer installation occurs in areas of non-virgin soil (i.e. areas of "fill"). Piers shall be provided when necessary for support. For structural reasons, ductile iron pipe, concrete encasement, or relocation shall be required when culverts or other conduits are laid such that the top of the sewer is less than 18 inches below the bottom of the culvert or other conduit.

2.1.9 Joints and Infiltration

Sewer joints should be designed to minimize infiltration and to prevent the entrance of roots. Standard laying lengths for PVC pipe shall not exceed 13.5 feet.

2.1.10 Manholes

- (a) Location: Manholes shall be installed at the upper end of each collection sewer line, at all changes in grade, at all changes in horizontal direction, at points of changes in size, at all pipe intersections, and at distances not greater than 1,000 feet.
- (b) Drop Manholes: A drop pipe shall be provided for a sewer entering a manhole at an elevation of 24 inches or more above the manhole invert. Where the difference in elevation between the incoming sewer and the manhole invert is less than 24 inches, the

invert should be U-shaped to prevent deposition of solids.

(c) Diameter: The minimum inside diameter of manholes shall be 48 inches. The entrance tube shall be at least 24 inches in diameter (inside).

(d) Invert Flow Angle: The minimum angle of a pipe invert with flow coming into the manhole shall be 90 degrees from the outlet pipe invert. When it is impossible to obtain this angle the inlet pipe must be a drop, splash or constructed invert above the flow channel installed in a manner that does not inhibit normal flow through the manhole.

(e) Manholes are not to be located in low lying areas where storm water runoff or other flows may extend to within 12 inches of the top of the manhole unless design and constructed to include watertight frames and covers and/or other means to prevent the intrusion of surface water.

(f) All manholes whose top of casting is lower than the top of a pump station wet well where their flows terminate shall have water-tight lids.

(g) Manhole receiving force main discharge shall comply with Sections 2.2.5(a)8 or Section 2.3.8(o) of these specifications.

2.1.11 Protection of Water Supplies

(a) Water Supply Interconnections: There shall be no physical connection between a potable water supply line and a sewer or appurtenance thereto which would permit the passage of any wastewater or polluted water into the potable supply.

(b) Horizontal Separation: Sewers should be installed at least 10 feet from any existing or proposed water pipe. Should local conditions prevent a lateral separation of 10 feet, a sewer may be laid closer to the water main if (1) it is installed in a separate trench and (2) the elevation of the top of the sewer pipe is at least 18 inches below the bottom of the water pipe.

(c) Vertical Separation: Whenever a sewer must cross under a water main, the sewer shall be installed at such elevation that the top of the sewer is at least 18 inches below the bottom of the water main. When the elevation of the sewer cannot meet the above requirement, the water main shall be (1) relocated to provide the separation or (2) reconstructed with ductile iron pipe for a minimum distance of 10 feet on each side of the sewer. At least one full length of water main should be centered over the sewer so that both joints shall be as far from the sewer as possible.

(d) When it is impossible to obtain proper horizontal and vertical separation as stipulated above, both the water and sewer mains shall be constructed to water line standards and shall be pressure-tested to assure watertightness.

2.1.12 Force Mains

- (a) Velocity: At design flow, velocity in excess of two feet per second shall be maintained.
- (b) Air Release Valve: An automatic air release valve shall be placed at high points in the force main to prevent air-locking.
- (c) Termination: Force mains shall terminate in the invert of a manhole.
- (d) Pipe diameter: Force mains are to be a minimum of 4 inches in diameter.
- (e) A maximum Hazen and Williams "C" factor of 130 shall be used regardless of the pipe material.

2.1.13 Wastewater Lift Stations

In general lift stations should be of the submersible or wet well/dry sump packaged configuration. Other designs may be considered for installation. Designs must conform to the requirements of ANSI/HI 1.1 through 9.8. Wet wells should include capacity for submergence, sump and storage cumulatively. Storage shall be determined from the point of lead pump start. Wet wells and /or dry sumps whose depth exceeds 12 ft must be evaluated for increased foundation size and a report provided for geotechnical bearing capacity of the soils at the wet well location.

Sites must be evaluated for local storm water runoff, ensure the runoff is deflected away from the station and passing runoff is non-erosive. Pipe entries into the wet well shall be in accordance with TDEC requirements. The site within 20 feet of the pump station shall have a finished grade slope of no greater than 2.5%. Acceptable submersible designs must be of a non-clog design and be able to pass a 3-inch solid.

Unless specifically exempted, the design and construction of all lift stations shall include a paved (asphalt or concrete) driveway, minimum 8-foot high 9-gauge barbed top chain-link fence enclosing the site, minimum 12-foot wide gate for access, and a permanent potable water supply. Potable water yard hydrants shall be located 10 feet or greater from the pump station/wet well; Separation of potable and sanitary lines shall be maintained as required/practicable.

Ultrasonic and bubbler type level sensors are acceptable. Piping shall include bypass piping with header piping outside the pump station wall terminating with male OPW type quick connect fittings. An exhaust blower for ventilation must be provided to the pump house or dry sump, turning on at 70°F and off at 55°F. The exhaust blower shall also be automatically activated when the entry hatch is opened and may be manually operated. Each pump shall have an approved bourdon-type pressure gauge to monitor discharge pressure. All valves must be non-rising stem gate valves. Portable heater and dehumidifier must be supplied with each station.

All electrical equipment must conform to the latest AIEE and NEMA standards and must have UL approval. The control unit must be SCADA (Supervisory Control and Data Acquisition) ready and must be integrated with the City of Alcoa SCADA system. and the SCADA must have – at a minimum – signals/displays for wet well level, pump run status, high level alarm, high sump alarm, discharge pressure, power phase fault, RTU AC power failure, and wet well & pump house/dry sump intrusion alarms. A digital display shall be mounted on the front of the control

panel to display level settings, current level and pump run status.

Plans and specifications must be submitted to the Alcoa Public Works & Engineering Department for approval. Plans and specifications shall include manufacturer's design submittal including pump curves, proposed station configuration and data. Prior to final acceptance of the constructed station, four (4) sets of installation and operating manuals and two sets of as-built drawings (one reproducible hardcopy and one electronic) shall be submitted. Two (2) sets of installation and operating manuals on CD (compact disk) MS Word or PDF format may be substituted for two (2) hardcopy sets.

2.1.14 Low Pressure Collection Systems

Low pressure sewer systems may be constructed where gravity sewer is extremely costly, impractical or inaccessible. A minimum velocity of 2 fps shall be designed for all lines. Grinder type pumps are only allowed (1) for users connecting to a low pressure sewer system or (2) when necessary for a user to access a gravity line that will not serve the premises by gravity flow.

A low pressure sewer system is defined as an engineered branching network of small grinder pump stations at each wastewater source that pumps into low pressure force mains (lines ranging in size from 1 1/4-inch to 6-inch) that combine to a single discharge directly into a gravity collector sewer or a conventional sewage pump station and is designed around a sole source manufactured grinder pump. When a grinder pump is tied to a gravity system, the grinder pump and all appurtenances remain the property and maintenance of the user.

Only grinder pumps shall be tied to a low pressure sewer system; the slurry produced by the grinder pump must pass through a minimum 1-1/4-inch service line. The designed system must utilize pumps that do not allow backflow conditions. The low pressure grinder pump unit(s) shall be water tight and must be located above the seasonal ground water table.

The serviced building/residence/structure shall have a sufficient electrical distribution panel to provide electrical power to operate the low pressure grinder pump unit and controls. Underground circuits must be provided to the pump unit. The pump control box shall have an audible and visual alarm mounted to the servicing building and, where practical, visible from the front of the lot. Electrical service shall be paid by the owner/tenant of the serviced unit.

Spare core pump units shall be supplied to the Alcoa Public Works & Engineering Department based on the total grinder pumps to be installed in a fully built out development/complex. Table 2.1.14a provides spares required to be delivered.

TABLE 2.1.14.1 SPARE PUMP REQUIREMENTS		
Pumps Installed		Required Spare(s)
1-10		1
11-20		2
21-40		3
41-60		4
61-100		5
101-200		6

When the number of pump units to be installed exceeds 200, the number of spares to be supplied is 3% of the total pump units.

Low pressure force mains are to be located within the public right-of-way or easements as conditions warrant; standard location for the collector mains is along the front lot line. These mains must be wrapped with a tracer wire during construction. Valves shall be placed on the upstream side of tees on the main and branching lines. The dead ends of all lines in a pressure system shall have a clean out with threaded connection in a ground level valve box.

Flushing stations shall be placed at a maximum of every 400 feet and made up of an isolation valve with a valved flushing connection on either side. A flushing station shall be built and contained in a single pit.

Air-Release valves shall be installed at 2,500 linear feet intervals on long horizontal runs, at each downward leg of 30 feet or more of drop and at each ascending leg at 2,000-foot intervals, as well as where shown on the plans.

Service line taps shall be 1 ¼" minimum; each service line is required to have installed an isolation valve and check valve installed in ground level valve box. All connections to the low pressure main shall enter vertically into the top of the main.

2.1.15 Easements

Easements are required when lines are installed within proximity or within property not considered public domain or right-of-way. When this occurs area is needed to provide access to conduct maintenance on the utility lines. Plans must show a delineation of this access by the use of easements. Easements must be acquired prior to final approval of plans by the City of Alcoa. A letter of intent and agreement to conditions must be provided with the property owner's signature.

Easement widths vary with depth of the utility line due to the necessary working space to avoid structural damage and to safely access and maintain the lines. The following are guides to easement widths:

TABLE 2.1.15.1 GRAVITY SEWER EASEMENTS		
Depth of Line	Width	Distance from Centerline
Minimum to 11 Feet	15 Feet	7.5 Feet
11 Feet to 20 Feet	25 Feet	12.5 Feet
Greater than 20 Feet	Special Case Design	

TABLE 2.1.15.1 GRAVITY SEWER EASEMENTS		
Depth of Line	Width	Distance from Centerline
Minimum to 11 Feet	15 Feet	7.5 Feet
11 Feet to 20 Feet	25 Feet	12.5 Feet
Greater than 20 Feet	Special Case Design	

2.2 PRODUCTS

2.2.1 General

- a. All materials must be approved by the City per Section 2.3.1(4) of these construction specifications.
- b. Manufacturers may be excluded from use due to non-performance or other material quality issues; the manufacturer shall be notified in writing and a period of performance review shall be conducted by the City. Reinstatement is the burden of the manufacturer who must provide assurances, a quality improvement plan and an extended **suitable** warranty on all supplied materials in writing.
- c. All materials shall be manufactured and assembled in the U.S.A. (domestic) or under U.S. standards (non-domestic) as provided by but not limited to the agencies listed in the reference index of these specifications. Manufacturers of non-domestic materials shall supply documentation/certification of quality control procedures and meeting required standards herein. Submittals for all materials shall be supplied by the material manufacturer and must show or disclose adherence to required standards within these specifications, additionally manufacturers of materials shall include the name and address of the point of manufacturing. When a manufacturer supplies both domestic and non-domestic manufactured materials, domestic manufactured materials are the preferred source by the City.
- d. Unless previously approved all materials used in the construction should be new materials manufactured no earlier than one year prior to the current year. When project material is stored long-term prior to use, it must be done to manufacturer's requirements, in a way to prevent contamination and is subject to rejection due to damage, mishandling and improper storage.

2.2.2 Pipe – Gravity Flow

(a) PVC Pipe:

1. Shall be manufactured from virgin, NSF approved resin conforming to the requirements of ASTM Standard D1784.
2. All PVC pipe shall conform to the requirements of either: 1) ASTM Standard **D3034** and have a Standard Dimension Ratio (SDR) of 35 or, 2) AWWA Standard C900.
3. Gaskets used for joining PVC pipe shall conform to ASTM Standard F477.
4. All PVC pipe shall be clearly marked with the manufacturer's name, nominal diameter; SDR, ASTM **D3034**; or AWWA C900 and NSF approved seal.
5. Use of ASTM **D3034**/SDR35 PVC pipe shall be limited to depths less than twelve (12) feet. Where depths to the sewer invert are twelve (12) feet or more, AWWA C900 PVC pipe or ductile iron pipe shall be used.

(b) Ductile Iron Pipe:

1. As a minimum, ductile iron pipe shall meet the latest requirements of AWWA Standard C150 and C151, min. Class 50 thickness, cement-mortar lined, meeting the latest requirements of AWWA Standard C110, with either mechanical joints or slip-on joints with rubber gaskets. A corrosion-resistant lining may be required when ductile iron pipe is used in close proximity to a lift station discharge or other locations where a corrosive atmosphere is likely.
2. Pipe sections shall be clearly marked with the manufacturer's name, D.I. or Ductile, weight, class or nominal thickness.
3. Ductile iron pipe shall be American, U.S. Pipe, Griffin or McWane pipe, or approval equal.
4. Ductile iron pipe or AWWA C900 PVC pipe shall be required where depths are twelve (12) feet or more to the sewer invert.

(d) Pipe Fittings:

1. PVC pipe fittings shall be manufactured from virgin, NSF approved resin conforming to the requirements of ASTM Standard D1784. Fittings should be supplied from the same manufacturer as the PVC pipe.
2. Ductile Iron and Cast Iron Fittings:
 - i. Ductile iron fittings for use in sewer lines shall be 350 psi pressure rating, cement-mortar lined, mechanical joints, meeting the latest requirements of AWWA Standard C153.
 - ii. Cast iron fittings for use in sewer lines shall be 250 psi pressure rating, cement-mortar lined, mechanical joints, meeting the latest requirements of AWWA Standard C110.
 - iii. A corrosion-resistant lining may be required when ductile iron and/or cast iron fittings are used in close proximity to a lift station discharge or other locations where a corrosive atmosphere is likely.
 - iv. Rubber gasket joints shall meet the latest requirements of AWWA Standard C111.
 - v. Ductile iron or cast iron fittings or other fittings approved by the Engineer shall be used in conjunction with ductile iron and AWWA C900 PVC pipe.

2.2.3 Pipe – Pressurized Main

2.2.3.1 Force Main

- (a) Pipe having a diameter of eight (8) inches in diameter and less, Pressure Class 235, C900 PVC pipe may be used. The pipe must meet the requirements set forth in ASTM Standards D1784 & D2122 for 4-inch through 8-inch pipe designated DR-18. If working pressure exceeds 235 psi for any portion of the main, DIP meeting the requirements of paragraph (b) of this section shall be used.

- (b) Pipe having a diameter greater than eight (8) inches shall be of ductile iron meeting the latest requirements of AWWA Standard C-151, min. Class 50 thickness, coated with a corrosion resistant interior lining with either mechanical joints or slip-on joints with rubber gaskets. Ductile iron pipe shall be either American Cast Iron, U. S. Pipe, Griffin, McWane Pipe, or City of Alcoa approved equal.
- (c) All force main pipe, whether PVC or ductile iron, must be installed with 12-gauge wire to allow post construction tracing / locating.
- (d) Fittings for force mains shall comply with the specifications of the City of Alcoa Public Works & Engineering Department for Water Distribution, **current edition**. A corrosion-resistant lining shall be required for all ductile iron and/or cast iron fittings.
- (e) Thrust restraint shall be installed in accordance with AWWA, DIPRA and manufacturers specifications.

2.23.2 Low Pressure Main

- (a) Low pressure force mains are 1¼ -inch to 3-inch and tied to low pressure grinder pump stations shall be Pressure Class 200, SDR 21 PVC pipe, Schedule 40 PVC or Pressure Class 200, PE 4710, DR 11, PE pipe. SDR 21 pipe shall meet ASTM D1784, Schedule 40 shall meet ASTM D1785 and D2665 and PE 4710 PE pipe shall meet ASTM D3350.
- (b) Low pressure main pipe shall be installed with 12-gauge wire to allow post construction tracing / locating.
- (c) Fittings for force mains shall comply with the specifications of low pressure main pipe, pressure class 200 or greater.

2.2.4 Concrete Materials

Concrete used in conjunction with the installation or repair of sewer lines and appurtenances shall meet the requirements of the City Street & Drainage Construction Specifications, Section 03001 Concrete Work, Class "A" Concrete:

1. Minimum compressive strength: 28 days, 4,000 psi. When cylinders are required for testing, a minimum of three (3) cylinders is required.

2.2.5 Manholes

(a) General Requirements

Manholes shall be precast reinforced concrete meeting the requirements of ASTM Standard C478 except as may be provided otherwise in the following. Where flows may exist at less than 2 fps or where sanitary force mains enter a gravity manhole the interior of the manhole shall be coated with an approved corrosion resistant coating.

1. Manhole inside diameter shall be 48 inches for 18-inch and lesser diameter pipe and 60 inches for 21-inch to 30-inch diameter pipe.

2. Wall thickness shall be a minimum of 5 inches.
3. The minimum compressive strength of precast manhole risers, bases, cone or top sections, and grade rings shall be 4,000 psi.
4. The access opening in top sections shall be a minimum diameter of 24 inches.
5. Joints: The reinforced concrete manhole base and riser sections, except grade rings, shall be formed with male and female ends, so that when the manhole base, riser, and top are assembled they will make a continuous and uniform manhole. **Joints shall conform to ASTM C443 standards.**
6. Lift eyes or holes may be provided in each section for the purpose of handling but must not protrude through the concrete walls.
7. Poured-in-place reinforced concrete manholes, polyethylene manholes, or fiberglass manholes may be used with prior permission of the City.
8. Manholes located on the discharge of a force main must be manufactured with hydrogen sulfide (H₂S) protection. The protection can be an admixture to the manhole concrete mix or a polymer liner plate installed prior and integrated with the concrete pour. Acceptable products are Xypex concrete additive and A•LOK DuraPlate liner plates.

(b) Precast reinforced concrete manhole bases:

1. The base riser sections shall be precast with integral floors.
2. Bases for pipe 10 inches diameter or less shall have a minimum outside height of 24 inches.
3. Bases for 12-inch through 18-inch diameter pipe shall have a minimum outside height of 36 inches.
4. Heights of bases for pipes greater than 18 inches in diameter shall be according to the manufacturer's specifications, subject to prior approval of the City.

(c) Precast Reinforced Concrete Tops:

Precast tops may be one of the following two types:

1. Eccentric cone
2. Flat slab top

Lift holes should be installed on the sides on the cone tops.

(d) Precast Reinforced Concrete / Manufactured Polymer Grade Rings:

1. Must meet or exceed AASHTO HS-25 loadings & ratings.
2. Grade ring wall thickness shall be a minimum of 5 inches.
3. Grade rings shall not be greater than 9 inches in height.
4. The combined height of stacked grade rings shall be a maximum of 12 inches.
5. All grade rings must be fastened to the manhole riser and casting and to each other when more than one is used.
6. Manufactured polymer grade rings shall be used on manholes located with in vehicular traffic areas. Approved rings (manufacturers) are Pro-Ring (Cretex), Adjustment Ring (Ladtech) and Elevation Ring (Underground Technologies).

(e) Manhole Steps (Precast and Poured-in-Place Concrete Manholes):

1. Manhole steps shall be fabricated from aluminum alloy 6061-T6 or Copolymer polypropylene aluminum core molded steps. Copolymer steps shall be orange in color or other OSHA applicable color code and shall meet or exceed the strength requirements of ASTM C478, Section 16.
2. Manhole steps shall be corrosion resistant, free from sharp edges, burrs, or other projections which may be a safety hazard and shall be of sufficient strength to support a live load of 300 pounds imposed at any point.
3. The minimum width of cleat shall be 10 inches.
4. The legs and struts shall be of sufficient length for the cleat to project a minimum clear distance of 4 inches from the wall when the step is securely imbedded in the manhole wall.
5. The top surface of the cleats shall be designed to prevent foot slippage.
6. Steps should be positioned vertically over a pipe inlet or outlet and at a maximum spacing of 16 inches.
7. Steps shall be the same size, projection, spacing, and alignment in each manhole.

(f) Section Joints:

Section joints: Base risers, section risers, and tops shall be designed for confined O-ring gasket joints meeting the latest requirements of ASTM Standard C443 or flexible butyl resin sealant meeting the latest requirements of ASTM Standard C990.

(g) Openings:

Openings in the base section wall shall be cored for the required number and size of pipes and shall be manufactured as to allow up to 20 degrees axial deflection.

(h) Pipe Entrance Couplings:

1. A watertight pipe to manhole gasket system using a flexible molded neoprene compound boot meeting the latest requirements of ASTM Standard C443 or rubber meeting the latest requirements of ASTM Standard C923 shall be installed for each core opening furnished in base riser sections.
 - i. Gaskets shall be designed to allow up to 20 degrees axial deflection.
 - ii. Internal expanding bands or power sleeves shall be of a type 304 stainless steel meeting the latest requirements of ASTM Standard C923 and shall be designed to allow contraction around the boot to clamp and seal the boot to the pipe.
2. Pipe openings made in the field in existing manhole walls for PVC pipe installation shall be machine cored. Each core shall have installed a flexible molded neoprene boot meeting requirements of Section 2.2.4 (h) 1. of these Standards.
3. Other specially designed flexible products may be approved by the Alcoa Public Works & Engineering Department.

(i) Manhole Covers:

1. Manhole cover frames and lids shall be of gray cast iron meeting the latest requirements of ASTM Standard A48, Class 30, (30,000 psi); painting of the frame and lid is not required.
2. Manhole frames and covers shall be round, with the cover/frame interface machine ground horizontally, and should weigh not less than 375 pounds.
3. Manhole frames shall have clear openings of 24 inches, heights of approximately 7-1/2 inches, and overall base diameters of approximately 35 inches. The base shall have four uniformly spaced holes for attachment to the manhole using 5/8-inch diameter bolts or threaded rods.
4. Lids shall have a thickness of 1-1/2 inches, a diameter of 26 inches, shall be solid and shall have either one or two concealed pick holes for lifting purposes.
5. Top surfaces of lids shall have embossed treads for non-slippage purposes and embossed words "SANITARY SEWER" with letters approximately two (2") inches in size. Special casting lettering/graphics may be used where developments provide a uniform code requirement for esthetic purposes. When special castings are used, a spare must be provided for every ten (10) castings placed in the collection system.

6. Manhole covers shall be Neenah R-1642; East Jordan Iron Works., No. V-1380; or approved equal.

(j) Watertight Manhole Covers:

1. Watertight manhole frames and covers shall be utilized when the manhole is located in flood prone areas or where storm water drains over a manhole. Where drainage is temporary and shall be removed during restoration and final grading, a manhole cover insert may be used.

2. Watertight manhole frames and covers shall be of the outer lid/inner watertight cover configuration; the frame and outer lid shall meet the same material and dimensional requirements of non-watertight covers.

3. The steel locking bar for the inner watertight cover shall be equipped with a minimum 3/4-inch diameter stainless steel or brass bolt for securing the cover. The bolt shall be equipped with a minimum 1/2-inch diameter, 4-inch long "tee" handle for installation and removal.

4. The inner watertight cover shall be equipped with two (2) cast iron, stainless steel or brass eye-hooks for ease of removal and installation of the cover and a neoprene gasket for a watertight seal between the inner cover and frame.

5. Watertight manhole frames and covers shall be Neenah Foundry Company No. R-1755-F1, John Bouchard & Sons No. 1123, or approved equal.

6. Manhole inserts for corrosion resistance shall be made of corrosion resistant polymer, from 3/32 to 6/32 thick and have a pull device attached for removal. Manufacturers are Parsons, FRW or approved equal. Inserts used with lock down lids shall not inhibit the locking function of the lid.

(k) Integral Cast Manhole Drops / Inside Manhole Drops

1. Outside manhole precast drops shall be integral and monolithically poured with the manhole base and each riser ring used to form the manhole during manufacturing. These drop manholes shall be designed by a Structural Engineer. When required by depth, the poured slab receiving the manhole base shall be extended to support the drop portion of the manhole in the same manner as a standard manhole.

2. Inside drops shall be manufactured and made from impact and chemical resistant polymer materials. Inside drops shall be attached to the inside walls as required by the manufacturer. A removable device must be included to allow full diameter access to the influent line where the drop is mounted. Inside drops must not interfere with ladder ways and used of ladder ways. Approved inside drops for 8" lines or greater are IntraFlow (Royal Enterprises) and for 6" lines Reliner (Duran Inc.).

2.2.6 Air Release Valves

Air release valves for use on pressure sewage mains shall be of the combination air release/vacuum breaker design. Internal valve components shall be constructed of stainless steel, brass, and/or bronze to minimize corrosion. Each valve shall be designed/sized for its particular application. Valves shall be manufactured by APCO, Crispin, Golden-Anderson or approved equal. Air-Release valves shall be installed in 4 foot diameter pre-cast concrete manholes.

2.2.7 Valves – Pressurized Main (Force Main)

- (a) Valves on force main lines 4 inches or greater shall be mechanical joint, resilient-seat type gate valves having an iron body, non-rising stem, "O"-ring, stem seal type, 2-inch square operating nut, open counter- clockwise.
- (b) Gate valves shall meet the latest requirements of AWWA Standard C-509 or C-515.
- (c) Gate valve pressure ratings shall be 200 psig.
- (d) Gate valves meeting the latest requirement of AWWA Standard C-509 shall be either Mueller Company, Model A-2360; U.S. Pipe & Foundry Company, Model No. 5460; McWane Pipe and Foundry, Model F-6100; Clow Company, Model Number 5065; Waterous Company, Series 500; M & H Company, Model 3067-01; and American Cast Iron Company, American Darling, or any succeeding Model numbers, or approved equal.
- (e) Valves on force main lines less than 4 inches shall have fully ported ball valves with a tee handle actuator. Low pressure system service check valves will be 1-1/4" full flow flap type valves; isolation valves for the check valves will include a full port 2-inch meter stop with locking wing. Ball valves shall be Chemtrol, Hayward, or approved equal.

2.2.8 Clean Outs / Flushing Stations - Low Pressure Sewer Systems

On low pressure sewer systems flushing stations shall be installed at no greater than 1,500 linear foot intervals, where two mains come together and at terminal ends in accordance with the details shown in the drawings. Each flushing station shall be constructed in accordance with the details shown on the plans depending on whether it is a mid line or end of the line station. Valves will be full port 2-inch meter stops with locking wings

2.2.9 Grinder Pump Units – Low Pressure Sewer Systems

The grinder pumps shall be able to obtain a range of total dynamic head from 0 to 130 feet (56 psi) at a discharge of 9 to 14 gpm. The grinder unit shall macerate all material of normal domestic and commercial sewage and a reasonable amount of foreign objects such as paper, wood plastic & glass chips to fine particles that pass freely through the pump. The pump units must be NSF and UL approved. The wet well shall be made of a heavy duty, corrosion resistant polymer material and have a minimum capacity of 70 gallons. The pump shall be a contained unit that is easily removed and installed without entering the unit. The wet well and upper enclosure shall each be water tight. Grinder Pumps shall be Barnes, Liberty, Environment-One (E-One) or approved equal. The manufacturer shall supply one set of special tools required for operation, adjustment and maintenance of the pumping station.

Low pressure service lines shall be 1-1/4 lines meeting all requirements of this section unless a larger line is required by design.

2.2.10 Pipe Casing – Bores

Casing materials for road bores shall be steel pipe manufactured in accordance with ASTM A139, Grade A, with minimum yield strength of 35ksi. Casing shall also meet the requirements of the agency or entity to which a permit is obtained for the bore.

2.3 CONSTRUCTION OF WASTEWATER COLLECTION LINES

All construction on the City of Alcoa's wastewater collection system that is not performed by the Public Works Department shall be executed by a person, firm, or corporation licensed to engage in contracting as set forth in the Tennessee Contractors Licensing Act of 1976 (TCA 62-601), as may be amended from time to time. This requirement shall apply to all construction regardless of the amount of work involved. These requirements apply also to subcontractors who may be engaged to conduct any part or all of the line installation work.

2.3.1 Pre-Construction Activities

Prior to commencement of work:

1. The contractor or developer may be required to provide a cash deposit, bond, certified check, or other acceptable form of security for the amount of the work to be completed or a portion thereof pursuant to the approved construction plans. The amount of this security shall be determined by and at the discretion of the Director of Public Works. Should the work not be performed in accordance with these Specifications and/or other applicable requirements, the City may execute the security for the purpose of remediation of any deficiencies and/or for the completion of the project. Within sixty (60) days of the completion and acceptance of all provisions of the approved plans, cash deposits or other legal arrangements, or unexpended or unobligated funds thereof, shall be refunded or terminated.
2. Supply two (2) complete sets of construction drawings, copies of all applicable permits (excluding City of Alcoa) and licenses.
3. Attend a mandatory Pre-Construction meeting with the City of Alcoa Public Works & Engineering staff. Responsible representatives for the contractor, subcontractor(s) & owner/developer must attend. Attendance of the engineer is optional unless required by the utility.
4. Supply material submittal sheets on all materials to be installed. Submittal sheets must contain manufacturer, required standards to be met, and marks or highlights to indicate model, size, type and material of material proposed for the project. All submittals must be approved prior to start of construction. All materials shall be manufactured or assembled in the U.S.A. or under U.S. standards as provided by but not limited to the agencies listed in the reference index of these specifications. Suppliers/manufacturers must show or disclose adherence to the same on their material submittal sheets.
5. Supply copy of Construction Start Notification submitted to the Division of Water Pollution Control, Tennessee Department of Environment & Conservation to the Public Works & Engineering Department.
6. Request a dig/locate request from the Tennessee One Call system 72 hours prior to commencement of excavation activities.

2.3.2 Soil Erosion Control

Unless otherwise specified, the Contractor shall be responsible for erosion control and slope stabilization relative to the construction of sanitary sewerage improvements. The contractor shall be responsible for installation and maintenance of all necessary temporary and permanent control measures. As a minimum, the Contractor shall construct and maintain all components shown in the Plans or directed by the Engineer during the life of the Contract to control erosion and pollution. Such measures may include, but not be limited to, berms, dikes, dams, sediment basins, fiber mats, netting, mulches, grasses, slope drains, temporary silt fences, and other control devices.

All work must be in compliance with applicable federal, state and local Stormwater Management Rules and Regulations.

(a) Materials

Erosion and Sediment Control are measures and materials required during the construction of sanitary sewerage improvements are 'Management Practices' as provided in the State of Tennessee Erosion and Sediment Control Handbook.

Use and application of these Management Practices are subject to approval and inspection by the City of Alcoa. Failure of one practice to perform adequately to satisfy applicable regulations and permits may warrant the use of greater practices until discharge limits are achieved.

(b) Construction Requirements

1. Unless otherwise specified, the Contractor shall be responsible for acquisition of all Federal, State, and local erosion control, water pollution, and other such permits applicable to construction of the sanitary sewerage improvements.
2. The City may limit the area of erodible soil exposed by clearing and grubbing operations, excavation, and other operations and may direct the Contractor to provide immediate permanent or temporary pollution control measures. The Contractor shall be cognizant of and strive to protect from pollution adjacent watercourses (streams, creeks, etc.), and impoundments (e.g., lakes, ponds). Cut and fill slopes and other excavated areas shall be seeded and mulched as work progresses.
3. The Contractor shall incorporate all erosion control features into the project at the earliest practicable time.
4. The area of erodible soil exposed at one time should not exceed 43,560 square feet (1 Acre) without approval of the Engineer. The area of excavation operations in progress shall be limited to the Contractor's ability to finish grade, stabilize, and/or construct other such permanent pollution control measures. Should seasonal limitations make such coordination unrealistic, temporary erosion control measures shall be constructed.

5. In the event of conflict between these requirements and pollution control laws, rules or regulations, or other Federal, State or Local agencies, the more restrictive laws, rules or regulations shall apply.

2.3.3 Preparation

- (a) Precautions and Permit to Excavate:
 1. Abide by each utility company's requirements when repairing, replacing or disturbing existing facilities.
 2. Prior to trench excavation being performed within any public right-of-way, including public alleys, a permit shall be obtained from the governing authority to perform such excavation. As a minimum, the trench backfill and street repair shall be made in accordance with the City of Alcoa Public Works & Engineering Department's Street & Drainage – Construction Specifications.
- (b) Prior to laying pipe, prepare suitable bedding in accordance with 2.1.7 of these Standards.
- (c) Before placing pipe in trench, field inspect for cracks or other defects; remove defective pipe from construction site.
- (d) Swab the interior of the pipe to remove all undesirable material.
- (e) Prepare the bell end and remove undesirable material from the gasket and gasket recess.
- (f) Trench excavation:
 1. Perform in such a manner as to form a suitable trench in which to place the pipe and so as to cause the least inconvenience to the public.
 2. To permit the proper installation of the pipe, allowing room for assembling joints and tamping backfill, the trench width at the crown of the pipe should be 2 feet plus the nominal diameter of the pipe. Unless approved by the Engineer, no trench less than 24-inches wide will be allowed.
 3. Cut pavements along neat, straight lines with either a pavement breaker or pavement saw.
 4. Trench depth shall be sufficient to provide a minimum cover in accordance with Section 2.1.2 of these Standards.
 5. Align trench as shown on the plans and in accordance with Section 2.1.4 of these Standards.
 6. Shape the bottom of the trench to provide uniform bearing of the pipe on undisturbed earth throughout its entire length. Dig bell holes to aid in securing uniform support of the pipe.

7. When unstable soil is encountered at the trench bottom, remove it to a depth required to assure support of the pipeline and backfill to the proper grade with AASHTO M-43, Size 3 or 4 course aggregate (stone).
8. Remove rock encountered in the trench excavation to a depth of 6 inches (for 24 inch pipe or less) and 9 inches (for 30 inch pipe or greater) below the bottom of the pipe barrel, backfill with suitable earth, and compact to uniformly support the pipe.
9. When ashes, cinders, refuse, organic materials or other unsuitable material is encountered during excavation; this material must be removed to a depth of 6 inches below any point of the bottom of the pipe and replaced with clean, stable backfill material. Should the potential exist for the pipe to come into contact of corrosive materials the pipe is to be encased with polyethylene.

2.3.4 Installing Gravity Sanitary Sewers

Maintaining accurate field notes of the installation of the waterline and all appurtenances is required of the contractor to ensure accurate As-builts are produced for final acceptance of the work.

- (a) Lay pipe true to the lines and grades from the grade and alignment stakes, or equally usable references.
 1. While using laser alignment equipment, provide two (2) offset hubs and one (1) grade hub at each manhole set at minimum of fifteen (15) feet or greater from the manhole centerline. Guard stakes should be provided with each.
 2. Lasers shall be retested at intervals of no greater than three (3) years. A copy of retesting certification shall be kept with the instrument or tagged by the recertification provider. When a laser is found to be in error of the minimum design grade on a project or greater, it may no longer be used until repaired and recertified by a certified tester.
 3. Installation of PVC pipe must be constructed as specified in ASTM-D2321 and manufacturer's requirements.
- (b) Carefully inspect all pipe and each fitting prior to its placement in the trench, and reject any defective pipe or fitting from the job site.
- (c) Lay pipe progressively upgrade, with bell upstream in such a manner as to form close, concentric joints with smooth bottomed inverts. Joining of all pipes shall be in accordance with manufacturer's specifications.
- (d) Bed each pipe section in accordance with the following requirements and those specified in Section 2.1.8 of these standards.

1. Backfill material from a foot above the pipe should not exceed 6 inches in diameter at its greatest dimension. Special care shall be used in placing bedding in the haunching region.
 2. Ductile Iron Pipe and AWWA C900 PVC Pipe: Each sewer pipe section shall be laid on a 6-inch bed of Size No. 7 or Size No. 67 crushed stone and shall be backfilled to the springline of the pipe using Size No. 7 or Size No. 67 compacted crushed stone.
 3. SDR 35/ASTM 3034 PVC Pipe: Each sewer pipe section shall be completely encapsulated with 6 inches of bedding material on the top, both sides, and the bottom of the pipe. Bedding materials shall be Size No. 7 or Size No. 67 crushed stone.
 4. Check dams shall be installed in the bedding and backfill of all new or replaced sewer lines to limit the french drain effect of gravel bedding. Major rehabilitation projects shall also include check dams in the design. Dams shall consist of compacted clay bedding and backfill at least three (3) feet thick to the top of the trench and cut into the walls of the trench two (2) feet. Alternatively, concrete may be used, keyed into the trench walls. Dams shall be placed no more than 500 feet apart. The preferred location is upstream of each manhole. All stream crossings shall include check dams on both sides of the crossing
- (e) Unless otherwise specified, provide all gravity sewer lines with a minimum of 4 feet of cover in roadways and 2-1/2 feet of cover in non-traffic areas, unless ductile iron pipe or concrete encasement is used.
- (f) Ductile iron pipe shall be required when sewer installation occurs in areas of non-virgin soil (i.e. areas of "fill"). Piers shall be provided for when necessary for support. An impermeable barrier of compacted clay or concrete encasement shall be used at the transition from fill to virgin soil to prevent piping of water through the crushed stone bedding.
- (g) For structural reasons, ductile iron pipe, concrete encasement, or relocation shall be required when culverts or other conduits are laid such that the top of the sewer is less than 18 inches below the bottom of the culvert or conduit.
- (h) Do not allow walking on completed pipelines until backfill has been placed to a depth of at least 6 inches above the crown of the pipe.
- (i) Keep the pipe free of all unneeded material; upon completion of a section between any two manholes, it shall be possible to view a complete circle of light when looking through the pipe.
- (j) When laying pipe ceases for work breaks, the end of a work day, etc, close the open ends of the pipe with a suitable plug for preventing the entrance of foreign materials.

- (k) Couplings and adapters used for joining dissimilar gravity pipe materials or for repairing and rejoining sections of gravity sewer shall be of neoprene construction with stainless steel clamps.
- (l) All connections, tapping and other modifications to the existing Public Sanitary Sewer System shall be conducted by the City of Alcoa or, when approved, by a contractor in the presence of authorized City of Alcoa personnel.

2.3.5 Installing / Repairing Sanitary Sewer Lines in Street, Highway, and Railroad Rights-of-Way

- (a) Permits as may be required for crossing streets, highways, and railroads and performing other work within their rights-of-way shall be obtained from the appropriate authorities.
- (b) As a minimum, boring and jacking methods shall be in accordance with Section 02305 of the current City of Alcoa Street and Drainage Construction Specifications.
- (c) When working within or in close proximity to the right-of-way of any street or highway the contractor shall install and maintain traffic control devices in accordance with the standards of the Manual of Uniform Traffic Control Devices.

2.3.6 Initial Proof Testing of Sanitary Sewers

It is the intent to specify a "test as you go" procedure in order to establish confidence in the installation and avoid the unnecessary delay of final acceptance. Initial proof testing will be required when the total footage of a contracted project is greater than 4,000 LF and when 50% of the project footage has been installed or in the event the run between manholes is greater than 12 ft in depth. Acceptance does not initiate a reduction in retainage for that section of completed work.

2.3.7 Final Testing

- (a) Before the sewer line is accepted and before any houses are connected, a final testing procedure is to be followed. Testing must be coordinated with and conducted in the presence of authorized City of Alcoa personnel.
- (b) Perform a visual inspection. A TV-inspection of the line may be required. All visible leaks shall be repaired.
- (c) If there is evidence of infiltration, make measurement with suitable pipe weirs or other instrumentation.
 1. If the flow through the lowermost manhole of a continuous section of sewer pipe does not exceed 25 gallons per day per inch of pipe diameter per mile of pipeline and the groundwater level is representative of the highest annual level, the entire continuous section shall be approved for leakage.
 2. The leakage test will be conducted with all lines connected, including service lines.

3. If the apparent infiltration rate exceeds 25 gallons per day per inch of pipe diameter per mile, then take additional weir measurements to isolate those sections leaking.
 4. Any single reach of pipeline which exhibits an apparent infiltration rate in excess of 25 gallons per day per inch of pipe diameter per mile will not be accepted and all leaks will be located and corrected.
- (d) A low-pressure air test shall be made. Low-pressure air testing of all pipes shall be as specified in ASTM C828 for VCP pipe and ASTM F1417 for PVC pipe.. The pressure drop shall be calculated as the number of seconds for the air pressure to drop from a stabilized pressure of 3 1/2 psig to 2 1/2 psig.

MINIMUM TEST TIME FOR VARIOUS PIPE SIZES

(Based upon ASTM C828)

NOMINAL PIPE DIA. (inches)	TIME (Min. / 100 ft.)
6	0.7
8	1.2
10	1.5
12	1.8

(Based upon ASTM C1417)

NOMINAL PIPE DIA. (inches)	TIME (Min.:Sec. / 100 ft.)
6	5:40
8	7:34
10	9:26
12	11:20

Sewers larger than 12-inch diameter shall be tested in accordance with the latest TDEC-DWR standards.

Identify and repair / replace any section of line that fails the low-pressure air test.

- (e) When PVC pipe is used, pulling an approved "go/no-go" deflection mandrel of 95/100 pipe diameter through all reaches of gravity sewer may be required. No sections will be accepted that exhibit a deflection of more than five (5%) percent.

2.3.8 Installing Manholes

- (a) Manholes shall be furnished as provided under Section 2.2.4 of these Standards.
- (b) Depth of manholes shall be the vertical distance from the lowest invert in the manhole to the top of the manhole cover frame.
- (c) Backfill manholes with the same material used for pipelines.

- (d) Prepare manhole subgrade on undisturbed earth. Remove all loose earth prior to placing crushed stone base or concrete slab. Fill all disturbed areas below subgrade level with compacted bedding stone.
- (e) Manholes having a depth of less than 12 feet shall be set on a compacted Size No. 7 or 67 crushed limestone base of minimum 6 inches thickness. Manholes having a depth of 12 feet or more shall be set on a 6-inch thick reinforced concrete slab having a minimum diameter 1 foot greater than the outside diameter of the manhole base section. The concrete slab shall be poured on a minimum 3-inch thick compacted crushed stone bedding. Concrete shall meet the conditions of Section 2.2.4 of these Standards.
- (f) The crushed limestone base shall be placed on dry consolidated and, when possible, undisturbed soil. If earth beneath the manhole has been disturbed, it shall be compacted using an approved mechanical compaction device or under cut to suitable material and back filled with clean stone as provided in Section 2.3.8 (e).
- (g) Manholes shall be set plumb.
- (h) Manhole inverts shall be accurately shaped, using concrete, to a smooth surface texture. Invert flow channels shall be shaped having the same radii as those of the pipes for which the channels are being provided. The depth of the channels shall be a minimum of 1/2 the diameter of the pipes being accommodated. From the edge of the shaped flow channels to the manhole walls, inverts shall be sloped upward at a minimum of 1 to 6.
- (i) Inlets and outlets of each manhole shall be finished smooth and flush with the sides of the manhole wall so as not to obstruct the flow of wastewater through the manhole.
- (j) When completed, the manhole shall be free from channel obstruction and leakage.
- (k) Seal joints between manhole sections with rubber O-ring gaskets or flexible butyl resin sealant. Manufacturer's recommendations for placing gaskets or sealant shall be followed.
- (l) All lift eyes or holes provided in precast manhole sections shall be filled with concrete or cement mortar. Any manhole component having a lift eye or hole that fully penetrates shall be rejected for use on a sanitary sewer project.
- (m) Precast concrete grade rings shall be set using a controlled expansion waterstop sealant. Manhole cover frames shall be attached to the manhole barrel or grade rings by means of 4, 5/8-inch anchor bolts or threaded rods and shall be set on a controlled expansion waterstop sealant. Joints of precast concrete grade rings and manhole frames shall be made so as to prevent leakage.
- (n) Drop Manholes:
 - 1. The preferred outside drop manhole is an integral cast outside drop as provided in section 2.2.5 (k) of these specifications.

2. When making a drop connection to an existing manhole, the preferred connection is an inside drop as provided below. When the connection does not allow for preferred drop connections, outside drops are to be constructed from C900 PVC or ductile iron pipe and fittings. Constructed outside drops are to have restrained joints and a secure cast in place base extending twelve inches (12") above the upper end of the bottom 90 degree bend. That maximum gap between the manhole and outside drop pipe is twelve inches (12"). Concrete used in constructing drop pipe assemblies shall meet the conditions under Section 2.2.4 of these Standards
3. Internal Drop Assemblies – Shop drawing for pre-manufactured internal drop assemblies shall be submitted for review and approval by the Alcoa Public Works & Engineering Department.
 - (o) Manholes receiving force main discharges or other similar corrosive influent shall receive a corrosion resistant coating or lining. The coating/lining shall be a minimum 100 mill thick with bonding properties to all structural materials in the manhole. New and existing pre-cast manholes shall have all surfaces prepared to manufacturer's specifications prior to application. Brick manholes are to be replaced with pre-cast manholes and treated as new or existing manholes.
 - (p) Odor control devices may also be required due to detention time or other odor causing materials in the influent flow (e.g. force main discharge). Odor control devices shall be reviewed and approved by the Alcoa Public Works & Engineering Department prior to installation.
 - (g) Manholes designed with inlets for future use shall be plugged with a twelve (12) to eighteen (18) inch stub-out of pipe with a cap affixed to the outside end of the stub-out.

2.3.9 Vacuum Testing

Vacuum testing shall be conducted on each manhole. The test shall be performed such that the integrity of each component (i.e. pipe connections, seal(s) between manhole sections, seal between manhole and cover frame) is verified. Testing will be in accordance with ASTM C1244.

Prior to testing, all pipe inlets and outlets shall be plugged and braced. A vacuum of ten (10) inches of mercury shall be drawn and the vacuum pump shut off. With no additional vacuum added by the pump, the manhole assembly will be accepted if the time measured for the vacuum to drop to nine (9) inches does not exceed the given value from the table below. If the given time is exceeded, repairs shall be made or manhole parts replaced until the test time is met.

MINIMUM TIMES FOR MANHOLE VACUUM TEST (Sec.) *
DEPTHS (ft.)

MH DIA	0-8	10	12	14	16	18	20	22	24	26	28	30
48"	20	25	30	35	40	45	50	55	59	64	69	74
60"	26	33	39	46	52	59	65	72	78	85	91	98
72"	33	41	49	57	67	73	81	89	97	105	113	121

Ref. ASTM C1244

2.3.10 Sewer Service Assemblies

- (a) The standard collector tap shall consist of a tee connected with a minimum full length pipe section 6-inch diameter branch. The tap will consist of fittings made of the same material as that of the line (i.e. cast iron or ductile iron fittings on a ductile iron or AWWA C900 PVC line) except that PVC fittings may be used on vitrified clay lines. Ductile iron pipe and either ductile iron fittings or cast iron fittings or concrete encasement shall be used in roadways where cover is less than 4 feet, or in open areas where cover is less than 2-1/2 feet. Also, ductile iron pipe shall be used where velocities greater than 15 feet per second are attained.
- (b) Risers having 45 degree angles or less measured from the horizontal may be used when the depth of the sewer collector is greater than 8 feet or when their use will facilitate connection of individual services. All risers having angles of 30 degrees or greater measured from the horizontal shall be placed in a bedding of compacted Size No. 7 or 67 crushed stone having a minimum width of 3 times the pipe diameter, a minimum thickness under the pipe equal to the pipe diameter, and an overall thickness of twice the pipe diameter. A minimum of 6 inches of bedding stone shall be placed above the top of all PVC risers in accordance with the provisions of Section 2.1.7 of these standards.
- (c) Tee branches not to be used immediately shall be plugged with air-tight plugs or caps of the same material and joints used on the collector lines.
- (d) Installation of Service Pipe and Fittings in Developments
 - 1. Service pipe and fittings shall be supplied by the developer and installed from the collector lines to the street right-of-way lines or edges of easements provided. Service pipe and fittings shall meet the conditions under Section 2.2 of these Standards.
 - 2. Ends of service pipe shall be plugged and covered the same as collectors.
 - 3. The minimum grade on service pipes shall be one percent or 1/8 inch per foot.
 - 4. Ends of service pipes shall be field located:
 - (i) For as-built drawings, a) record the distances measured along the collector lines from the nearest downstream manhole to points at right

angles to such service pipe ends, b) record the perpendicular distances measured between the collector lines and the service pipe ends, and c) record depth of service pipe end from the ground surface; and

- (ii) Install a length of minimum 1/2-inch diameter iron bar at the service pipe ends, having a 1-foot hook at the base, placed within 1.5 feet of the end of the assembly and buried no more than 6 inches from finished grade.

2.3.11 Low Pressure Sanitary Sewer Placement & Testing

Work conducted under this section consists of furnishing all labor, materials, equipment and services for the construction of a complete and working Low Pressure Sanitary Sewer (LPSS) system. A complete system includes all piping, fittings, pumping units and controls.

Pipe is to be installed in a manner to eliminate the possibility of dirt, gravel or other foreign materials from entering the installed pipe. At the end of each work period where the pipe is left exposed or buried, a temporary plug must be installed during idle periods. When open cutting of pavement is allowed, the contractor shall use street plates to allow temporary opening of the road to traffic during curing of the flowable back-fill.

Material shall be stored in a manner to eliminate debris from entering the pipe & fittings. All grinder pumps and control equipment shall be stored inside a secure weather resistant building, trailer or storage system.

Where stone back fill is required, the stone shall be placed six (6) inches above the pipe. Where earth back fill is allowed, back fill material shall be free of any materials which may cause damage to the pipe and shall be compacted to 90% Standard Density Proctor as provided by ASTM D698.

Lubricant furnished for lubricating joints shall be non-toxic, does not support bacteria growth and shall not cause deterioration of the pipe or gaskets.

Prior to testing the low pressure lines shall be filled and held at working pressure for two (2) days. Low pressure lines from 1 inch through 8 inches shall be pressure tested to 150 psig. The line shall be gauged at the low point of each section of pipe but at no greater than 1,500 feet sections. The test shall be conducted for a minimum of two (2) hours. All pipe, fittings and other materials found defective during the test shall be removed and replaced with non-defective material. Testing shall include service lines to the grinder pump.

2.3.12 Warranty Inspection

Twelve (12) months following acceptance of the sewer line, a follow-up inspection will be made to determine if any failures/deficiencies have occurred as a direct result of the contractor's work and/or materials. Present at this inspection will be a representative(s) of the Alcoa Public Works & Engineering Department and of the developer and/or contractor. The developer and/or contractor will be responsible for correction of all failures/deficiencies that have occurred during the first year of operation.

2.4 STANDARDS FLEXIBILITY

2.4.1 Interpretations of these Standards and Design Criteria

Interpretations of these Standards and Design Criteria or the determination of any other Public Works & Engineering Department standards and design criteria not covered under these Standards shall be at the discretion of the City of Alcoa Public Works & Engineering Director. The decision of the Director shall be based on past practices, traditional policies, widely accepted professional principles and practices of the industry.

2.4.2 Right of Appeal

Any disagreement with the interpretations or determinations made by the Public Works & Engineering Director with respect to these Standards or any other standards not covered herein may be appealed to the Alcoa City Manager.

APPENDIX A.1

**TAKEN FROM TENNESSEE DEPARTMENT OF ENVIRONMENT & CONSERVATION – DIVISION
OF WATER RESOURCES DESIGN CRITERIA – CHAPTER 2**

Design Basis for Wastewater Flow and Loadings

Table 2-A.1. Typical Wastewater Flow Rates from Commercial Sources

(Source: Crites and Tchobanoglous, 1998)

FACILITY	UNIT	Flow, gallons/unit/day	
		Range	Typical
Airport	Passenger	2 - 4	3
Apartment House	Person	40 - 80	50
Automobile Service Station	Vehicle served	8 - 15	12
	Employee	9 - 15	13
Bar	Customer	1 - 5	3
	Employee	10 - 16	13
Boarding House	Person	25 - 60	40
Department Store	Toilet Room	400 - 600	500
	Employee	8 - 15	10
Hotel	Guest	40 - 60	50
	Employee	8 - 13	10
Industrial Building (Sanitary waste only)	Employee	7 - 16	13
Laundry (self-service)	Machine	450 - 650	550
	Wash	45 - 55	50
Office	Employee	7 - 16	13
Public Lavatory	User	3 - 6	5
Restaurant (with toilet)	Meal	2 - 4	3
	Customer	8 - 10	9
	Short order	3 - 8	6
	Bar/cocktail lounge	2 - 4	3
Shopping Center	Employee	7 - 13	10
	Parking Space	1 - 3	2
Theater	Seat	2 - 4	3

Table 2-A.2. Typical Wastewater Flow Rates from Institutional Sources

(Source: Crites and Tchobanoglous, 1998)

FACILITY	UNIT	Flow, gallons/unit/day		
		Range	Typical	
Assembly Hall	Seat	2 - 4	3	
Hospital, Medical	Bed	125 - 240	165	
	Employee	5 - 15	10	
Hospital, Mental	Bed	75 - 140	100	
	Employee	5 - 15	10	
Prison	Inmate	80 - 150	120	
	Employee	5 - 15	10	
Rest Home	Resident	50 - 120	90	
	Employee	5 - 15	10	
School, day-only:				
	With cafeteria, gym, showers	Student	15 - 30	25
	With cafeteria only	Student	10 - 20	15
Without cafeteria, gym, or showers	Student	5 - 17	11	
School, boarding	Student	50 - 100	75	

Table 2-A.3. Typical Wastewater Flow Rates from Commercial Sources
(Source: Crites and Tchobanoglous, 1998)

FACILITY	UNIT	Flow, gallons/unit/day	
		Range	Typical
Apartment, resort	Person	50 - 70	60
Bowling Alley	Alley	150 - 250	200
Cabin, resort	Person	8 - 50	40
Cafeteria	Customer	1 - 3	2
	Employee	8 - 12	10
Camps:			
Pioneer Type	Person	15 - 30	25
Children's, with central toilet/bath	Person	35 - 50	45
Day, with meals	Person	10 - 20	15
Day, without meals	Person	10 - 15	13
Luxury, private bath	Person	75 - 100	90
Trailer Camp	Person	75 - 125	125
Campground-developed	Person	20 - 40	30
Cocktail Lounge	Seat	12 - 25	20
Coffee Shop	Customer	4 - 8	6
	Employee	8 - 12	10
Country Club	Guests on-site	60 - 130	100
	Employee	10 - 15	13
Dining Hall	Meal Served	4 - 10	7
Dormitory/bunkhouse	Person	20 - 50	40
Fairground	Visitor	1 - 2	2
Hotel, resort	Person	40 - 60	50
Picnic park, flush toilets	Visitor	5 - 10	8
Store, resort	Customer	1 - 4	3
	Employee	8 - 12	10
Swimming Pool	Customer	5 - 12	10
	Employee	8 - 12	10
Theater	Seat	2 - 4	3
Visitor Center	Visitor	4 - 8	5

APPENDIX B

CITY OF ALCOA WATER & WASTEWATER CONSTRUCTION SPECIFICATIONS LIST OF CITED STANDARDS

- AASHTO** American Assn. of State Highway and Transportation Officials
M 198 Same As ASTM C990
M-43 Sizes of Aggregate (*Stone*) for Road and Bridge Construction
- ANSI** American National Standards Institute
B2.1 Pipe Threading (except Dryseal)
A21.11 same as AWWA C111
- ASTM** American Society for Testing and Materials
A47 Standard Specification for Ferritic Malleable Iron Castings
A48 Standard Specification for Gray Iron Castings
A139 Standard Specification for Electric-Fusion (Arc)-Welded Steel Pipe (NPS 4 and Over)
A193 Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications
A307 Standard Specification for carbon Steel bolts, Studs, and Threaded Rod 60000 PSI Tensile Strength
A536 Standard Specification for Ductile Iron Castings
B88 Standard Specification for Seamless Copper Water Tube
C150 Standard Specification for Portland Cement
C443 Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
C478 Standard Specification for Circular Precast Reinforced Concrete Manhole Sections
C828 Standard Test Method for Low-Pressure Air Test of Vitrified Clay Pipe Lines
C923 Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals
C990 Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants
C1244 Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test prior to Backfill
D698 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort
D1784 Standard specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds
D1785 Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80 and 120
D2122 Standard Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings
D2241 Standard Specification for Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
D2321 Standard Specification for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
D2665 Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste and Vent Pipe and Fittings

- D3034 Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings
- D3350 Standard Specifications for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter
- F477 Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
- F1417 Standard Practice for Installation Acceptance of Plastic Non-pressure Sewer Lines Using Low-Pressure Air

AWWA

- American Water Works Association
- C-104 Cement-Mortar Lining for Ductile-Iron Pipe and Fittings
 - C-110 Ductile-Iron and Gray-Iron Fittings
 - C-111 Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
 - C-150 Thickness Design of Ductile-Iron Pipe
 - C-151 Ductile-Iron Pipe, Centrifugally Cast
 - C-153 Ductile-Iron Compact Fittings
 - C-502 Dry-Barrel Fire Hydrants
 - C-504 Rubber-Seated Butterfly Valves, 3 In. (75 mm) through 72 In. (1,800 mm)
 - C-509 Resilient-Seated Gate Valves for Water Supply Service
 - C-512 Air-Release, Air/Vacuum, and Combination Air Valves for Waterworks Service
 - C-515 Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service
 - C-600 Installation of Ductile Iron Water Mains and Their Appurtenances
 - C-651 Disinfecting Water Mains
 - C-700 Cold-Water Meters--Displacement Type, Bronze Main Case
 - C-702 Cold-Water Meters - Compound Type
 - C-707 Encoder-Type Remote-Registration Systems for Cold Water Meters
 - C-800 Underground Service Line Valves and Fittings
 - C-900 Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 in. Through 12 in.
 - C-904 Cross-Linked Polyethylene (PEX) Pressure Pipe
 - C-906 Polyethylene (PE) Pressure Pipe and Fittings, 4in through 63 for Water Distribution and Transmission.

DIPRA

- Ductile Iron Pipe Research Association
 "Thrust Restraint Design for Ductile iron Pipe".

HI

- Hydraulic Institute
 ANSI-HI Pump Standards

NFPA

- National Fire Protection Association
 13 STANDARD FOR THE INSTALLATION OF SPRINKLER SYSTEMS
 1963 Standard for Fire Hose Connections

NSF

- National Sanitation Foundation Testing Laboratory, Inc.
 61 Drinking Water System Components

TDEC Tennessee Department of Environment and Conservation
Chapter 0400-45-01 Public Water Systems
Community Public Water Systems Design Criteria

Tennessee Department of Environment and Conservation
Chapter 0400-40-01 thru 0400-40-02 Water Pollution Control
Design Criteria for Conveyance and Treatment of Wastewater
Tennessee Erosion and Sediment Control Handbook

Rules of the Tennessee Board of Examiners for Land Surveyors: Chapter 0820-03
“Standard of Practice”

UL Underwriters Laboratories, Inc.
50 Standard for Enclosures for Electrical Equipment
50E Enclosures for Electrical Equipment, Environmental Considerations