

SECTION K
MATERIAL SPECIFICATIONS

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MATERIAL SPECIFICATIONS

ITEM 100 GENERAL

100.1 DESCRIPTION

This section of the specifications contains the detail specifications for all major materials which enter into the project and become a permanent part thereof. The specifications are intended to be so written that only materials of the best quality and grade will be furnished. The fact that the specifications may fail to be sufficiently complete in some detail will not relieve the Contractor of full responsibility for providing materials of high quality and protecting them adequately until final acceptance.

100.2 SPECIFICATION REFERENCES

When reference is made in these specifications to a particular ASTM, AWWA, ANSI, or other standards, it shall be understood that the latest revision of such standards prior to the date of these General Specifications, or revisions thereof, shall apply.

100.3 MINIMUM PIPE DIAMETER REQUIREMENTS

All water mains shall be a minimum of eight (8) inches in diameter, and sewer lines shall be at least eight (8) inches in diameter. Exceptions will be evaluated on a case-by-case basis. This does not include stub-outs for fire hydrants which shall be as specified in Item 125: FIRE HYDRANTS, and sanitary sewer force mains which will be sized according to Engineering Design requirements.

100.4 SUBSTITUTIONS

The specifications for materials set out the minimum standard of quality which the Owner believes necessary to procure a satisfactory project. No substitutions will be permitted until the Contractor has received written permission of the Engineer to make a substitution for the material which has been specified.

Where the term "or equal" or "or approved equal" is used, it is understood that, if a material, product or piece of equipment bearing the name so used is furnished, it will be approvable, as the particular trade name was used for the purpose of establishing a standard of quality acceptable to the Owner. If a product of any other name is proposed for use, the Engineer's approval thereof must be obtained before the proposed substitute is procured by the Contractor.

In the event the Contractor proposes to use materials or equipment, other than that specified, the Contractor shall submit catalog cuts on both the materials and equipment which he proposes to use and the materials and equipment which is specified. Wherever the term "or equal" is used it is understood to mean "or approved equal".

It shall be understood that the Contractor shall have the full responsibility of proving that the proposed substitution is, in fact, equal.

END OF ITEM

MATERIAL SPECIFICATIONS

ITEM 101
BACKFILL / EMBEDMENT MATERIALS

101.1 GRANULAR EMBEDMENT

Fine granular material will be defined as free flowing sand or lime material or mixed sand and pea gravel that is free of stone, organic material or clay and which material shall not form mud or muck when wet. This material may be an inferior grade or "pit-run" sand not normally considered satisfactory for construction purposes, and it may be used directly from pits without processing. No fine granular material will be installed by the Contractor without the Engineer's approval.

101.2 SELECT BACKFILL

Select backfill material will be defined as good quality road gravel, sandy gravel, or other material meeting the requirements listed below. Select backfill materials shall be divided into general classifications, as follows:

A. Road Gravel: All road gravel used for backfill shall meet the following requirements:

Plasticity Index: 10 Maximum

Gradation:

<u>Screen Size</u>	<u>% Retained</u>	<u>Sieve Size</u>	<u>% Retained</u>
2"	0	#4	40-80
1"	0-10	#100	95-100
½"	20-50		

B. Other Materials: Other materials shall meet the requirements listed below:

1. Material having not more than 50% of rock. The rock shall be three (3) inches or less in greatest dimension. Not more than 10% of the rock shall be as large as three (3) inches in dimension.
2. Material having not more than 25% of clay or gumbo lumps. The lumps shall be no larger than six (6) inches in greatest dimension.
3. All rocks and/or lumps must be uniformly distributed to be considered acceptable.
4. In trenches four (4) feet or greater in width, occasional stones larger than three (3) inches but not greater than six (6) inches and/or clay or gumbo lumps larger

than six (6) inches in greatest dimension may be uniformly distributed in the trench.

All select backfill material having a plasticity index (PI) over ten (10) shall be tamped to achieve the density desired. Material having a PI of less than ten (10) may be jetted. No select backfill shall be installed by the Contractor without the Engineer's approval.

101.3 WASHED GRAVEL BACKFILL

Where ground water is encountered the trench shall be backfilled to a depth of 4 inches with a clean washed gravel, ranging in size from one (1) inch to one-fourth (1/4) inch and shall not exceed ten percent (10%) of fines or five percent (5%) of coarser materials. The gravel shall not contain in excess of five percent (5%) clay. The gravel shall be placed only at the direction of the Engineer.

101.4 BALLAST STONE

Ballast stone is defined as washed stone three (3) inches to six (6) inches in its greatest dimension. This material is to be used only when the trench bottom is in an unstable condition that it will not permit normal construction, then only at the direction of the Engineer.

101.5 CRUSHED LIMESTONE

Crushed limestone to be used in the lower six (6) inches of the trench to bed either water or sewer pipe shall consist of a cherty type stone having a percent of wear not to exceed thirty-five (35) when tested in accordance with ASTM C131 and shall be crushed and graded as follows:

<u>Sieve Size</u>	<u>Percent By Weight Passing</u>
1"	100
3/4"	90 - 100
3/8"	20 - 55
No. 4	0 - 10
No. 8	0 - 5

101.6 BACKFILL IN LOCATIONS OTHER THAN STREETS

All backfill and embedment material shall be the same as required above, except that occasional rock up to six (6) inches in greatest dimension may be placed in the select backfill.

END OF ITEM

MATERIAL SPECIFICATIONS

ITEM 103
CONCRETE PRESSURE PIPE AND FITTINGS

103.1 SCOPE

These specifications cover the manufacturer of concrete pressure pipe designed for internal pressure from a minimum of 20 psi to a maximum of 350 psi. The specifications cover six (6) types of such pipe:

- A. Reinforced Vibrated Concrete Cylinder Pipe.
- B. Prestressed Concrete Cylinder Pipe.
- C. Pretensioned Concrete Cylinder Pipe.
- D. Prestressed Concrete Lined Cylinder Pipe.
- E. Reinforced Centrifugal Concrete Pipe.
- F. Reinforced Vibrated Concrete Pipe.

103.2 GENERAL

The manufacturer shall submit a complete experience record in the design and construction of the type of concrete pressure pipe involved. Each type of pipe, with the exception of the pipe made in accordance with AWWA Standards, shall have the complete approval of the Underwriters' Laboratories for the manufacturer of the pipe specified and diameters required.

Each bidder shall submit with his bid, drawings showing full details of joint construction and of reinforcement and concrete section of the pipe. Upon the award of the contract, the Contractor shall furnish the Owner with Shop Drawings, showing the pipe and fittings to be furnished, and shall include a tabulated layout schedule with the reference to the stationing on the contract drawings with plan and profile drawings. Such drawings shall be subject to the approval of the Engineer, and fabrication of pipe and fittings shall not commence until such drawings have been approved by the Engineer. Such approval by the Engineer will not relieve the Contractor of any responsibility of providing pipe and/or fittings in accordance with the plans and specifications.

103.3 DESIGN PRESSURES AND STRESSES

The design pressures and stresses for each of the six (6) types of concrete pressure pipe are as follows:

- A. Reinforced Vibrated Concrete Cylinder Pipe shall be designed for an internal working pressure of 150 pounds per square inch, except where otherwise shown on the Plans and/or specified in the Technical Specifications. The combined cross-sectional area of steel in the cylinder and the reinforcement cage shall be such that under no condition will the steel be stressed in excess of 12,500 psi at the design internal pressure, not in excess of 18,000 psi for combined internal and external loading conditions in which the external loading is a determining factor of design.
- B. Prestressed Concrete Embedded Cylinder Pipe shall be designed for an internal working pressure of 150 pounds per square inch, except where otherwise shown on the Plans and/or specified in the Technical Specifications. The size of the high tensile wire and the spacing and tension under which it is would shall be such that the core will be sufficiently compressed to prevent tensile stresses from occurring in the core under the combination of normal internal operating pressure and external static trench loads. At a pressure equal to twice the design pressure, the stress in the wire shall not exceed its original gross wrapping stress.
- C. Pretensioned Concrete Cylinder Pipe shall be designed for an internal working pressure of 150 pounds per square inch, except where otherwise shown on the Plans and/or specified in the Technical Specifications. The combined cross-sectional area of steel in the cylinder and spirally wound reinforcement shall be such that the stress in the steel, when the pipe is subjected to an internal pressure equivalent to the designed hydrostatic head with no allowable for the tensile strength of the concrete, shall not exceed 16,500 pounds per square inch. The cross-sectional area of the circumferential rod reinforcement shall not exceed sixty (60%) percent nor be less than 0.23 square inches per linear foot, nor shall the center-to-center rod spacing exceed two (2) inches.
- D. Prestressed Concrete Lined Cylinder Pipe shall be for an internal working pressure of 150 pounds per square inch, except where otherwise shown on the Plans and/or specified in the Technical Specifications. The size of the high tensile wire and the spacing and tension under which it is would shall be such that the core will be sufficiently compressed to prevent tensile stresses from occurring in the core under the combination of normal internal operating pressure and external static trench loads. At a pressure equal to twice the design pressure, the stress in the wire shall not exceed its original gross wrapping stress.
- E. Reinforced Centrifugal Concrete Pipe and reinforced vibrated concrete pipe shall be designed for an internal working pressure and external loading, as fixed by the Plans and/or specified in the Technical Specifications. The combined cross-sectional area of circumferential steel in the reinforcement cage or cages shall be such that under no

condition will the steel be stressed in excess of 12,500 pounds per square inch at the design internal pressure nor for combined internal and external loading conditions in which the external loading is a determining factor of design.

103.4 REINFORCED VIBRATED CONCRETE CYLINDER PIPE

The pipe shall consist of a welded sheet steel or plate steel cylinder with steel joint rings of the bell and spigot type welded to the ends of the steel cylinder, helically wound steel rod reinforcement in one or two cages concentrically located with the steel cylinder; a wall of dense concrete completely surrounding the steel assembly and a self-centering joint with a preformed rubber gasket designed so that it will be watertight under all conditions of service. The pipe shall comply in all respects with the requirements of the "American Water Works Association Standard for Reinforced Concrete Pressure Pipe, Steel Cylinder Type for Water and Other Liquids", AWWA Standard Designation C300-97, with modifications as herein set forth.

103.5 PRESTRESSED CONCRETE EMBEDDED CYLINDER PIPE

The pipe shall consist of a welded sheet-steel cylinder with steel joint rings welded to its ends, a core consisting of the steel cylinder embedded in concrete; reinforcement consisting of high-tensile steel wire wound around the outside of the core at a predetermined stress and securely fastened at its ends; a coating of dense mortar of concrete covering the core and wire; a self-centering joint with a preformed rubber gasket designed so that it will be water tight under all conditions of service. The pipe shall comply in all respects with the requirements of the "American Water Works Association Standard for Reinforced Concrete Pressure Pipe, Steel Cylinder Type, for Water and Other Liquids". AWWA Standard Designation C300-97, with modifications herein set forth. This pipe is manufactured under AWWA C306.

103.6 PRETENSIONED CONCRETE CYLINDER PIPE

The pipe shall consist of a welded sheet-steel or plate-steel cylinder with joint rings attached, inside of which a cement mortar lining is centrifugally spun; a pretensioned rod spirally wrapped under measured tension on the steel cylinder, and a protective concrete coating applied to the outside of the cylinder and spirally wrapped rod. The pipe shall comply in all respects with the requirements of the "American Water Works Association Standard for Reinforced Concrete Pressure Pipe, Steel Cylinder Type, Pretensioned, for Water and Other Liquids", AWWA Standard Designation C303-95, with modifications herein set forth.

103.7 PRESTRESSED CONCRETE LINED CYLINDER PIPE

The pipe shall have a welded steel cylinder with steel joint rings welded to its ends; a core consisting of a lining of concrete either poured or centrifugally spun within the steel cylinder; reinforcement consisting of high tensile wire wound around the outside of the steel cylinder at a predetermined stress and securely fastened at its ends; a coating of dense mortar or concrete covering the core and wire with a minimum thickness measured from the outside of the steel

cylinder with one and one-fourth (1-1/4") inches; a self centering joint with a preformed gasket of rubber so designed that the joint will be watertight under all conditions of service. The pipe shall comply in all respects with the requirements of the "American Water Works Association Standard for Prestressed Concrete Pressure Pipe, Steel Cylinder type, for Water and Other Liquids", AWWA Standard Designation C301-_, with modifications as herein set forth.

103.8 REINFORCED CENTRIFUGAL CONCRETE PIPE OR REINFORCED VIBRATED CONCRETE PIPE

The pipe shall consist of a reinforcing cage or cages of steel rods; a wall of dense centrifugally spun or poured concrete covering the reinforcing cage or cages inside and out; an approved type of joint as shown on the Plans or specified in the proposal with a preformed gasket or gaskets of rubber so designed that the joints will be watertight under all normal conditions of service. The pipe shall comply in all respects with the requirements of the "American Water Works Association Standard for Prestressed Concrete Pressure Pipe, Steel Cylinder type, for Water and Other Liquids", AWWA Standard Designation C302-95, with modifications as herein set forth.

103.9 FITTINGS AND SPECIALS

The manufacturer shall furnish all fittings and special pieces required for closures, bends, branches, manhole, air valves, blowoffs, and connections to mainline valves, and other fittings and specials shall be either "Type A" or "Type B". All openings in the pipe for fittings, manholes, taps, blowoffs, etc., shall have the interior and exterior surfaces or steel lines coated with mortar. The type of fittings and details covering the design of fittings and specials shall be furnished by the manufacturer and subject to the approval of the Engineer. The fittings and specials shall comply in all respects with the requirements of the AWWA Standards C303-95, with modifications set forth herein.

103.10 PLASTIC SEALING COMPOUND FOR WELDED JOINTS

The plastic joint sealing compound shall be cold applied, preformed, ready to use plastic and shall be furnished with an appropriate primer. The sealing compound shall be packaged in extruded rope-like shape of proper size protected by a suitable removable two-piece wrapper so designed that one wrapper may be removed longitudinally as the compound is applied to the joint surface, without disturbing the other wrapper which remains attached to the compound for protection. The sealing compound shall be impermeable to water, have high immediate bonding strength to steel, concrete, clay, etc., maintain permanent plasticity, have excellent resistance to sagging in vertical and overhead joints, water, acids and alkalis, and have no undesirable odor or taste effect on potable water. The compound shall be applied in accordance with the manufacturer's recommendations. The joint sealing compound and primer shall be RAM-NEK, as supplied by K. T. Snyder Company, Houston, Texas, or approved equal.

103.11 TESTS

In addition to certification of all applicable tests required by governing AWWA Standards, the following tests, or certification of tests, will be required:

Steel Cylinder Pipe: The manufacturer shall submit for approval the specified details of materials and methods of welding he proposes to use before any welding is done.

Concrete Cylinder Fittings and Specials: The welds shall be inspected and the completed cylinder tested for tightness by one of the following methods:

- A. By water pressure tests as provided for the cylinder of the pipe.
- B. Strip weld method of introducing air into the strip under ten (10) pounds per square inch pressures and checking for leaks around the weld with a soap solution.
- C. Turco Dy-Chek method. The method of testing shall be in strict accordance with the Dy-Chek manufacturer.

Two test cubes out of each day's pour of the concrete used, or as required by the Owner, shall be furnished for testing by an independent laboratory. At the discretion of the Engineer, certified test reports made by the manufacturer will be acceptable in lieu of the test cubes, provided such test certificates show that they cover pours from which the purchaser's pipe is made.

Test certificates showing the physical properties of the compound used in the gaskets shall be furnished the Owner upon request.

103.12 INFORMATION AND SERVICES FURNISHED BY PIPE MANUFACTURER

Upon the award of the contract, the Contractor shall furnish the Owner shop drawings showing the pipe and fittings to be furnished and shall include a tabulated layout schedule with reference to the stationing on the contract drawings with plan and profile drawings. Such drawings shall be subject to the approval of the Engineer, and fabrication of pipe and fittings shall not commence until such drawings have been approved by the Engineer. Such approval by the Engineer will not relieve the Contractor of any responsibility of providing pipe and/or fittings in accordance with the Plans and Specifications.

Reproducible drawings of the finally approved shop drawings shall be furnished the Owner upon request.

END OF ITEM

MATERIAL SPECIFICATIONS

ITEM 104
HIGH DENSITY POLYETHYLENE (HDPE) PIPE

104.1 GENERAL

The work in this section consists of providing HDPE pipe and fittings.

104.2 HDPE PIPE

A. Water

The pipe shall be fabricated in accordance with these Specifications and the Standard Specifications of the Americas Society of Testing Materials and the American Water Works Association (AWWA) as follows:

1. ASTM D 3350 – Specification for Polyethylene (PE) Pressure Pipe and Fittings
2. AWWA C 906 – Standard for Polyethylene (PE) Pressure Pipe and Fittings

6 Inches and Larger - Pipe shall be manufactured from a PE 3408 resin listed with the Plastic Pipe Institute (PPI) as TR-4. The resin material will meet the specifications of ASTM D3350 with a cell classification of PE:345464C. Pipe shall have a manufacturing standard of ASTM F714. Pipe sizes 4-Inch to 24-Inch shall be available in both steel pipe sizes (IPS) and ductile iron pipe sizes (DIPS). Pipe shall have a minimum pressure rating of 200 psi for pipe sizes up to 20-Inch unless otherwise specified on the plans. For pipe larger than 20-Inch the pipe shall have a pressure rating of 150 psi. The pipe shall contain no recycled compounds except that generated in the manufacturer's own plant from resin of the same specification from the same raw material.

B. Sewer

Pipe shall be manufactured from a PE 3408 resin listed with the Plastic Pipe Institute (PPI) as TR-4. The resin material will meet the specifications of ASTM D3350-99 with a cell classification of PE:345464C. Pipe shall have a manufacturing standard of ASTM F714. Pipe shall be DR 17 (100psi WPR) unless otherwise specified on the plans. The pipe shall contain no recycled compounds except that generated in the manufacturer's own plant from resin of the same specification from the same raw material.

104.3 FITTINGS

- A. Butt Fusion Fittings - Fittings shall be PE3408 HDPE, Cell Classification of 345464C as determined by ASTM D3350-02, and approved for AWWA use. Butt Fusion Fittings shall have a manufacturing standard of ASTM D3261. Molded & fabricated fittings shall have a pressure rating equal to the pipe unless otherwise specified in the plans. Fabricated fittings are to be manufactured using Data Loggers. Temperature, fusion pressure and a graphic representation of the fusion cycle shall be part of the quality control records. For water, all fittings shall be suitable for use as pressure conduits, and per AWWA C906, have nominal burst values of three and one-half times the Working Pressure Rating (WPR) of the fitting.
- B. Electrofusion Fittings - Fittings shall be PE3408 HDPE, Cell Classification of 345464C as determined by ASTM D3350-02. Electrofusion Fittings shall have a manufacturing standard of ASTM F1055. Fittings shall have a pressure rating equal to the pipe unless otherwise specified on the plans. For potable water applications, all electrofusion fittings shall be suitable for use as pressure conduits, and per AWWA C906, have nominal burst values of three and one-half times the Working Pressure Rating (WPR) of the fitting.
- C. Flanged and Mechanical Joint Adapters - Flanged and Mechanical Joint Adapters shall be PE 3408 HDPE, Cell Classification of 345464C as determined by ASTM D3350-02. Flanged and Mechanical Joint Adapters shall have a manufacturing standard of ASTM D3261. Fittings shall have a pressure rating equal to the pipe unless otherwise specified on the plans.

104.4 PIPE CONNECTIONS

The butt-fusion system for pipe jointing shall be carried out in the field by operators with prior experience in fusing polyethylene pipe with similar equipment using proper jigs and tools per standard procedures outlined by the pipe manufacturer. These joints shall have a smooth, uniform, double rolled back bead made while applying the proper melt, pressure, and alignment. It shall be the sole responsibility of the Contractor to provide an acceptable butt-fusion joint.

END OF ITEM

MATERIAL SPECIFICATIONS

ITEM 105
DUCTILE IRON PIPE AND AND FITTINGS

105.1 DUCTILE IRON PIPE

The ductile iron pipe furnished for this contract shall conform to the applicable dimensions, weights and tolerances of the following specifications:

Pipe Specifications	ANSI Specification A-21.51-81 (AWWA C151)
Joint Specifications	ANSI Specification A-21.51-80 (AWWA C111)
Cement Lining	ANSI Specification A-21.4-85 (AWWA C104)
	Standard Coating
Standard Coating Outside	ANSI Specification A-21.5-820 (AWWA C105) Outside
Standard Coating Inside	ANSI Specification A-21.4-85 (AWWA C104) (Inside <u>over</u> the cement mortar lining)

Unless otherwise indicated in the Plans or specified in the Special Provisions, the pipe shall be furnished with either mechanical or "push-on" type joints.

Unless otherwise specified in the Special Provisions, all ductile iron pipe shall be cement-lined on the interior and coated with appropriate coatings on the finished surfaces. All ductile iron pipe shall be marked in accordance with ANSI Specification A-21.51-81 (AWWA C151).

Polyethylene encasement shall be provided for all buried pipe.

105.2 QUALITY OF IRON AND PHYSICAL COMPOSITION

All ductile iron pipe purchased for use under this Material Standard shall be designed for installation in accordance with ANSI A21.50-81 (AWWA C150) laying condition "Type 2". Under appropriate test, the pipe materials tested shall have the following properties:

Tensile Strength	65,000 psi
Yield Strength	45,000 psi
Elongation in 2 Inches	12%

105.3 THICKNESS AND COVER CLASSIFICATION

All ductile iron pipe furnished under this Material Specification shall be designed for Type 2 laying condition, thickness class 51 and twelve (12) feet of cover.

105.4 JOINT TYPES FOR DUCTILE IRON PIPE

Ductile iron pipe purchased under this Material Standard shall be manufactured with either "Push-on" or mechanical type joints. When joint type is not specifically designated on purchase orders or project plans and specifications, "Push-on" joints shall be furnished.

Both joint types shall be manufactured in full accordance with ANSI Specifications A-21.11-80 (AWWA C111) with the stipulation that the glands for mechanical joints be made of ductile iron, and the mechanical joint bolts and nuts be made of a high strength, low alloy, corrosion-resistant steel and shall conform to High Strength Bolts for Standard Steel Joints, ASTM Designation A325 (Type 3).

105.5 DUCTILE IRON FITTINGS

Ductile iron fittings conforming to the requirements of Material Specification Item 102 of these General Specifications shall be used in conjunction with the installation of ductile iron pipe. In general, under Construction Specification Item 202, all ductile iron fittings and specials as well as the ductile iron pipe installed shall be in accordance with any additional requirements contained under the Standard Construction Specifications Item 205 INSTALLATION OF DUCTILE IRON PIPE. Fittings shall be mechanical type joints.

105.6 TESTS AND REPORTS

- A. Contractor Requirements: When ductile iron pipe is furnished as a part of a construction contract, the Contractor shall furnish the Owner with at least two copies of the manufacturer's sworn test certificates in the form of test reports (see sub-paragraph C below) which indicate that each run of pipe furnished has met specifications; that all control point inspections have been made; and that tests have been performed as required by ANSI Specification A-21.51-81 (AWWA C151) and A-21.11-80 (AWWA C111). Certified test reports relating to ductile iron pipe furnished for contract installation must be supplied to the Engineer not later than two weeks after beginning construction when the pipe is furnished by a company whose material of a similar nature that has been previously approved by the Owner, or prior to start of construction when the pipe is furnished by a company whose material has not been previously approved.
- B. Owner's Purchase Requirements: The manufacturer's certified test results in the quantity and scope indicated in sub-paragraphs A and C must be furnished by the supplier for all pipe purchased directly by the Owner. Certification records shall have the Engineer's approval before final payment will be made.
- C. Manufacturer's Certification: Each manufacturer's certified test report shall include a statement, either written or graphic or a combination of both, which clearly indicates the methods and procedures used to derive the inspection, test or laboratory data reported. The certified test report data shall reflect chemical composition of each melt used in the pipe manufacture and shall contain, as a minimum, representative data indicating

compliance with specified controls of the following requirements:

1. Joint Qualification*
2. Tensile Strength
3. Yield Strength
4. Notched Charpy Tests
5. Pipe Barrel Thickness Dimensions

* See Paragraph 105.4 and ANSI Specification A-21.11-80 (AWWA C111). Such joint qualification may be by similarity, provided the manufacturer re-qualifies joints in all sizes specified at regular and sufficient intervals so as to assure the integrity of all molds and processes used to manufacture the pipe. However, joints found to leak in field installations shall be sufficient grounds for the Engineer to disqualify joints and reject pipe, if he so chooses. See Paragraph 105.7 below.

105.7 REJECTION

The failure of any ductile iron pipe sample to meet the minimum inspection or test requirements provided in ANSI Specification A-21.51-81 (AWWA C151) and A-21.11-80 (AWWA C111) or the amended requirements provided in this Material Standard shall be cause for mandatory rejection of ductile iron pipe represented by the sample, and such rejected pipe shall not be supplied as part of the order. Should any ductile iron pipe that is represented by a sample evidencing sub-standard inspection or test data be shipped, the Contractor (or supplier in the case of Owner purchase) shall be required to provide acceptable substitute pipe and shall absorb all costs associated with the exchange. Should local inspection or field operation reveal that the ductile iron pipe does not meet these Material Standard requirements, the pipe shall be rejected; and the Contractor and supplier, as applicable, shall replace the ductile iron pipe with acceptable pipe at no additional cost to the Owner.

END OF ITEM

MATERIAL SPECIFICATIONS

ITEM 106
STEEL PIPE

106.1 STEEL WATER PIPING

This item covers the furnishing and coating of all steel pipe. The pipe shall be fabricated and coated in accordance with these Specifications and the Standard Specifications of the American Water Works Association (AWWA) as follows:

- A. Specification C200-97: Steel Water Pipe Six (6) Inches and Larger.
- B. Specification C203-97: Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot Applied.
- C. Specification C205-95: Cement Mortar Protective Lining and Coating for Steel Water Pipe - Four (4) Inches and Larger - Shop Applied.
- D. Specification C206-97: Field Welding of Steel Water Pipe.
- E. Specification C207-94: Steel Pipe Flanges for Waterworks Service - Sizes Four (4) Inches Through One Hundred Forty-Four (144) Inches.
- F. Specification C208-96: Dimensions for Fabricated Steel Water Pipe Fittings.
- G. Specification C209-95: Cold Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines.

Steel pipe two (2) inches in diameter and smaller shall be Schedule 80 steel pipe with threaded connections.

106.2 WORKING PRESSURE AND MINIMUM THICKNESS

Steel pipe shall be for the working pressure indicated (including shock). The several sizes of pipe shall have the following thicknesses:

Diameter in Inches	Thickness in Inches		
	100 psig	150 psig	250 psig
4	0.156 (5/32")	0.188 (3/16")	0.219 (7/32")
6	0.188 (3/16")	0.219 (3/16")	0.219 (7/32")
8	0.188 (3/16")	0.219 (7/32")	0.250 (1/4")
10	0.188 (3/16")	0.219 (7/32")	0.250 (1/4")
12	0.188 (3/16")	0.219 (7/32")	0.250 (1/4")
14	0.188 (3/16")	0.219 (7/32")	0.250 (1/4")
16	0.188 (3/16")	0.219 (7/32")	0.250 (1/4")
18	0.188 (3/16")	0.219 (7/32")	0.250 (1/4")
20	0.188 (3/16")	0.250 (1/4")	0.281 (7/32")
24	0.188 (3/16")	0.250 (1/4")	0.313 (5/16")
30	0.250 (1/4")	0.281 (9/32")	0.375 (3/8")
36	0.250 (1/4")	0.313 (5/16")	0.438 (7/16")
42	0.250 (1/4")	0.375 (3/8")	0.500 (1/2")
48	0.313 (5/16")	0.375 (3/8")	0.563 (9/16")
54	0.313 (5/16")	0.438 (7/16")	0.625 (5/8")

106.3 SEAMS

Pipe twenty (20) inches in diameter and less shall have only one longitudinal seam per joint. Pipe larger than twenty (20) inches may have two longitudinal seams per joint; in general, girth seams shall not be spaced closer together than six (6) feet.

106.4 PIPE CONNECTIONS

Pipe shall be connected by butt welding, flanges Dresser coupling, or Victaulic couplings as indicated on the Plans. Ends of the pipe shall be prepared for the particular type of connection to be used. The general location of pipe connections are indicated on the Plans; however, subject to the approval of the Engineer, pipe and fittings may be fabricated in length different from that shown.

Bolts and nuts for connections shall be corrosive resistant steel alloy equal to Cor-Ten Bethlehem Matari or equal.

Flanges shall be in accordance with AWWA Standard C207-94, "Steel Pipe Flanges for Waterworks Service Sizes Four (4) Inches Through One Hundred Forty-four (144) Inches" with laying dimensions and drilling for ASA B16.1 Class 125 flanged fittings unless otherwise indicated on the Plans.

Where Victaulic couplings are shown on the Plans, for lines thirty (30) inches and smaller, the coupling shall be Style No. 77. For lines thirty (30) inches and larger, the coupling shall be Style No. 41.

Screwed on flanges will be permitted only when a better method of connection is not feasible and when approved by the Engineer. Steel pipe to be threaded shall have all burrs removed by reaming prior to threading. Threads shall be full cut and not more than three (3) threads on the pipe shall remain exposed.

106.5 COATINGS AND LININGS

The interior of all steel water pipe shall be lined with a coat of coal tar primer, followed by a hot coat of coal tar enamel, in accordance with the AWWA Standard C203-97.

The exterior of steel pipe to be installed underground shall be given a coat of primer followed by a hot coat of coal tar enamel into which has been bonded a layer of asbestos felt wrap and finished with a coat of water resistant whitewash in accordance with AWWA C203-97.

The exterior of steel pipe which will be exposed shall be thoroughly cleaned and primed with a primer compatible to the final exterior paint to be used. Refer to painting specifications, and insulation specifications for additional pipe protective coatings.

END OF ITEM

MATERIAL SPECIFICATIONS

ITEM 107
PVC WATER PIPE

107.1 GENERAL

This specification governs the materials for polyvinyl chloride (PVC) pressure pipe for water lines, sizes four (4) inches through twenty-four (24) inches. Materials and installation shall conform to the requirements of this item and to all other applicable items of these Specifications. The manufacturer shall furnish an Affidavit of Compliance to the effect that all materials meet the specification requirements.

107.2 PIPE

All pipe shall be integral bell and spigot type conforming to the requirements of AWWA Standards C905; POLYVINYL CHLORIDE (PVC) PRESSURE PIPE, Class 150 pipe, ductile iron pipe O.D., with wall thickness of DR 18 for pipe 16" and smaller. Use class 200 pipe for pipe larger than 16". Pipe shall be suitable for use in a potable water system, and shall be approved by Underwriter's Laboratories for use in fire lines and water mains, and shall have the NSF Seal of Approval.

107.3 JOINTS

Joints must provide for contraction and expansion of the pipe. Bells shall be integral with the pipe and shall have a solid cross section elastomeric ring meeting the requirements of ASTM Specification D-3139. Bells shall be designed to be of equal or greater type designed for water service.

107.4 FITTINGS

Fittings for PVC pipe shall be standard ductile iron conforming to the requirements of Item 102, DUCTILE IRON FITTINGS, of these Specifications, PVC adaptors shall be provided for eight (8) inch and larger pipe sizes where necessary for connection to ductile iron fittings.

107.5 PHYSICAL REQUIREMENTS

Pipe shall meet all physical property requirements of AWWA Standard C900 or C-905. Standard laying lengths shall be twenty (20) feet, plus or minus one (1) inch, with a maximum of fifteen (15) percent furnished in shorter lengths of not less than ten (10) feet.

END OF ITEM

MATERIAL SPECIFICATIONS

ITEM 108
COPPER TUBING AND BRASS GOODS
FOR WATER SERVICE CONNECTIONS

108.1 SCOPE

This specification governs the manufacture of seamless copper tubing and miscellaneous brass goods such as corporation stops, curb stops, couplings, unions, adapters, branch connections, etc., used to construct water service connections in the domestic water system, manufactured in accordance with ANSI/AWWA C 800, latest revision, "Underground Service Line Valves and Fittings".

108.2 MATERIALS

- A. Brass Goods. Brass goods shall be all brass of 85-5-5-5 alloy, as defined in ASTM B 62, which has a normal composition of eighty-five percent (85%) copper and five percent (5%) each of tin, lead, and zinc, plus or minus one percent (1%).
- B. Copper Tubing. Copper tubing used for one inch (1") water service lines shall be Type K, Soft (Annealed). Copper tubing for two inch (2") water services shall be Type K Hard. All copper tubing shall conform to ASTM B 88, "Seamless Copper Water Tube", or Federal Specification WW-T-799. Two inch (2") diameter service lines shall be straight lengths with compression fittings. For one inch (1") water service lines, no joints will be allowed from the corporation stop to the curb stop.

All material used shall be approved by the National Safety Foundation.

108.3 PHYSICALS

- A. Brass Goods. Brass shall have a tensile strength of not less than 30,000 psi when tested in accordance with Figure 5 of ASTM B 208.

Fittings shall be designed for 200 psi working pressure. When subjected to hydrostatic test pressures one and one-half times (1-1/2) working pressure or when subjected to a minimum of 85 psi air pressure while submerged in water, fittings shall not leak or show signs of structural failure.

Brass goods containing brass to brass moving parts shall be shipped prelubricated with a light fluid lubricant between moving parts. Lubricant shall remain fluid indefinitely, either in storage or in service.

- B. Copper Tubing. Copper tubing shall have a minimum ultimate tensile strength of 30,000 psi.

108.4 DESIGN FEATURES OF CORPORATIONS STOPS

- A. Seating surfaces of the ground key type shall be tapered and shall be accurately fitted together by turning the key and reaming the body. Seating surfaces shall be lapped together using suitable abrasives to insure accurate fit. The large end to the tapered surface of the key shall be reduced in diameter for a distance that will bring the largest end of the seating surface of the key into the largest diameter of the seating surface of the body. The taper seat in the body shall be relieved on the small end so that the small end of the key may extend through, to prevent wearing of a shoulder and to facilitate proper seating of the key. The stem end of the key, key nut, and washer shall be so designed that if the key nut be tightened to failure point, the stem of the key shall not fracture. The nut and the stem shall withstand a torque on the nut of at least three (3) times the manufacturer's recommended torque requirements.
- B. Corporation stops shall be so designed as to rotate about the axis of the flow passageway within a circle of rotation small enough to properly clear the inside of any standard tapping machine of appropriate size.
- C. Corporation stops shall be male AWWA thread on the inlet side and copper service thread on the outlet side and shall be used only for one inch (1") taps.

108.5 DESIGN FEATURE OF CURB STOPS

- A. The ball stop shall have a full port opening with straight-through flow, and Teflon coated, bronze ball with a minimum of 0.5 mil thickness coating. The operating stem shall be one piece construction. No roll pins will be allowed.
- B. Plug type stop shall have full port opening with straight-through flow. Seating surfaces shall be brass (or Teflon coated brass) to rubber O-rings, providing positive pressure seal without mechanical means. Material for rubber O-rings should conform to requirements of ASTM D 200.
- C. Inlet and outlet threads, of the types specified, shall conform to the applicable tables of AWWA C 800, and threads shall be protected in shipment by a plastic coating or other equally satisfactory means.
- D. The brass curb stop configuration shall be female iron pipe threaded on both ends. The maximum and minimum laying lengths for a three-quarter inch (3/4") curb stop are three and three-eighths inches (3-3/8") and three and one-half inches (3-1/2") respectively. The maximum and minimum laying lengths for a one inch (1") curb stop are three and three-quarter (3-3/4") and four and one-quarter inches (4-1/4") respectively. All curb stops shall be the less stop design.

108.6 DESIGN FEATURES OF FLANGED ANGLE VALVES

Flanged angle valves shall be of inverted key style with "O" ring gaskets. Inlet to be compression type with a Buna N beveled gasket. Compression nut shall have an approved restraining device to lock down on the copper tubing. Outlet shall be flanged for drop-in gaskets with bolt holes for either one and one-half inch (1-1/2") or two inch (2") meters. Design is to include lock wings and flow directional arrow.

108.7 DESIGN FEATURES OF FITTINGS

All castings shall be smooth, free from burrs, scales, blisters, sand holes, and defects of every nature. Nuts shall be smooth cast and shall have symmetrical hexagonal wrench flats. All thread fittings, of all types, shall have NPT threads, and male threaded ends shall be protected in shipment by a plastic coating or other equally satisfactory means. Compression tube fittings shall have a Buna N beveled gasket. Compression nut shall have an approved restraining device to lock down on the copper tubing.

108.8 TESTS

Copper tubing shall be tested for material, tensile strength, and expansion in accordance with the applicable ASTM specifications. Brass goods included in this section shall be tested in accordance with the applicable provisions of the specifications relating thereto.

108.9 REJECTION

Copper tubing and brass goods may be rejected for failure to meet any of the requirements of these specifications.

END OF ITEM

MATERIAL SPECIFICATIONS

ITEM 109
REINFORCED CONCRETE PIPE

109.1 GENERAL

Reinforced concrete pipe is defined as pipe composed of concrete and reinforcing steel which meets these Specifications for installation as part of a drainage system, either as storm drains or pipe culverts, or where shown on the Plans, for sewer systems.

All reinforced concrete pipe shall be inspected and tested by an independent testing laboratory approved by the Owner. Costs of such laboratory inspection and testing shall be paid by the pipe manufacturer. All pipe furnished shall bear the initials or name of the manufacturer, date of manufacture and testing laboratory's stamp of approval.

The Owner shall have free access to the manufacturer's plant while production is in progress. If the plant is found to be not following stipulations of the ASTM Standards or is producing a product not uniform in characteristics within the permissible limits of the Contract Specifications, the Owner may refuse to accept any or all of the pipe manufactured by this company.

109.2 REINFORCED CONCRETE PIPE

Pipe furnished for this project shall conform to the requirements of current ASTM C76 or ASTM C655, except as hereinafter modified, and ASTM C443 for joints.

- A. All pipe shall be machine-made by a process which will provide for uniform placement of zero slump concrete in the form and compaction by a mechanical device which will assure a dense concrete in the finished product.
- B. Maximum absorption shall be six and one-half (6-1/2) percent.
- C. Reinforced concrete pipe shall be steam-cured in accordance with ASTM C76.
- D. Sizes larger than sixty (60) inches diameter shall be manufactured, using two (2) cages of circular reinforcement. When Class III pipe of sizes larger than sixty (60) inches diameter is specified in the Plans, minimum "Wall B" thickness shall apply and the minimum steel areas as listed for two (2) circular cages under Table II may be submitted at the manufacturer's option for those listed in Table II, provided test strength requirements for Class II pipe are satisfactorily met.

- E. All pipe shall be Class III, except where indicated otherwise in the Plans and/or in the Specifications.
- F. All reinforced concrete pipe shall have circular reinforcement in one or two cages, and under no circumstances will elliptical reinforcement be permitted.
- G. Portland cement used in the manufacture of the reinforced concrete pipe shall be Type II, with a maximum of five (5) percent tricalcium aluminate.

109.3 JOINTS AND GASKETS

Connecting joints shall be made using a flexible, trapped, watertight, rubber-type compression gasket. The gasket shall be the sole element of the joint depended upon to provide water tightness.

- A. **JOINTS:** The taper on the conic surfaces (exclusive of seal recesses, etc.) of the inside of the bell or groove and the outer surface of the spigot or tongue, measured from a longitudinal trace on the inside surface of the pipe, shall not be more than:
 - 1. Three degrees for pipe fifteen (15) inches and less in internal diameter, nor
 - 2. Two degrees for pipe larger than fifteen (15) inches in internal diameter.

The planes formed by the ends of non-beveled pipe shall not vary from the perpendicular to a longitudinal tract on the inside surface of the pipe by more than three sixteenth (3/16) of an inch for internal diameters and thirty (30) inches to fifty-four (54) inches, inclusive; or by more than three-eighths (3/8) of an inch for internal diameters sixty (60) inches and larger.

Seal retainers for concrete pipe joints shall conform to ASTM C443 and shall be trapped O-Ring design, with the following additions:

- a. The spigot or tongue shall be shaped to provide a groove within which the gasket will be largely confined when compressed.
- b. The bell and spigot, or tongue and groove, ends of the pipe joints shall be accurately manufactured so that the width of the annular space between the gasket bearing surfaces, when the joint has been fully closed, shall not vary, at any point around the circumference of the pipe by more than plus or minus six (6) percent of the uncompressed thickness of the gasket from that provided in the design.
- c. The joint shall be designed such that the gasket is not required to support the weight of the pipe when the joint is in normally closed position, and with concrete-to-concrete contact between the outer surface of the spigot

and the inner surface of the bell, the minimum annular space at the seat shall not be less than fifty (50) percent of the uncompressed thickness of the applied gasket. The uncompressed thickness is defined as the smallest cross-section of the round gasket.

Sanitary sewer pipe joints shall meet the requirements of ASTM C425, Paragraph 6.1.2.

3. GASKETS: Rubber-type gaskets from concrete pipe shall be of the round O-Ring design, and shall be extruded or molded and cured in such a manner that any cross-section will be uniform in density, homogeneous, and free of porosity, blisters, pitting and other imperfections.
 - a. The gasket shall be a continuous ring, which when in position in the gasket "seat" on the spigot or tongue end of the pipe, shall not be stretched more than twenty-four (24) percent of its original circumference, when seated on the spigot end of the pipe, except that one pipe forty-eight (48) inches in diameter and larger, the gasket shall be stretched not more than thirty (30) percent of its original circumference.
 - b. All gaskets for use in sanitary sewer pipe shall be neoprene or other acceptable synthetic rubber material.

109.4 DRAWINGS AND SUBMITTALS

The manufacture shall furnish detailed design drawings of the pipe and joint for approval; prior to commencement of pipe delivery. Such drawings shall contain all dimensions, tolerances, materials, etc., which affect specific design.

In addition, all pipe thirty (30) inches diameter and larger shall have submitted for approval a pipe laying schedule, plan and profile and other drawings as may be necessary prior to manufacture of the pipe.

109.5 TESTING AND REPORTS

Manufacturers of pipe to be furnished under this Specification shall provide certification by an independent testing laboratory that the pipe supplied conforms fully with these Specifications, including such laboratory tests supporting such certification. In any event, the pipe supplied on the project must be permanently marked in a fashion to establish the manufacturer's name, the date of manufacture, and identification with the tests performed to warrant its certification as being in conformance with these Specifications. As a minimum, actual test results will be required as follows:

- A. Load Bearing

B. Material Tests

C. Exfiltration and other hydrostatic Tests.

All tests on concrete pipe shall be made in accordance with the applicable ASTM Standards and shall be made on a minimum of one (1) percent of the pipe purchased.

Acceptable certificate of pipe tests shall be submitted for approval prior to delivery of pipe to the job site.

In addition, field inspections will be made of all pipe delivered to the project site. All pipe with defects which may indicate a poor structural condition or poor workmanship will be rejected. These defects include cracks of any type, honeycomb, bell or spigot breaks. Such pipe shall not be repaired and returned to the project site.

If a load of pipe delivered to the job site contains more than a twenty-five (25) percent of the pipe showing defects, the entire shipment shall be rejected and replacement pipe shall be obtained that fully meets the requirements of these Specifications, at no additional cost to the Owner.

END OF ITEM

MATERIAL SPECIFICATIONS

ITEM 110
SANITARY SEWER PIPE

110.1 GENERAL

Sanitary sewer pipe is defined as pipe composed of fiberglass, Polyethylene, Polyvinyl Chloride (PVC), and Ductile Iron Pressure Pipe, which meets the requirements of these specifications for installation of a sanitary sewer system.

All sewer pipe shall be inspected and tested by an independent testing laboratory approved by the Owner, costs of such laboratory inspection and testing shall be paid by the pipe manufacturer. All pipe furnished shall bear the initials or name of the manufacturer, date of manufacture, and testing laboratory's stamp of approval.

The Owner shall have free access to the manufacturer's plants while production is in progress. If the plant is discovered not following the stipulation of the ASTM Specification or is producing a product not uniform in characteristics within the permissible limits of the Standard Specifications, the Owner may refuse to accept any or all of the pipe manufactured by this company.

110.2 FIBERGLASS (GLASS-FIBER REINFORCED) SEWER PIPE

A. General:

This specification designates requirements for fiberglass glass-fiber reinforced thermosetting-resin pipe (RTRP) sizes from eight (8) to one hundred forty-four (144) inches for the conveyance of domestic sewage and shall conform to ASTM Designation D 3262 for gravity application and ASTM Designation D 3754 for force main applications. Engineering evaluations of specific installation requirements are recommended.

B. Stiffness:

Minimum pipe stiffness at five (5) percent deflection shall be thirty-six (36) psi for gravity and pressure sanitary sewers and eighteen (18) psi for gravity sliplining applications as specified for all sizes when calculated in accordance with ASTM Designation D 2412.

C. Joint Tightness:

Joint tightness shall be tested in accordance with ASTM Designation D 4161.

D. Installation:

Installed pipe produced to these specifications shall be installed utilizing an envelope of standard crushed rock bedding materials, Item 2.1.8, to a minimum of six (6) inches above the crown of the pipe. The internal diameter of the installed barrel of the pipe must not be reduced by more than three (3) percent of its base inside diameter when measured not less than thirty (30) days following completion of installation. The long term deflection shall not exceed five (5) percent.

E. Testing:

Pipe shall be tested for inside and outside diameter, wall thickness, squareness of pipe ends, chemical requirements, stiffness, beam strength as specified in the respective ASTM Designations D 3681, D 2412, and D 3262.

110.3 POLYETHYLENE (PE) LARGE DIAMETER SEWER PIPE WITH MODIFIED WALL PROFILES AND PERFORMANCE STANDARDS

A. General:

High Density Polyethylene gravity sewer pipe and fittings in nominal sizes eighteen (18) inches through one hundred twenty (120) inches with integral bell joints shall conform to current ASTM Designation F 894. Engineering evaluations of specific installation requirements are recommended.

B. Materials:

The pipe and fittings shall be made of high density, high molecular weight polyethylene pipe material meeting the requirement of Type III, Class C, Category 5, Grade P34, as defined in ASTM D 128 Standard Specification for Polyethylene Plastics Molding and Extrusion Materials.

C. Stiffness:

Minimum pipe stiffness at five (5) percent deflection shall be ten (10) psi for sanitary sewer as specified for all sizes when calculated according to Appendix XI, "Relation of RSC To Pipe Properties and Pipe Stiffness" of ASTM Designation F 894.

D. Joint Tightness:

Joint tightness shall be tested in accordance with ASTM Designation D 3212.

E. Installation:

Installed pipe produced to these specifications shall be installed utilizing an envelope of standard crushed rock bedding materials, Item 2.1.8, to a minimum of six (6) inches above the crown of the pipe. The internal diameter of the installed barrel of pipe not be

reduced by more than five (5) percent of its base diameter when measured not less than 30 days following completion of installment.

F. Testing:

Pipe shall be tested for flattening, quality and ring stiffness as specified in the applicable ASTM Designations.

110.4 POLYVINYL CHLORIDE (PVC) SEWER PIPE & FITTING WITH DIMENSION CONTROL

A. General:

All PVC Sewer Pipe and Fittings shall conform to the current ASTM Designation D 3034 for 4 inch through 15 inch diameter ASTM Designation F 679 for greater than 15 inch diameter. Engineering evaluations of specific installation requirements is recommended.

B. Pipe Sizes:

1. For pipe sizes 4 through 15 inches in diameter. The pipe shall be Type PSM SDR-35 or SDR-26 as specified in ASTM Designation D 3034.
2. For pipe sizes greater than 15 inch diameter. The pipe shall be Type T-1 A and T-2B as specified in ASTM Designation F 679.

C. Material:

The pipe shall be made of PVC plastic having cell classification of 12454-B, 12454-C or 12364-C, and fittings shall be made of PVC plastic having cell classifications of 12454-B, 12454-C or 13343-C as defined in ASTM Designation D 1784.

D. Installation:

Pipe produced to this specification shall be installed in accordance with ASTM Designation D 2321. The internal diameter of the installed barrels of the pipe must not be reduced by more than 5% of its base inside diameter when measured not less than 30 days following completion of installation.

E. Testing:

All pipe shall meet ASTM requirements for flattening, impact resistance, stiffness, joint tightness and extrusion quality as specified in ASTM Designation D 3034 and F 679.

F. Dimensions:

Nominal Size	Outside Diameter (Inches)		Minimum Wall Thickness (Inches)	
	Average	Tolerance (±)	SDR 35	SDR 26
ASTM D 3034				
4	4.215	0.009	0.120	0.162
6	6.275	0.011	0.180	0.241
8	8.400	0.012	0.240	0.323
10	10.500	0.015	0.300	0.404
12	12.500	0.018	0.360	0.481
15	15.300	0.023	0.437	0.588
ASTM F 679				
	Average	Tolerance (±)	T-1A	T-2B
18	18.701	0.028	0.536	0.499
21	22.047	0.033	0.632	0.588
24	24.803	0.037	0.711	0.661
27	27.953	0.042	0.801	0.754
30	31.496	0.047	0.903	0.840
33	35.433	0.053	1.016	0.945
36	39.370	0.059	1.129	1.050

110.5 POLYVINYL CHLORIDE (PVC) SEWER PIPE AND FITTINGS WITH MODIFIED WALL PROFILES AND PERFORMANCE STANDARDS

A. General:

This specification designates requirements for PVC plastic gravity sewer pipe for the conveyance of domestic sewage with various modified wall profiles and performance requirements. Engineering evaluations of specific installation requirements is recommended.

B. Stiffness:

Minimum pipe stiffness at five percent deflection shall be 46 psi for sanitary sewer and 10 psi for storm sewer applications as specified for all sizes when calculated in accordance with ASTM Designation D 2412.

C. Joint Tightness:

Joint tightness shall be tested in accordance with ASTM D 3212.

D. Pipe Classification:

1. ASTM Designation F 789, "Type PS-46 PVC Plastic Gravity Flow Sewer Pipe and Fittings", size 4 inch to 18 inch pipe conforming to ASTM Designation F 789 shall be joint compatible to ASTM 3034 pipe joint dimensions.
2. ASTM Designation F 794, "PVC Ribbed Gravity Sewer Pipe and Fitting Based on Controlled Inside Diameter", sizes 4 inch through 48 inch.
3. ASTM Designation F 949, "PVC Corrugated Sewer Pipe with Smooth Interior and Fittings", sizes 4 inch through 36 inch.

E. Installation:

Pipe produced to these specifications shall be installed in accordance with ASTM Designation D 2321. The internal diameter of the installed barrel of the pipe must not be reduced by more than 5% of its base inside diameter when measured not less than 30 days following completion of installation.

F. Testing:

Pipe shall be tested for flattening, impact resistance and extrusion quality as specified in the applicable ASTM Designations.

110.6 POLYVINYL CHLORIDE (PVC) PRESSURE-RATED PIPE (SDR SERIES)

A. General:

PVC pressure rated pipe shall conform to the current ASTM Designation D 2241, for 4 inch through 36 inch diameter. An engineering evaluation of specific installation requirements is recommended.

B. Material:

The pipe shall be made of PVC plastic having cell classifications of 12454-B, 12454-C or 14333-D.

C. Installation:

Pipe produced to this specification and when used in a wastewater application, shall be installed in accordance with ASTM Designation D 2321. The internal diameter of the installed barrels of the pipe must not be reduced by more than 5% of its base inside diameter when measured not less than thirty (30) days following completion of installation.

D. Joint Tightness:

Joint tightness shall be tested in accordance with ASTM D 3139.

E. Testing:

All pipe shall meet ASTM requirements for sustained pressure test, accelerated regression test, burst pressure, flattening and impact resistance.

F. Rejection:

PVC pressure rated pipe shall be rejected for failure to meet all the requirements of this specification.

110.7 DUCTILE IRON PRESSURE PIPE AND FITTINGS

A. General:

Ductile iron pressure pipe 3 inches (75mm) in diameter and larger shall conform to the current American National Standard for Ductile Iron Pipe Centrifugally Cast for Water or Other Liquids, AWWA Standard C 151.

B. Design Requirements:

The ductile iron pipe shall conform in all respects to the specifications set forth in ASTM Designation A 377 (A 377M), Standard Index of Specifications for Ductile Iron Pressure Pipe. The specific grade of ductile iron used shall be Grade 60-42-10, with Minimum Tensile Strength of 60,000 psi, a Minimum Yield Strength of 42,000 psi, and a Minimum Elongation in 2 inches of 10 percent.

Pipe shall be specified by either Thickness Class or Pressure Class, in accordance with AWWA Standard C 150 and AWWA Standard C 151 and shall be so designated in the Plans and Contract Documents.

C. Joints:

All ductile iron pressure pipe shall be furnished with one of the following types of joints and as described in the proposal or bid request:

Type Joint	AWWA Standard
Push-On	AWWA C 111
Mechanical Joint	AWWA C 111
Flanged Ends	AWWA C 110 or AWWA C 115
Grooved Ends	AWWA C 606

Bolts and nuts for mechanical joints or flanged ends (if used underground) shall be of a high-strength low-alloy corrosion-resistant steel and shall conform to High Strength Bolts for Standard Steel Joints, ASTM Designation A 325 (Type 3).

All threaded flanges shall be ductile iron.

D. Coating and Lining:

All ductile iron pipe shall be bituminous coated outside and cement mortar lined inside with seal coat in accordance with AWWA Standard C 104.

E. Fittings:

Fittings shall be of gray or ductile iron and shall conform to the current American National Standard for Gray-Iron Fittings, 3 inch through 16 inch for Water and Other Liquids; AWWA Standard C 110; or American National Standard for Ductile Iron Compact Fittings, 3 inch through 6 inch for Water and Other Liquids; AWWA Standard C 153, unless otherwise specified in the Specifications or in the Plans.

Use of ductile iron compact fittings is prohibited if soil resistivity measurements are less than 1000 ohms/cm³.

All fittings shall be rated for a minimum of 250 psi (2069 kpa) working pressure.

Special fittings using end condition combinations of bells, spigots, mechanical or push-on joints, flanges, or special internally locked joints shall be dimensioned in accordance with AWWA Standard C 110.

Bolts and nuts for mechanical joints or flanged ends shall be of a high-strength, corrosion-resistant low-alloy steel and shall conform to ASTM Designation A 325 (Type

3).

Fittings shall be bituminous coated outside and cement-mortar lined inside with seal coat in accordance with AWWA C 104.

F. Underwriters' Approval:

Ductile iron pipe shall be approved by the Underwriters' Laboratories, Inc., and shall be accepted by the State Fire Insurance Commission for use in water distribution systems without penalty. All pipe and fittings shall be new.

G. Tests:

All ductile iron pipe and fittings shall be tested in accordance with the applicable provisions of the specifications relating thereto and the class, weight, and casting period shall be shown on each pipe.

H. Rejection:

Ductile iron and fittings may be rejected for failure to meet all of the requirements of this specification.

END OF ITEM

MATERIAL SPECIFICATIONS

ITEM 113
CAST-IN-PLACE CONCRETE

113.1 SCOPE OF WORK

This section of the Specifications includes all work required in placing, finishing and curing cast-in-place concrete associated with the following:

- A. Cast-in-place concrete building frame members, floors, shear walls, elevator shaft walls, foundations and supported slabs and tanks.
- B. Floors and slabs on grade.
- C. Control, and expansion and contraction joint devices associated with concrete work.
- D. Equipment pads, light pole bases, thrust blocks and manhole bases.

113.2 REFERENCES

- A. ACI 301-84: Structural Concrete for Buildings (Revised 1988).
- B. ACI 302: Guide for Concrete Floor and Slab Construction.
- C. ACI 304: Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete.
- D. ACI 305R: Hot Weather Concreting.
- E. ACI 305R: Cold Weather Concreting.
- F. ACI 308: Standard Practice for Curing Concrete.
- G. ACI 318/318R-89: Building Code Requirements for Reinforced Concrete.
- H. ANSI/ASTM D1752: Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.
- I. ASTM C33-86: Concrete Aggregates.
- J. ASTM C94-86: Ready-Mixed Concrete.
- K. ASTM C150-86: Portland Cement.

- L. ASTM C260-86: Air Entraining Admixtures for Concrete.
- M. ASTM C494: Chemical Admixtures for Concrete.

113.3 SUBMITTALS

- A. Product Data: Provide data on joint devices, attachment accessories, curing compounds, admixtures, mix designs, tests performed to establish mix designs, and physical capacity of mixing plant and trucking facilities.
- B. Manufacturer's Installation Instructions: Indicate installation procedures and interface required with adjacent work.

113.4 PROJECT RECORD DOCUMENTS

Submit in accordance with Standard General Conditions, Article 6.12. Accurately record actual locations of embedded utilities and components which are concealed from view.

113.5 QUALITY ASSURANCE

All work shall be performed in accordance with the standards referenced in Part 1.02. Cement and aggregate shall be obtained from the same source for all work.

113.6 COORDINATION

Coordinate the placement of joint devices with erection of concrete formwork and placement of form accessories.

113.7 CONCRETE MATERIALS

- A. Cement: ASTM C150, Type II.
- B. Cement: ASTM C150, Type III where specified.
- C. Fine and Coarse Aggregates: ASTM C33.
 - 1. Do not use aggregates containing soluble salts or other substances such as iron sulfides, pyrite, marcasite, ochre, or other materials that can cause stains on exposed concrete surfaces.
 - 2. Fine Aggregate: Clean, sharp, natural sand free from loam, clay, lumps or other deleterious substances. Dune sand, bank run sand and manufactured sand are not acceptable.
 - 3. Coarse Aggregate: Clean, uncoated, processed aggregate containing no clay, mud, loam or foreign matter, as follows:
 - a. Crushed stone, processed from natural rock or stone.

- b. Wash gravel, either natural or crushed. Use of slag and pit or bank run gravel is not permitted.
 - c. Coarse Aggregate Size: Size to be ASTM C33, Nos. 57 or 67, except that No. 467 may be used for footings, foundation mats and walls 16 inches or greater in thickness.
- D. Water: Clean and not detrimental to concrete.

113.8 ADMIXTURES

- A. Air Entrainment: ASTM C260; MB-VR manufactured by Master Builders Company or approved equivalent.
- B. Chemical: ASTM C494, Type A - Water Reducing Pozzolite manufactured by Master Builders Company or approved equivalent.
- C. Set-Control Admixtures: ASTM C494, as follows:
 - 1. Type B, Retarding.
 - 2. Type C, Accelerating.
 - 3. Type D, Water-reducing and Retarding.
 - 4. Type E, Water-reducing and Accelerating.
 - 5. Type F, Water-reducing, High Range.

113.9 ACCESSORIES

- A. Bonding Agent: Sika-Dur Hi-Mod manufactured by Sika Chemical Corporation or approved equivalent.
- B. Non-Shrink Grout: As specified in Section 03600.
- C. Reinforcing doweling system for existing concrete shall be capsule anchors. Anchor Bolts, Expansion Anchors and Concrete Inserts, and shall be installed per the manufacturer's instructions.

113.10 JOINT DEVICES AND FILLER MATERIALS

Joint Filler Type B: ASTM D1752; Type II Cork and Type III Self-Expanding Cork.

113.11 CONCRETE MIX

- A. Provide concrete with the following mix design limitations where Class "A" concrete is specified to result in concrete placed in the field of minimum compressive strength of 4000 psi at 28 days based on test cylinders which are taken during concrete placement.

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<u>Unit</u>	<u>Measurement</u>
Minimum Compressive Strength (7 day)	3000 psi
Minimum Compressive Strength (28 day)	4000 psi
Coarse Aggregate	ASTM C33, No. 57 or 67
Fine Aggregate	ASTM C33
Water/Cement Ratio (maximum)	0.44 by weight
Air Entrainment	5-7 percent
Slump - Plus or minus 1 inch (50 mm)	3 inches
Minimum Cement Content	564 pounds per cubic yard

- B. Provide concrete with the following mix design limitations where Class “B” concrete is specified to result in concrete placed in the field of minimum compressive strength of 3000 psi at 28 days based on test cylinders which are taken during concrete placement.

<u>Unit</u>	<u>Measurement</u>
Minimum Compressive Strength (7 day)	2250 psi
Minimum Compressive Strength (28 day)	3000 psi
Coarse Aggregate	ASTM C33, No. 467
Fine Aggregate	ASTM C33
Water/Cement Ratio (maximum)	0.50 by weight
Air Entrainment	4-6 percent
Slump - Plus or minus 1 inch (50 mm)	3 inches
Minimum Cement Content	470 pounds per cubic yard

- C. Provide concrete with the following mix design limitations where Class “C” concrete is specified to result in concrete placed in the field of minimum compressive strength of 200 psi at 28 days based on test cylinders which are taken during concrete placement.

<u>Unit</u>	<u>Measurement</u>
Minimum Compressive Strength (7 day)	1500 psi
Minimum Compressive Strength (28 day)	2000 psi
Coarse Aggregate	ASTM C33, No. 467
Fine Aggregate	ASTM C33
Water/Cement Ratio (maximum)	0.82 by weight
Air Entrainment	None
Slump - Plus or minus 1 inch (50 mm)	4 inches
Minimum Cement Content	376 pounds per cubic yard

- D. Provide concrete with the following mix design limitations where Class “D” concrete is specified to result in high early strength concrete placed in the field of minimum compressive of 4000 psi at 28 days based on test cylinders which are taken during concrete placement.

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<u>Unit</u>	<u>Measurement</u>
Minimum Compressive Strength (1 day)	2000 psi
Minimum Compressive Strength (3 day)	4000 psi
Minimum Compressive Strength (28 day)	4000 psi
Coarse Aggregate	ASTM C33, No. 57 or 67
Fine Aggregate	ASTM C33
Water/Cement Ratio (maximum)	0.44 by weight
Air Entrainment	5-7%
Slump - Plus or minus 1 inch (50 mm)	3 inches
Minimum Cement Content	564 pounds per cubic yard

- E. The concrete mix design listed above for the various classes shall be proportioned to produce 28 days concrete compression strength above the specified 28 days concrete compression strength when cylinder test is made from concrete mixed and moisture cured in the laboratory as follows:

<u>Specified 28 Days Strength</u>	<u>Laboratory 28 Days Test Cylinder</u>
$P'_c = 3000$ psi and under	$P'_c + 1000$ psi
$f'_c = 4000$ psi to 5000 psi	$f'_c + 1200$ psi

Adjustment in the limitation listed in mix design shall be made to produce the required strength of laboratory main and cured cylinder.

- F. Use accelerating admixtures in cold weather only when approved by ENGINEER. Use of admixture will not relax cold weather placement requirements.
- G. Do not use calcium chloride in concrete or in any admixture.
- H. Use set retarding admixture during hot weather only when approved by ENGINEER.
- I. Use air entraining agent in all concrete mix except for interior slabs subject to abrasion or unless otherwise shown.
- J. Maximum chloride ion content for corrosion protection shall meet table 4.3.1 listed in ACI 318/318R (1989). Testing for chloride ion content shall conform to AASHTO T260.

END OF ITEM

MATERIAL SPECIFICATIONS

ITEM 114
REINFORCING STEEL

114.1 DESCRIPTION

This section contains detail specifications for furnishing and placing reinforcing steel of the type, size and quantity designated for use in structures as shown on the Plans and in accordance with these requirements.

114.2 MATERIALS

All bar reinforcement shall be Grade 60 open hearth new billet steel of structural, intermediate, or hard grade or shall be rail steel concrete reinforcement bars. Stirrups and tie bars may be Grade 40.

New billet steel shall conform to the requirements of the latest Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement, ASTM Designation A615.

Rail steel reinforcement shall conform to the requirements of the latest Standard Specification for Rail Steel Deformed and Plain Bars for Concrete Reinforcement, ASTM Designation A616.

Unless otherwise shown on the Plans, all reinforcing bars shall be deformed bars. Twisted bars are not considered as deformed bars and will not be used. The form of deformed bars shall be such as to provide a net sectional area at all points equivalent to that of the plain round bars of equal nominal size.

Wire for fabric reinforcement shall be cold-drawn from rods hot rolled from open hearth, basic oxygen, or electric furnace billet steel. Wire shall conform to the requirements of the latest Standard Specification for Cold-Drawn Steel Wire for Concrete Reinforcement ASTM Designation A82.

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The bar designation number, nominal diameter, nominal area and the theoretical weight of reinforcing steel bars covered by this specification are as follows:

BAR DESIGNATION	NOMINAL DIAMETER (INCHES)	NOMINAL AREA (SQURE INCHES)	WEIGHT - LBS. PER LINEAR FOOT
2	0.250	0.05	0.167
3	0.375	0.11	0.376
4	0.500	0.20	.0668
5	0.625	0.31	1.043
6	0.750	0.44	1.502
7	0.875	0.60	2.044
8	1.000	0.79	2.670
9	1.128	1.00	3.400
10	1.270	1.27	4.303
11	1.410	1.56	5.313

Where wire is ordered by gauge numbers, the following relation between number and diameter, in inches, shall apply:

GAUGE NUMBER	EQUIVALENT DIAMETER (INCHES)	GAUGE NUMBER	EQUIVALENT DIAMETER (INCHES)
0	0.3065	8	0.1620
1	0.2830	9	0.1483
2	0.2625	10	0.1350
3	0.2237	11	0.1205
4	0.2253	12	0.1055
5	0.2070	13	0.0915
6	0.1920	14	0.8000

114.3 BENDING

The reinforcement shall be bent cold to shapes indicated on the Plans. All bending of hard grade and rail-steel bars shall be done in the shop. Bending of other grades shall be done in the shop. Bends shall be true to the shapes indicated, and irregularities in bending shall be cause for rejection.

Unless otherwise shown on the Plans, bends for stirrups and ties shall be made around a pin having a diameter in terms of nominal bar diameter (d) as follows:

Bends of 90 degrees and greater in stirrups, ties and other secondary bars that enclose another bar in the bend shall be:

	Grade 40	Grade 60
#3, #4, #5	4d	4d
#6, #7, #8	6d	6d

All bends in main bars and in secondary bars not covered above shall be:

	Grade 40	Grade 60
#3 through #8	6d	6d
#9, #10, #11	8d	8d
#14, #18	10d	10d

114.4 STORING

Steel reinforcement shall be stored above the surface of the ground upon platforms, skids, or other supports, and shall be protected as far as practicable from mechanical injury and surface deterioration caused by exposure to conditions producing rust. When placed in the work, it shall be free from dirt, scale, dust, paint, rust, oil, or other foreign material.

114.5 SPLICES

No splicing of bars, except when provided on the Plans, or specified herein, will be permitted without written approval of the Engineer.

Splices not provided for on the plans will be permitted in slabs not more than fifteen (15) inches in thickness, columns, walls and parapets, but not included for measurement subject to the following:

Splices will not be permitted in bars thirty (30) feet or less in plan length. For bars exceeding thirty (30) feet in plan length, the distance center to center of splices shall not be less than thirty (30) feet minus one splice length, with no more than one individual bar length less than ten (10) feet. Splices not shown on the Plans, but permitted hereby, shall be made in accordance with Table 1. The specified concrete cover shall be

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maintained at such splices and the bars placed in contact and securely tied together.

<u>SIZE</u>	<u>GRADE 40</u>	<u>LAP LENGTH</u> <u>GRADE 60</u>
No. 3	1' - 0"	1' - 0"
No. 4	1" - 2"	1' - 9"
No. 5	1' - 5"	2' - 2"
No. 6	1' - 9"	2' - 7"
No. 7	2' - 4"	3' - 5"
No. 8	3' - 0"	4' - 6"
No. 9	3' - 10"	5' - 8"
No. 10	4' - 10"	7' - 3"
No. 11	5' - 11"	8' - 11"

Spiral steel shall be lapped a minimum of one turn.

Sizes No. 14 and No. 18 may not be lapped.

END OF ITEM

MATERIAL SPECIFICATIONS

ITEM 115
EXPANSION JOINT AND WATERSTOP MATERIAL

115.1 DESCRIPTION

The filler for all expansion joints shall comply with the following requirements:

115.2 EXPANSION JOINT MATERIALS

Preformed expansion joint material composed of cork, self-expanding cork, sponge rubber or cork rubber shall conform to the requirements of the Standard Specifications for Preformed Expansion Joint Fillers for Concrete, ASTM Designation D544.

“Bituminous Premolded Expansion Joint Material” shall consist of an asphalt compound formed to the thickness and cut to the dimension shown on the Plans. The physical properties shall be as follows:

Absorption:	Not more than	5%
Distortion:	Not more than	1-1/2 %
Brittleness:	The material shall not crack or shatter when subjected to the test for brittleness.	

Asphalt for “Poured Joint Material” shall be homogenous, free from water, and shall not foam when heated to 390° F. It shall conform to the following requirements:

Flash Point (Open Cut) not less than	390° F
Softening Point (Ring and Ball Method)	150 to 230° F
Penetration @ 115°F 50 gms., 5 sec., not more than	110
Penetration @ 77°F, 100 gms., 5 sec.	30 to 50
Penetration @ 32°F, 200 gms., 60 sec., not less than	10
Loss on Heating @ 325°F, 50 gms., 5 hours, not less than	1.0%
Penetration on Residue @ 77°F, 100 gms., 5 sec., after Heating @ 325°F, as compared with penetration of Asphalt Before Heating, not less than	60.0%
Ductility @ 77°F, not less than	3.0 cm
Proportion of Bitument Soluble in CC14, not less than	99.0%
Total Bitument Soluble in CC14, not less than	99.0%

115.3 SAMPLING AND TESTING PREMOLDED EXPANSION JOINT MATERIAL

The method of sampling and testing preformed expansion joint material composed of cork, self-expanding cork, sponge rubber, or cork rubber shall conform to the requirements of the

“Standard Methods of Testing Preformed Joint Fillers for Concrete”, ASTM Designation D545. At least one sample of “Bituminous Premolded Expansion Joint Material” shall be tested for each lot of Two Thousand Five-Hundred (2,500) linear feet or less. Each sample shall consist on at least three (3) pieces, selected at random, not less than one (1) foot in length and the full width of the piece.

The following methods shall be used in testing the material:

- A. Absorption: Three (3) specimens, two (2) inches by six (6) inches, shall be cut from the pieces composing the sample in such a manner that all edges are freshly exposed. The specimens shall be weighed to the nearest tenth of a gram and immersed for twenty-four (24) hours in water maintained at 77°F. The specimens shall then be removed, all free surface wiped off with a damp cloth, and weighed immediately. The increased weight shall be calculated to the first decimal place in percentage of the initial weight.

- B. Distortion: Longitudinal specimens, two (2) inches by six (6) inches and the full thickness of the joint shall be tested. The specimen shall be clamped in a horizontal position between two wood blocks so that it projects three and one-half (3-1/2) inches. The clamp and joint material shall then be heated in an oven to a temperature of 125°F in which the temperature shall be maintained for two (2) hours. The specimen shall then be removed from the oven and the distortion measured.

- C. Brittleness: Longitudinal specimens, two (2) inches by six (6) inches and of the full thickness, of the joint shall be tested. The specimen shall be maintained at a temperature between 39.2°F and 42.8°F for at least one hour.

The specimen shall then be clamped between two blocks so that it projects three and one-half (3-1/2) inches and the blocks shall be fastened in a suitable support.

A cast iron ball having a diameter of 1.875 inches and weighing 0.95 pounds shall be suspended above the specimen in such a manner that when released it will strike the center of the cantilevered portion.

The ball shall be suspended above the joint in accordance with the following schedule:

<u>Joint Thickness</u>	<u>Fall of Ball</u>
1/4"	0" - 8"
3/8"	1' - 0"
1/2"	1' - 4"
3/4"	2' - 0"
1"	2' - 8"

The ball shall be released by burning the string above the attachment to the ball. The effect of the ball striking the specimen shall be recorded.

115.4 WATERSTOPS

Waterstops shall be furnished and installed in accordance with the details shown on the Plans. Except where otherwise indicated on the Plans, waterstops may be manufactured from either natural (plain) or synthetic rubber or from polyvinyl chloride (PVC) as specified below:

A. Materials

1. Natural (plain) rubber waterstops shall be manufactured from a stock composed of a high-grade compound made exclusively from new plantation rubber, reinforcing carbon black, zinc oxide, accelerators, anti-oxidants, and softeners. This compound shall contain not less than 72% by volume of new plantation rubber.
2. Synthetic rubber waterstops shall be manufactured from a compound made exclusively from neoprene or GRS, reinforcing carbon black, zinc oxide, polymerization agents, and softeners.

This compound shall contain not less than 70% by volume of neoprene or GRS.

3. Physical properties of natural or synthetic rubbers for waterstops shall be as shown in the table below:

PHYSICAL PROPERTIES FOR RUBBER FOR WATERSTOPS

	Natural (Plain) Rubber	Synthetic (Neoprene GRS) Rubber
<u>ORIGINAL PHYSICAL PROPERTIES:</u>		
Hardness-ASTM Designation D676 (Durometer)	60 ± 5	55 ± 5
Tensile Strength, Minimum psi		
ASTM Designation D412	3500	2500
Elongation at Break, Minimum Point	550	425

ACCELERATED TESTS TO BE DETERMINED AGING CHARACTERISTICS:

Either - after 7 days in or at least 158° F (± 2°F)
(ASTM Designation D573)

Or - after 48 hours in oxygen (ASTM Designation D572)
at 158°F (± 2°F) and 300 psi pressure Tensile

Strength, % change, Maximum	35	35
Elongation, % change, Maximum	35	--

4. Polyvinyl Chloride (PVC) Unless otherwise specified on the Plans, the material shall conform to the Corps of Engineers Specifications No. CRD-C572-60.

- B. Manufacturer's Certification: The manufacturer shall furnish certified test results indicating compliance with this specification, for each batch or lot of waterstop furnished under this contract. In case of doubt of the quality furnished, the burden of proof shall be on the manufacturer, and the decision of the Engineer shall be final.
- C. Manufacturing Requirements
1. Rubber Waterstops: Waterstops shall be manufactured with an integral cross-section which shall be uniform within plus or minus one-eighth ($1/8$) inch in width, and the web thickness or bulb diameter, within plus one-sixteenth ($1/16$) inch and minus one thirty-second ($1/32$) inch. No splices will be permitted in straight strips. Strips and special connection pieces shall be well cured in a manner such that any cross-sections shall be dense, homogeneous, and free from all porosity. All junctions in the special connection pieces shall be full-molded. During the vulcanized period the joint shall be securely held by suitable clamps.
 2. PVC Waterstops: Requirements shall be the same as above for Rubber Waterstops except that splicing of PVC shall be performed by heat sealing the adjacent surfaces in accordance with the manufacturer's recommendations. A thermostatically controlled electric source of heat shall be used to make all splices. The heat shall be sufficient to melt but not to char the plastic.

END OF ITEM

MATERIAL SPECIFICATIONS

ITEM 125
FIRE HYDRANTS

125.1 DESCRIPTION

Fire hydrants which are to be installed at locations shown on the Plans or to be furnished for general installation shall be dry-barrel traffic models that conform to the current AWWA Standard C502 for Dry-Barrel Fire Hydrants, except for changes and/or additions specifically stated below or as shown on the Plans.

125.2 REQUIREMENTS IN ADDITION TO AWWA STANDARDS

- A. Type of shutoff shall be compression
- B. Inlet connection shall be mechanical joint unless otherwise specified and shall be for a six (6) inch cast iron pipe with minimum net valve opening of five (5) inches unless otherwise specified.
- C. Delivery classification shall be two (2) hose nozzles and one (1) pumper nozzle conforming to standards now in use by the Water System Owner.
- D. Bury length ground to bottom of connecting pipe shall be three feet six inches (3'-6") unless otherwise designated and hydrants shall be of such design that will permit extension without disturbing the bottom section of the hydrant.
- E. Hydrants shall be provided with an automatic and positively operating non-corrodible drain or drip valve so as to drain the hydrant completely when the main valve is shut. A drain valve operating by springs is not acceptable and tapping the drain opening to receive threaded pipe will not be required.
- F. All hydrants shall open by turning the operating stem to the left and the markings shall be so indicated.
- G. The body of the hydrant between the elbow and the top cap must be made in two parts connected by a swivel flange, or breakable flange which will permit facing of the nozzles in any desired direction in increments of forty-five (45) degrees. The complete hydrant shall be of such design that, when the hydrant barrel is broken through traffic collision or otherwise, it may be replaced without disturbing the bottom section of the hydrant.
- H. The spindle of the operating stem and the stem nuts for hydrants having the operating threads located in the barrel or waterway shall be of manganese bronze, Everdur or other high quality non-corrodible metal. The upper part of the operating stem shall be of

wrought iron or steel. All working parts in the waterway except for sliding stem support mechanism shall be bronze to bronze, or bronze to iron.

Operating stems whose threads are not located in the barrel or waterway shall be made of wrought iron or steel.

Hydrant stem packing boxes, where needed, shall be packed with standard packing. The use of "O" rings will be permitted.

Hydrants having a vertically operating valve for which the operating threads are located in such a manner as to seal the operating threads from the water while hydrant is in use.

- I. Hydrants closing with the pressure must have a bronze cap nut to seal the bottom end of stem threads against contact with the water. Hydrants which must have the seat removed before the valve can be taken out shall have the seat ring screwed into a bronze bushing and not into iron threads.
- J. Extension sections, where required, shall include a barrel extension section, extension rod with connectors, all gaskets, bolts, and nuts required for the complete unit, and shall provide for lengthening the operating stem. These units shall be available in increments of six (6) inches in length.

125.3 RECORD OF MANUFACTURE

Fire hydrants will not be acceptable to the Owner unless they are produced by a manufacturer who has been engaged regularly and continuously for the past ten (10) years in the production of fire hydrants which have been in satisfactory use and operation in municipal water systems comparable to the Owner's Water System.

125.4 HYDRANT DRAWINGS

Shop drawings showing complete dimensioned details of the hydrant shall be submitted when requested.

END OF ITEM

MATERIAL SPECIFICATIONS

ITEM 127
SANITARY SEWER MANHOLES AND VALVE VAULTS

127.1 GENERAL

This specification covers basic materials, material composites and preformed material components for use in the construction of manholes, vaults, etc.

127.2 MANHOLES AND VAULT MATERIALS

A. Precast Concrete:

Precast reinforced concrete shapes shall be furnished for sanitary sewer manhole or vault construction in the form of risers, concentric cones, and grade rings. For water-containment construction, precast reinforced concrete manhole sections shall be of the bell and spigot or tongue and groove design meeting the requirements of ASTM C478 having a wall thickness equal to that of ASTM C76 wall "B", using a trapped type preformed O-Ring rubber gasket conforming to the requirements of ASTM C443. Risers shall be in standard lengths of one (1) through six (6) feet in increments of one (1) foot. Non water-containment construction, such as valve vaults, shall be fabricated with tongue and groove design reinforced concrete pipe meeting the requirements of ASTM C478, wall thickness identical to that required for ASTM C76, wall "B".

B. Monolithic Manholes:

Monolithic concrete manholes shall be poured on the job site in forms as approved by the Engineer. These manholes shall be poured from Class "A" concrete. Forms shall provide a minimum wall thickness of at least six (6) inches and inside diameter of 4 ft. minimum.

C. Fiberglass Manholes:

See Specification 128 and 228 herein.

127.3 COMPONENTS FOR MANHOLES AND VAULTS

A. General Requirements:

Iron castings shall meet the requirements specified here and on the Plans and Contract Documents.

1. Material: Iron castings shall conform to the following ASTM Designation as applicable:

<u>MATERIAL</u>	<u>ASTM</u>	<u>GRADE</u>
Gray Iron Castings	A48	Class 25 Minimum
Gray Iron Casting for Valves, Flanges, and Pipe Fittings	A126	Class B

2. Workmanship: All casting shall be true to pattern in form and dimension, free from pouring faults, sponginess, cracks, blow holes and other defects in positions affecting strength and value for the service intended. Angles shall be filleted, and risers shall be sharp and true.
3. Coatings: Castings shall be coated with hot or cold applied tar as appropriate.
4. Railings and Posts: Fittings and castings for steel pipe shall be malleable iron or cast steel and shall meet the requirements of Malleable Iron Castings, ASTM Designation A47, Grade 35018, or Mild-to-Medium-Strength Carbon-Steel Castings for General Application, ASTM Designation A27, Grade 70-36. All fittings and castings shall be galvanized, and the galvanizing shall meet the requirements of Zinc Coating (Hot-Dip) on Iron and Steel Hardware, ASTM Designation A153.
5. Rockers and Bearing Plates: Rockers and bearing plates shall be cast iron of the type and grade indicated on the Plans and Contract Documents.
6. Rejection: Any metal or material specified in this section may be rejected for failure to meet all of the provisions of this specification or for any defect causing said metal or material to be unusable for its intended use.

B. Specific Requirements

Specific requirements as to shapes and patterns for castings shall be as follows:

1. All manholes shall have 24 inch standard manhole rings and cover weighing not less than 300 pounds. All covers shall have pick bars and the word "sewer" visible in the casting. The seating surface shall be matched (machined) for smooth fit. A double ring (1/2") GS/5 Precast Concrete Sealant, as manufactured

by General Sealants, Inc., shall be used to seal the frame to concrete and between all grade rings used in adjusting the manhole. The exterior of the grade rings and frame shall then be mortared.

Watertight rings and covers shall have machined matching surfaces with a watertight gasket held securely in place with cadmium plated bolts and washers.

2. Manholes shall not have steps or rungs.

C. Accessories:

All accessories such as bolts, rivets, spacers, washers, etc., used for assembling castings shall be new, first quality, standard commercial materials, free from all defects which affect their strength or value. The materials shall be selected, in addition to strength, on the basis of minimizing the effect of electrolysis.

127.4 REJECTION

Materials, material composites, casting and accessories may be rejected for failure to meet any of the requirements of this specification.

END OF ITEM

MATERIAL SPECIFICATIONS

ITEM 128
FIBERGLASS MANHOLES

128.1 GENERAL

Each manhole shall be a one-piece unit manufactured to meet or exceed all specifications of ASTM D-3753, latest edition, as manufactured by Containment Solutions of Conroe, Texas; L.F. Manufacturing, Inc., Giddings, Texas; Associated Fiberglass Engineers of Fort Worth, Texas; or approved equal. All manholes shall be "heavywall", ½ inch minimum wall thickness.

128.2 MATERIALS

Resin: The resins used shall be a commercial grade unsaturated polyester resin or other suitable polyester or vinyl ester resin.

Reinforcing Materials: The reinforcing materials shall be commercial Grade "E" type glass in the form of continuous roving, and chop roving, having a coupling agent that will provide a suitable bond between the glass reinforcement and the resin.

Interior Surfacing Material: The inner surface exposed to the chemical environment shall be a resin-rich layer of 0.010 to 0.020 in. thick. The inner surface layer exposed to the corrosive environment shall be followed with a minimum of two passes of chopped roving of minimum length 0.5 in. (13mm) to maximum length of 2.0 in. (50.8 mm) and shall be applied uniformly to an equivalent weight of 3 oz/ft. Each pass of chopped roving shall be well-rolled prior to the application of additional reinforcement. The combined thickness of the inner surface and interior layer shall not be less than 0.10 in. (2.5 mm)

Wall Construction Procedure: After inner layer has been applied the manhole wall shall be constructed with chop and continuous strand filament wound manufacturing process which insures continuous reinforcement and uniform strength and composition. The cone section, if produced separately, shall be affixed to the barrel section at the factory with resin-glass reinforced joint resulting in a one piece unit. Seams shall be fiberglassed on the inside and the outside using the same glass-resin jointing procedure. Field joints shall not be acceptable by anyone except the manufacturer.

Exterior Surface: For a UV inhibitor the resin on the exterior surface of the manhole shall have gray pigment added for a minimum thickness 0.125 in.

Stubouts and Connections: Stubouts shall be installed at locations shown on the drawings. Installation of SDR 35 PVC sewer pipe shall be performed by sanding, priming, and using resin fiber-reinforced hand layup. The resin and fiberglass shall be same type and grade as used in the fabrication of the fiberglass manhole. Kor-N-Seal boots for each pipe connection shall be installed by manhole manufacturer using fiberglass reinforced pipe stubout for Kor-N-Seal boot

sealing surface.

Manhole Bottom: Manholes shall have resin fiber-reinforced bottoms. Bottom shall have a minimum of three 1½ in. deep x 3½ in. wide stiffening ribs completely enclosed with resin fiber-reinforcement and have a minimum 3 in. anti-flotation ring as shown on the drawings. Manhole bottom shall be a minimum of 5/16 in. thick.

Fillers and Additives: Fillers, when used, shall be inert to the environment and manhole construction. Sand shall not be accepted as an approved filler. Additives, such as thixotropic agents, catalysts, promoters, etc., may be added as required by the specific manufacturing process to be used to meet the requirements of this standard. The resulting reinforced-plastic material shall meet the requirements of this specification.

128.3 MANUFACTURE

Manhole cylinders, manway reducers, and connectors shall be produced from glass fiber-reinforced polyester resin using a combination of chop and continuous filament wound process.

Interior Access: All manholes shall be designed so that a ladder or step system can be supported by the installed manhole. Manhole steps will not be required, however.

Manway Reducer: Manway reducers will be concentric with respect to the larger portion of the manhole diameters through 60 inches.

Cover and Ring Support: The manhole shall provide an area from which a grade rings can be installed to accept a typical metal ring and cover and have the strength to support an H-20 traffic load without damage to the manhole.

128.4 REQUIREMENTS

Exterior Surface: The exterior surface shall be smooth with no sharp projections. Hand-work finish will be acceptable as long as enough resin is present to eliminate fiber show. The exterior surface shall be free of blisters larger than 0.5-inch diameter, delamination or fiber show.

Interior Surface: The interior surface shall be resin rich with no exposed fibers. The surface shall be free of crazing, delamination, blisters larger than 0.5-inch diameter and wrinkles of 0.125-inch or greater in depth. Surface pits shall be permitted if they are less than 0.75 inches in diameter and less than 0.0625-inch deep. Voids that cannot be broken with finger pressure and that are entirely below the resin surface shall be permitted if they are less than 0.5-inch diameter and less than 0.0625-inch thick.

Repairs: All manhole repairs by the manufacturer shall result in a product which meets all requirements of this specification. Field repair of manholes will not be allowed.

Diameter Tolerance: Tolerance of inside diameter shall be +/- 1% of required manhole

diameter.

Load Rating: The complete manhole shall have a minimum dynamic-load rating of 16,000 lbf. when tested in accordance with ASTM D-3753 8.4 (note 1). To establish this rating the complete manhole shall not leak, crack, or suffer other damage when load tested to 40,000 lbf. and shall not deflect vertically downward more than 0.25-inc at the point of the load application when loaded to 24,000 lb.

Stiffness: The manhole cylinder shall have the minimum pipe-stiffness values shown in table below when tested in accordance with ASTM D-3753 8.5 (note 1).

HEIGHT - FT.	F/AY - PSI
3 - 6.5	0.75
7 - 12.5	1.26

Soundness: In order to determine soundness, apply an air or water pressure test to the manhole test sample. Test pressure shall not be less than 3 psig or greater than 5 psig. While holding at the established pressure, inspect the entire manhole for leaks. Any leakage through the laminate is cause for failure of the test. Refer to ASTM D-3753 8.6.

Chemical Resistance: The fiberglass manhole and all related components shall be fabricated from corrosion proof material suitable for atmospheres containing hydrogen sulphite and dilute sulfuric acid as well as other gasses associated with the wastewater collection system.

128.5 PHYSICAL PROPERTIES

	Hoop Direction	Axial Direction
Tensile Strength (psi)	18,000	5,000
Tensile Modules (psi)	0.6×10^6	0.7×10^6
Flexural Strength (psi)	26,000	4,500
Flexural Modules (psi)	1.4×10^6	0.7×10^6
Compressive (psi)	18,000	10,000

128.6 QUALITY CONTROL

Each completed manhole shall be examined for dimensional requirements, hardness, and workmanship. All required ASTM D-3753 testing shall be completed and records of all testing shall be kept and copies of test records shall be presented to customer upon formal written request within a reasonable time period.

As a basis of acceptance the manufacturer shall provide an independent certification which consist of a copy of the manufacturer's test report and accompanied by a copy of the test results that the manhole has been sampled, tested, and inspected in accordance with the provisions of this specification and meets all requirements.

END OF ITEM

MATERIAL SPECIFICATIONS

ITEM 129
POLYETHYLENE WRAP FOR METAL PIPE AND FITTINGS

129.1 GENERAL

These specifications cover polyethylene film used as a wrap to protect ductile iron and other metals in a corrosive soil environment.

129.2 MATERIAL

- A. Film: The polyethylene film shall be eight (8) mils (0.008") thick, with the following minimum flat tube widths for the specified pipe sizes. The polyethylene film shall be extracted from polyethylene resin, Type I, Class C, Grade E-1, and as specified in Polyethylene Plastics Molding and Extrusion Materials, ASTM Designation D1248, with the following characteristics:

Flow Rate - 0.4 maximum
Tensile Strength - 1200 psi minimum
Elongation - 300% minimum
Dielectric Strength - volume resistivity
Minimum ohm - $\text{cm}^3 = 10^{15}$
800 Volts per mil thickness minimum

- B. Polyethylene Tape: The polyethylene tube seams and overlaps may be wrapped and held in place by means of two (2) inch wide plastic backed adhesive tape ten (10) mils (0.010) thick. The tape shall be Polyken No. 900, Scotchwrap No. 50, or approved equal.

129.3 MINIMUM WIDTH OF FILM TUBE (WHEN LAYING FLAT)

Nominal Pipe Size (Inches)	Push-on Joint Flat tube Width (Inches)	Mechanical Joint Bell Flat Tube Width (Inches)
4	14	16
6	17	20
8	21	24
10	25	27
12	29	30
14	33	34
16	37	37
18	41	41
20	45	45
24	53	53

129.4 REJECTION

Failure to meet any of the specifications contained in this section shall be cause for rejection of the materials.

END OF ITEM

MATERIAL SPECIFICATIONS

ITEM 157
PIPE INSTALLED BY OTHER THAN OPEN CUT

157.1 DESCRIPTION

1. Furnish materials and necessary accessories, with strengths, thickness, coatings, and fittings indicated, specified and/or necessary to complete the work.
2. All excavation shall provide an open area conforming to the outside diameter of the casing and/or carrier conduit. The excavation shall be to an alignment and grade which will allow the carrier conduit to be installed to proper line and grade as shown on the Plans and as established in the Specifications.
3. Work shall be performed in accordance with the requirements of the Benbrook Water and Sewer Authority, the Texas Department of Transportation, or railroad company, as applicable.

157.2 MATERIALS

1. Casing Pipe: Casing pipe shall be steel conforming to ANSI B36.10 and the following:
 - a. Field Strength: 35,000 psi minimum.
 - b. Wall thickness: 0.375 in. minimum (0.5 for railroad crossings).
 - c. Diameter: As shown on the drawings (minimum size requirements).
 - d. Joints: Continuous circumferential weld in accordance with AWS D1.1.
2. Carrier Pipe in Casing: Carrier pipe shall be as shown on drawings and as specified in the General Contract Documents.
3. Sewer Pipe without Casing Pipe: Shall be minimum Class 51 ductile iron pipe, or as designated on the plans.
4. Grout: Grout shall be Portland Cement grout of min. 2000 psi compressive strength at 28 days. Proportioned not less than 1 cu. ft. of cement to 3 cu. ft. of fine sand with sufficient water added to provide a free flowing thick slurry.

END OF ITEM