

PART B

WASTEWATER COLLECTION SYSTEM STANDARD SPECIFICATIONS

ARTICLE I

GENERAL

- 1.01 **Authority.** These Specifications are promulgated by the Fountain Sanitation District. The interpretation, enforcement, and revision of these Specifications is hereby delegated to the District Manager of the District.
- 1.02 **Effective Date of Specifications.** These Specifications shall be in effect immediately upon adoption by the District board and shall supersede all former standard specifications for installation of sanitary sewer mains within the District.
- 1.03 **Revisions, Amendments or Additions.** These Specifications may be revised, amended or added to. Such revisions, amendments and additions shall be binding and in full force and effect when adopted in the manner set forth in Section 1.02.
- 1.04 **District Control.** These Specifications will apply to the installation, operation and maintenance of all wastewater collection facilities under the control of the Fountain Sanitation District.
- 1.05 **Organization and Interpretation of Specifications.** These Specifications are composed of design criteria and provisions, material specifications, installation specifications and standard drawings. The interpretation of any section or of differences between sections, when appropriate, shall be made by the Superintendent of the District and his/her interpretation shall be binding and controlling in its application.
- 1.06 **Definitions.** As used in these Specifications, or in any of the drawings where these Specifications govern, unless the context shall otherwise require, the following words defined shall have the meanings herein ascribed:
- a. **District Manager or Manager.** The Manager of the Fountain Sanitation District or his/her designated representative.
 - b. **Engineer.** The Engineer or consultant of the District, acting either directly or through properly authorized agents, such agents acting within the scope of the particular duties entrusted to them.
 - c. **Collection System.** Sewer mains, together with all appurtenant and necessary manholes, clean outs, taps, service pipes, and associated materials, easements, property and equipment collecting sanitary sewage from individual customers.
 - d. **Wastewater Main or Sanitary Sewer Main.** That portion of the wastewater system which collects sewage from users to the District wastewater treatment plant, excluding service lines.

- e. Service Line. The sewage collection pipeline extending from the premises down to and including the connection to the wastewater or sanitary sewer main.
- f. Applicant for System Extension. Any person, association, corporation, entity, or government agency desiring sanitary sewer service for premises under their control, often a subdivider, a developer or an owner.
- g. Main Extension. Extensions to the existing collection system network.
- h. Contractor. In the context of these Specifications a person or persons, partnership or corporation employed by an applicant for the purpose of installing wastewater system extensions or replacements.
- i. Inspector. The authorized representative of the District assigned to the project.
- j. Standard Drawings. District Standard Drawings are a part of these Specifications.
- k. District. The Fountain Sanitation District responsible for overseeing the wastewater system's operations.

1.07 Abbreviations. All references to documents or specifications shall be the latest edition or revision thereof:

- a. ASTM American Society for Testing and Materials
- b. ANSI American National Standards Institute
- c. NSF National Sanitation Foundation
- d. OSHA Occupational Safety and Health Act
- e. USGS United States Geological Survey
- f. DIP Ductile Iron Pipe
- g. PVC Polyvinyl Chloride Plastic Pipe

ARTICLE II
DESIGN PROVISIONS

2.01 Planning Considerations. The land use and population densities approved for the District shall be used to determine wastewater facility design parameters. Where approved master plans do not exist, the following criteria shall be used unless specific approval for other criteria has been given by the District.

- a. Design Period: The sewer systems shall be designed for the estimated ultimate tributary population. The tributary areas shall be studied to determine the area for each projected land use.
- b. Population densities including public use lands:
 - (1) Single-family units at 3.2 persons per unit.
 - (2) Multi-family and condominiums at 2.5 persons per unit.
 - (3) Four (4) single-family units per acre.
 - (4) Sixteen (16) multi-family cluster housing or condominiums per acre.
- c. Per capita flows: Sewer systems shall be designed on the basis of not less than the following unless other values are specifically authorized by the District:
 - (1) One hundred (100) gallons per person per day.
 - (2) Three hundred (300) gallons per capita per day peak flow for submains and laterals.
 - (3) Two hundred fifty (250) gallons per capita per day peak flow for main trunk, interceptor or outfall sewers.
 - (4) Infiltration of 100 gallons per day per inch of diameter per mile per manhole run for new systems. New system installations which will service a portion of the existing collection system will require an infiltration allowance as established by the District.
 - (5) Commercial land uses at 1400 gallons per acre per day with a peak factor of 2.
 - (6) Industrial land uses at 1600 gallons per acre per day with a peak factor of 3.
 - (7) Public use, park and open space at 1000 gallons per day with a peak factor of 2.

2.02 Minimum Size. No public sewer shall be less than 8 inches in diameter. No service line shall be less than 4 inches in diameter.

2.03 Depth of Cover. In general, sewers shall be designed deep enough to drain basements and to prevent freezing and provide protection from damage from loads applied at the ground or pavement surface. No public mains shall be less than 5 feet deep measured from the top of pipe unless special protection is required. Special protection shall consist of:

- (a) Less than 5 feet but more than 3 feet of cover requires ductile iron, or reinforced concrete encasement or arch. Plastic pipe material may be used where the depth of cover is more than 5 feet.
- (b) Less than 3 feet of cover requires ductile iron or cast iron with reinforced concrete encasement.

No building sewer shall be less than 5 feet deep in traffic areas without similar special protection listed above except that concrete driveways may be substituted for protection of service lines.

PVC pipe shall not be used where the depth of cover is more than 16 feet. Special analysis and design shall be accomplished to design suitable materials and/or other protection for the pipe.

2.04 Minimum Slopes. All sewers shall be designed to transport average sewage flows at a minimum mean velocity of 2 feet per second based on a Manning's roughness factor of 0.013. The slope between manholes shall be uniform. In no case shall the slope be less than the following for sewer mains and services:

MINIMUM GRADE TABLE

Services

	<u>Pipe Diameter</u>	<u>Slope</u>
	4 Inches	2% or 1/4 inch per foot
foot	4 Inches	Ductile iron or cast iron pipe - 1% or 1/8 inch per
	6 Inches	1% or 1/8 inch per foot

Mains and Services

<u>Pipe Diameter</u>	<u>Slope</u>
8 Inches	0.60%
10 Inches	0.35%
12 Inches	0.26%
15 Inches	0.20%
18 Inches	0.15%

2.05 High Velocity Protection. In the case of sewers where the slopes are such that over 15 percent grades are attained, special provisions as determined by the District shall be made to prevent excessive erosion of material surfaces or displacement by impact.

Such high velocity protection shall be shown on detail drawings and approved by the District on a case-by-case basis.

2.06 Alignment.

a. Sewers in Streets

When the sewers are placed in streets, they shall be placed as follows:

- (1) Collection system sewers shall be placed on the centerline of street sections located midway between curb and gutter on each side of the traveled surface.
- (2) On streets running north and south where it is not possible to locate the pipe on centerline, the sewer line shall be placed no more than 10' (ten feet) west of the centerline of the street.
- (3) On streets running east and west where it is not possible to locate the pipe on centerline, the sewer line shall be placed no more than 10' feet (ten feet) south of the centerline of the street.
- (4) On streets shaped as a "U" or on streets having unusually sharp turns, the sewer line will conform to the above specifications as near as is practical, but the final locations shall be as determined by the Engineer or other District representative. Curvilinear sewer mains shall not be allowed without prior approval of the District. Designs must attempt to minimize the use of manholes and maximize the operability and maintainability of the collection system.
- (5) In no case shall the sewer line be installed closer than 5'0" to the lip of the pan or gutter.

b. Sewers in Easements

In areas where sewer lines are placed in easements, all sewer lines shall be located within the easements shown on the contract drawings. All sewer easements must be minimum of 30' (thirty feet) in width, and must be prepared in accordance with Part I of the District Sewer Use Regulations. No sewer shall be located less than 5' (five feet) from the edge of the easement.

- (1) All sewer lines in easement between lots shall be thickness Class 50 ductile iron pipe per Section 3.02.

2.07 Pipe Alignment in Manholes

- a. Intersections. All pipes shall have free discharge into the collection system. Where possible, the flow line of the intersecting pipe shall be the spring line (horizontal center of pipeline) of the collection sewer. All manhole inverts shall be designed with a 0.1 foot drop except for changes in alignment in excess of 30' shall have a 0.3 foot drop in the invert through the manhole. Changes in direction at intersections shall not be greater than 90°.

When the intersecting pipe is smaller in diameter than the pipe exiting the manhole, the crown or inside-top of the intersecting pipe shall match the crown or inside-top of the main pipe entering the manhole. In no case shall the difference in elevation between the flowline of the pipe exiting the manhole and the flowline of the intersecting sewer be less than 0.3 feet.

- b. Increasing Size. When sewers are increased in size with no intersecting sewers, the invert of the larger sewer shall be lowered sufficiently to maintain the same energy gradient.

2.08 Manhole Location. Manholes shall be installed at the end of each line, at all pipeline intersections, changes in grade, size, alignment and at intervals not greater than 400 feet. Manholes must be located to allow unassisted and unrestricted access by District maintenance vehicles. Lines and manholes located in areas where access, in the opinion of the District, is not possible, will not be approved for construction.

2.09 Manhole Details

- a. Manhole Sizes. The inside diameter of the manhole shall not be less than 4 feet on lines 8 inches through 15 inches in diameter and not less than 5 feet on lines 18 inches through 30 inches in diameter for standard design manholes (see standard drawings for standard manhole design). If lines larger than 30 inches are necessary or other special conditions exist, special design considerations will be necessary as determined by the District.
- b. Drop Manholes. External drop manholes will be permitted only in extreme and special conditions where approval has been granted by the District. As a general criteria, a minimum difference in elevation of 1.5 feet between the inlet and outlet is required before considering use of external drop manhole design. The maximum amount of vertical drop allowable in a drop manhole shall be 10 feet. The external drop sections must be totally encased in reinforced concrete and placed on an adequate foundation (see standard drawing for standard drop manhole design). A cleanout must be placed in the manhole at the level of the main sewer line. All drop manholes must be completely lined with coal tar epoxy 45 mils thick or an acceptable form of protective coating.
- c. Manhole Channels. The flow channel shall be made to conform to the slope and shape of the sewer pipe entering and exiting the manhole. The channel shall be formed from cast-in-place concrete to a cross-section matching the circular pipes. The channel shall be constructed with vertical walls from a point one-half the pipe diameter above the channel flowline as shown in the standard drawings. At intersections with other lines, channels shall be formed with a curve to minimize turbulence. The flow channel shall be constructed to have a minimum depth equal to the pipe diameter. Refer to standard drawings.
- d. Manhole Gaskets. The pipes entering and exiting the manhole shall be equipped with a manhole gasket placed around the pipe and cast in the base. If a precast base is used, a watertight seal shall be obtained by use of a premanufactured rubber gasket in the precast base section using to a Kor-N-Seal boot or approved equivalent premanufactured pipe fitting.

- e. Rings and Covers. The ring and cover shall be constructed of cast iron for traffic bearing conditions and cast aluminum or cast iron for non-traffic bearing conditions. All manholes located outside of dedicated street or alley rights-of-way will be designed and constructed with a locking type cover and the ring bolted to the concrete cone. Grade adjustment rings or blocks between the ring and cover and the concrete cone cap shall not exceed 6 inches in total height.
- f. Watertightness. Precast concrete manhole joints shall be made watertight. Manholes of brick or segmented block shall not be used in the sanitary sewer system.
- (1) Each precast manhole segment shall be joined with a rubber "O" ring, Ram-Nek, Con-Seal or similar approved material.
 - (2) All interior concrete manhole joints above the flow channel shall receive a 3/8" to 1/2" thick coating of cement grout. Concrete surfaces shall be thoroughly wetted and damp prior to the application of cement grout. Liquid membrane curing compound shall be applied to the finished cement grout surface to facilitate proper curing. Where exterior cement grouting is required, it shall be applied prior to the application of dampproofing material and the liquid membrane curing compound shall be deleted. Exterior cement grout shall be film cured utilizing polyethylene sheets. The District reserves the right to require the entire interior surface above the flow channel to receive a 3/8" to 1/2" thick coating of cement grout, dependent upon existing ground water conditions.
 - (3) All exterior concrete manhole surfaces shall be coated with coal tar dampproofing material. Where ground water is present or, in the opinion of the District, ground water could be present, all exterior joints shall receive a 3/8" to 1/2" thick coating of cement grout. The joint shall be wrapped with an external elastomeric concrete joint wrap covering the area. The need for exterior cement grouting will be determined by the District.
 - (4) Dampproofing materials shall be applied to clean, dry surfaces in accordance with the coating manufacturer's written instructions/recommendations and the following:
 1. Preparation
 - a. Examine surfaces to receive dampproofing to assure conditions are satisfactory for application of materials
 - b. Remove dirt, dust, sand, grit, mud, oil, grease and other foreign matter
 - c. Brush down surfaces to remove all loose scale, fins, dust, etc.
 - d. Complete surface preparation in accordance with manufacturer's recommendations

2. Application

- a. General
 - 1) Apply in three (3) coats with high pile rollers or by spray equipment
 - a) Minimum air pressure: 90 psi
 - b) Spray apply in a fine mist
 - 2) Provide adequate forced ventilation when applying coating in enclosed spaces
 - 3) Do not use benzol or other volatile solvents for thinning coating
 - b. First coat
 - 1) Apply only when surface of concrete is dry and at a suitable temperature for adequate penetration
 - 2) Thin as recommended by manufacturer
 - 3) Apply for maximum penetration
 - 4) Absorbed by concrete within 5 to 30 minutes of application so no continuous film remains on surface
 - c. Second coat: Cover surface with 5 mil film
 - d. Third coat: Produce a high gloss 5 mil film
 - e. Cure material as recommended by manufacturer
 - f. Do not cover with backfill until installation is accepted by inspector
- g. Stub Outs from Manholes. Stub outs from manholes shall not exceed 40 feet except for lines which will be extended in the future. Whenever practical, designs to complete the manhole run shall be submitted to the District Superintendent for review to insure proper grade and alignment for future construction. Future extension of stub outs shall be of like material using the same grade and alignment.
- h. Design Features for Deep Manholes. Manholes which are more than sixteen (16) feet from the finished cover to the pipe invert shall be considered deep manholes subject to special design. The items given below shall be given special attention and subject to approval by the District.
- (1) Intermediate platforms constructed with manhole shaft offsets shall be governed by the OSHA regulations. Regardless of the application of OSHA regulations, an offset intermediate platform will be required on any manhole greater than 24-feet in depth at no more than 12-foot intervals.
 - (2) Structural integrity of precast or cast-in-place concrete structures shall be verified and certified by the responsible design professional for all manholes in excess of 16-feet in depth. Specific attention shall be given to concrete thickness, reinforcing design and concrete strength.
- i. Underdrain. Where an underdrain must be used, the underdrain must be carried under or around the manhole base. In no case shall any underdrain, sump pump or trench drain be connected to the public sewer main.
- j. Service Connection to Manholes. In general, sewer service lines will not be allowed to connect to manholes. Certain exceptions, however, may be made by the District. No sewer service shall connect to the main line closer than 5' to the uphill manhole.

2.10 Relation to Water Mains and Water Supplies. Sewer lines shall be located a minimum of 10 feet horizontally from existing or proposed water mains and the sewer lines shall be a minimum of 18 inches clear distance vertically below the water main. If this clear distance is not feasible, the crossing must be designed and constructed so as to protect the water main from potential cross connections and minimize the potential for structural damage to either pipeline. Minimum protection shall consist of the installation of an impervious and structural sewer as follows:

- a. Where the sewer pipe is above the water main, regardless of separation, one length of ductile iron pipe at least 18 feet long centered over the water main and jointed to the sanitary sewer pipe with a manufactured adapter specifically for such jointing shall be installed. It shall include rubber gasketed fittings with stainless steel tightening bands. The joints shall be enclosed in a concrete collar at least 6 inches thick and extending at least 6 inches either side of the joint.
- b. Where the sewer is beneath the water main but less than 18 inches clear distance vertically, the sewer pipe of any material shall be encased in reinforced concrete. Encasement shall be at least 6 inches thick and extend a distance of 10 feet on either side of the water main crossing. Reinforcing shall consist of a minimum of four No. 4 bars placed at quarter points around the pipe being encased.

The above-described protection from potential cross connections shall apply to service lines as well as sanitary sewer mains where the above described protection and special installation is required.

- c. There shall be no physical connection between a public or private potable water supply system and a sewer or appurtenance thereto which would permit the passage of any sewage or polluted water into the potable supply.
- d. While no general statement can be made to cover all conditions, it is generally recognized that sewers must be kept remote from public water supply wells or other water supply sources and structures in accordance with the applicable Health Department Standards.

2.11 Stream and Drainage Channel Crossings

- a. All stream and drainage channel crossings shall be ductile iron pipe encased in reinforced concrete where the installation is below the flow line of the stream or drainage channel.
- b. Crossings less than 4 feet below existing or proposed channel bottoms shall be supported by reinforced concrete caissons constructed in accordance with the approved special design.
- c. Where the pipeline crossing will be above the stream or drainage channel flow line, special approval and design will be required by the District. All details of the design shall be submitted to the District for review and approval.

2.12 Railroad, Highway and Street Crossings

- a. All work shall be accomplished in accordance with the appropriate permit issued by the responsible agency having jurisdiction over the work.
- b. Crossings under railroads, highways, and streets shall consist of polyvinyl chloride (PVC), ductile iron or epoxy coated steel pipe (carrier pipe) laid inside a steel pipe conduit (casing pipe), which is placed beneath the track or roadway. The steel conduit pipe (casing pipe) shall be jacked horizontally through the ground on substantially the grade of the sewer, with due allowance for the bells or joints of the carrier pipe. As the pipe is jacked along, the earth shall be excavated from the face and removed so that it will not be necessary to force the pipe through solid ground. Specifications for materials and installation of the railroad or highway agency shall govern.
- c. The District reserves the right to require a casing pipe be placed when crossing under a county, town, or city street.
- d. The casing pipe diameter for 16-inch and smaller carrier pipes shall be a minimum of 8 inches larger than the carrier pipe and the casing pipe diameter for larger than 16-inch diameter carrier pipe shall be a minimum of 12 inches larger than the carrier pipe.
- e. After the conduit has been completed, the carrier pipe shall be placed inside and blocked in exact position and grade with a support at least every 8 feet and behind each bell or coupling. A minimum of three blocks or other points of support shall be installed to prevent displacement by floating.
- f. Each end of the casing pipe shall then be plugged tight around the carrier pipe and inside the casing pipe. The plug may consist of a prefabricated rubber boot with stainless steel tightening bands specifically for sealing casing pipe ends.

2.13 Service Lines (Building Sewers)

- a. Service lines and stub outs from main sewers shall be extended to each property at a point 5 feet inside the property line and generally 5 feet above the low lot corner.
- b. Stub outs from a sewer main may be made to an unoccupied lot provided it is part of an officially platted and recorded subdivision. Such stubs shall be extended to 5 feet inside property line and plugged with a watertight and airtight cap or plug insert. Plugging or capping shall be sufficient to perform air testing of the pipeline. Records of the depth and location of the end of the service stub shall be recorded by party responsible for construction and submitted to the District for future reference.
- c. Four-inch diameter service lines shall have a maximum length of 250 feet. A 4-inch diameter cleanout shall be installed on the service lines where the total length exceeds 100 feet and at 75 foot intervals thereafter up to a maximum of 250 feet in length and at each horizontal directional change. The cleanout shall have a proper waterproof cap. For cleanout access, a prefabricated formed wye with a riser pipe shall be installed to the finished grade. A minimum of 10-inch long cast iron riser box

with "SEWER" cast in the lid shall be placed over the cleanout access, flush with finished grade.

Service lines projected to be longer than 250 feet in length shall have pipe 6 inches in diameter or as otherwise required by the District. Provisions for cleanouts shall also apply to pipelines 6 inches in diameter.

- d. No service line within the District's service area will serve more than one property or customer. Each house, building or business shall have an individual connection to the sewer main and service line from the main to the structure served.
- e. All service lines for commercial buildings or multi-family buildings shall be no less than 6-inches in diameter.
- f. A cleanout shall be installed on private sewer services at all changes in direction requiring bends.

2.14 Encasement and Casings.

a. General

Concrete encasements shall be installed under the following conditions:

- (1) Where sewer lines are at a depth too shallow to sustain traffic load or any other load to which they are subjected. The depth may range from 0 to 4 feet, depending on the loading conditions.
- (2) At all locations where infiltration is likely to be high.
- (3) At locations where horizontal movement of the sewer mains may be experienced, such as in stream beds with less than 5' of cover.
- (4) At potable water supply crossings.
- (5) At any location designated by the District Engineer.

b. Design Considerations

- (1) All concrete encasements shall be reinforced in accordance with the District's standard details and shall be of a length to completely span the condition encountered.
- (2) Unless so designed, encasements are for the purpose of pipeline protection and are not to be considered a structural beam. Therefore, special attention to a good foundation and compaction effort for the encasement must be provided.

c. Pipe Casings

Pipe casing shall be used where bores are required under rights-of-way by the governing agency. All pipe casings shall be constructed to conform with the District's

standard details, the Colorado Department of Transportation Standards, and the requirements of any other applicable approving agency.

2.15 Pump Station Design Parameters. Design of pump stations within the District's collection system shall be accomplished on a case by case basis. Pump stations shall not be used wherever gravity sewer service is available. Preliminary considerations and a rationale for the need of the pump station shall be reviewed in detail with the District's Manager prior to proceeding with preliminary and final design. As general guidelines for planning purposes, any pump station considered by the District must include, but is not necessarily limited to the following design features:

- a. Dry pit or wet well mounted pumping equipment.
- b. Multiple pumps.
- c. Standby power generation or dual source of power supply.
- d. Ventilation , heating and dehumidification equipment.
- e. Automatic controls.
- f. Remote alarm system for operating functions.
- g. Emergency overflow storage

2.16 Owner/Developer Costs

- a. Plans and Specifications. All costs associated with the design of sanitary sewer mains and services in accordance with District Rules and Regulations for undeveloped property shall be at the expense of the Owner/Developer.
- b. Construction. All costs associated with the furnishing and installation of sanitary sewer mains and services in accordance with District Rules and Regulations shall be at the expense of the Owner/Developer.
- c. Plan Review and Construction Administration. The Owner/Developer of property shall pay all District costs including administrative, legal, and engineering fees in regard to plan review, preconstruction and construction progress meetings, field inspections, installation compliance, punch list preparation and all other construction expenses related to the development of the property.

2.17 Sanitary Sewerage Plan Submittal Requirements

- a. Plans and Specifications. Three (3) copies of all plans and specifications for facilities to be installed under these rules and regulations shall be furnished to the District. One (1) copy will be returned to the applicant when approved by the District and bear evidence of such approval or comments requiring correction.
- b. Plan Content. As a minimum, the following information shall be required on all plans.

- (1) Plan View: The plan view shall show streets, alleys, rights-of-way and utility easements with the location and size of the sewers, locations and distance between manholes, the slope and other appurtenances indicated. It is desirable for plans to show the proposed size and location of service stubs and the location of all existing or proposed underground utilities and structures located within 20 feet horizontally or vertically, of the centerline of the proposed sewer extension. (The scale is optional, however, 1"=50' is commonly used.)
 - (2) Profile View: The profile view with vertical and horizontal grids shall show the existing ground surface (dotted) and proposed surface (solid). The profile view should also show the proposed sewer with elevations of manhole rims and inverts, the distance and grade between manholes and elevations of utility crossings.
 - (3) Detail drawings: Special detail drawings, made to scale, shall clearly show the nature of design and construction of the following :
 - (a) Special sewer appurtenances such as non-standard manholes and elevated sewers.
 - (b) Special joints and utility or storm sewer crossings.
 - (c) Stream and drainage channel crossings with elevations of normal high and low water levels.
- c. Supporting Data: Submit with the plans and specifications all necessary supporting data to fully describe the proposed installation. This data shall include but not necessarily be limited to a copy of the recorded plat of the subdivision in which the improvements are proposed to be installed and copies of dedicated rights-of-way and easements in which improvements are proposed to be installed. Submit copies of necessary permits from other governmental or private agencies having jurisdiction in the area of the proposed work.

Should a site application for a collection system extension be required by the Colorado Department of Public Health and Environment, the individual party responsible for construction of the facility shall also be responsible for obtaining this site approval.

- d. Upon completion of construction and prior to acceptance by the District, two (2) copies of "as-constructed" plans shall be submitted to the District for record. The two (2) copies shall be complete with all "as-constructed" information together with a certification by the party responsible for construction that all data thereon is accurate and represents actual "as-constructed" conditions. One (1) copy shall be a transparency suitable for blueprint reproduction. "As-constructed" plans shall be submitted within two weeks of completion of the sanitary sewer construction in any identifiable phase of a development. No authorization to connect to the system or discharge to the system will be allowed until the "as-constructed" documents have been received and accepted by the District.

An electronic file of all "As-constructed" record documents and drawings shall be provided to the District. All drawings shall be in an AutoCAD 2002*.Dwg format.

- e. All plans, specifications and supporting documents shall be prepared by or under the direct supervision of a professional engineer registered to practice in the State of Colorado. All plans and specifications shall bear the seal and signature of said registered professional engineer.

2.18 Sewage System and Trench and Foundation Drains

- a. In no case shall any trench drains, foundation drain or other drainage fixture be connected to the District's system which may introduce any wastewater other than sanitary sewage into the system.
- b. All piping material incorporated into the District's sanitary sewage system shall not be white unless utilizing Schedule 40 PVC. At the time of the preparation of these specifications, the predominant pipe color is green. All trench or foundation drainage piping shall be white to preclude accidental cross-connection of the drainage systems.

ARTICLE III

PIPE AND MANHOLE MATERIALS

3.01 PVC Pipe and Fittings (Polyvinyl Chloride)

a. Conformance

ASTM 3034; Standard Dimension Ratio (SDR) shall be maximum of 35.

b. Joints

ASTM D3212; Bell and spigot, push-on with single rubber gasket.

Jointing of dissimilar pipe materials shall be accomplished with a specially manufactured rubber connection with stainless steel tightening bands (Mission Rubber Company, Fernco or equivalent).

c. Length of Joints

The length of joints for flexible conduits shall not exceed 13 feet for grades less than one percent.

d. Criteria for Acceptance. Pipe which has any of the following visual defects will not be accepted.

- (1) Improperly formed pipe such that pipe intended to be straight has an ordinate, measured from the concave side of the pipe exceeding 1/16 inch per foot of length.
- (2) Pipe which is out-of-round to prohibit proper jointing.
- (3) Improperly formed bell and spigot ends or bells which are less than 1-1/2 inches in length.
- (4) Pipe which is fractured, cracked, chipped or damaged in any manner.
- (5) Pipe that has been damaged during shipment or handling.
- (6) Pipe or fittings not properly marked as required by the following specifications.

e. Marking of Material. The following shall be clearly shown on the exterior of the pipe:

- (1) Manufacturer's name.
- (2) Appropriate ASTM designation.
- (3) Appropriate SDR number of 4-inch and 6-inch pipe.
- (4) Homemark.

- f. Material Handling and Storage. Avoid damage to pipe from impact, bending, compression or abrasion during handling and storage.

Store pipe on flat surface which provides even support for the pipe barrel with bell end overhanging. Do not stack pipe higher than 5 feet. Do not store pipe and fittings in direct sunlight for extended periods (greater than two to three weeks). Any discoloration of the pipe material shall be evidence of ultraviolet damage and shall be reason for rejection and the removal from the project.

Ship rubber gaskets in cartons and store in a clean area away from grease, oil, ozone producing electric motors, heat and the direct rays of the sun.

Use only nylon protected sling to handle pipe. The use of hooks, bare cables or chains will not be permitted.

For pipe slopes less than one percent, the maximum pipe joint length shall be 13 feet.

- g. All PVC pipe installed in the District's sanitary sewer system including mains and services shall be non-white in color. Trench and foundation drain piping used in the District shall be white to better assure that there is no accidental connection between the two separate drainage systems.
- h. PVC pipe shall not be installed at depths in excess of fourteen (14) feet without specific approval of the District.

3.02 Ductile Iron Pipe

a. Conformance

ANSI 21.51/AWWA C151; ASTM A536, Grade 60-42-10; Thickness Class 50, unless otherwise required for internal or external loading.

Fittings shall conform to ANSI 21.10 for flanged, mechanical joints and push-on joints (AWWA C110 or C153).

b. Joints

- (1) Mechanical Joint: ANSI A21.11
- (2) Push-On: ANSI A21.11
- (3) Flanged: ANSI B16.1, 125 lb. drilling
- (4) Rubber Gaskets: AWWA C111 (ANSI A21.11)

c. Protective Coatings and Linings

- (1) Exterior Coating: Manufacturer's standard bituminous coating approximately 1 mil thick.

- (2) Interior Lining:
 - (a) Type: Calcium aluminate cement
 - (b) Thickness: Single calcium aluminate lining
 - (c) Design Basis: Griffin-20, SewperCoat lined or equivalent
 - d. Polyethylene Wrapping. All ductile iron pipe shall be installed with an 8 mil thick polyethylene wrapping. The polyethylene wrapping shall conform to AWWA C105 latest revision.
 - e. Criteria for Acceptance. In addition to any deficiencies covered by the reference specifications above, any of the following visual defects will not be accepted.
 - (1) Improperly formed pipe such that pipe intended to be straight has an ordinate, measured from the concave side of the pipe exceeding 1/16 inch per foot of length.
 - (2) Pipe which is out-of-round to prohibit proper jointing.
 - (3) Pipe which is fractured, cracked, chipped or damaged in any manner.
 - (4) Pipe that has been damaged during shipment or handling.
 - (5) Pipe which has lining which is fractured, cracked, chipped or damaged in any manner and would not provide satisfactory service under the conditions intended.
 - f. Marking of Material & Certification of Manufacturer. All materials shall be marked with the name of the manufacturer of origin. Manufacturer will provide a certification to the District that all products supplied to the project site are in conformance with these specifications.
 - g. Material Handling and Storage. Handle pipe fittings and accessories using lifting hoist or skidding to avoid shock or damage. Do not drop such materials. Do not allow pipe unloaded on skidways to be skidded or rolled into pipe previously unloaded. Protect the pipe coatings and linings from damage during delivery and handling.
- 3.03 Manholes. Except as otherwise specifically approved by the District, manholes shall be precast concrete and manufactured in accordance with the referenced specifications.

a. Conformance

Precast concrete in conformance with ASTM C478.

b. Size of Manholes

<u>Size of Sewer Main</u>	<u>Inside Diameter of Manhole</u>
8 inches through 15 inches	4'
18 inches through 30 inches	5'

c. Cement

All cement used in manhole construction shall be Type II or Type IIIA. All concrete shall have a 28-day compressive strength of at least 3,000 pounds per square inch (psi).

Rubber gasketed joints for pre-cast manhole sections shall be an R-4 joint and designed in accordance with ASTM C443.

Manhole joints may be joined with flexible plastic/rubber gaskets constructed of Ram-Nek, Rubber-Nek, Con-Seal or equivalent.

3.04 Cast-In-Place Concrete. All cast in place concrete utilized in sanitary sewer construction shall have a minimum compressive strength of 3000 psi at 28 days unless specifically required otherwise by the project.

a. Aggregates

Conform to ASTM C33, maximum size shall be 3/4 inch nominal diameter.

b. Cements

Portland Cement in accordance with ASTM C150, Type II or IIIA will be used for all concrete.

c. Admixtures

Air entraining admixtures will be permitted in conformance to ASTM C260. Maximum entrained air shall be 6.5% and minimum shall be 5.0%. Water reducing and retarding admixtures may be utilized with the specific approval of the District. Such admixtures shall be in conformance with ASTM C493. Flyash or calcium chloride are not permitted for use.

d. Water/Cement Ratio

Maximum water cement ratio shall be 0.45.

e. Slump

Maintain within the following limits:

1" minimum, 3" maximum for all concrete to be incorporated in sanitary sewerage facilities.

3.05 Castings

a. Cast Iron

(1) Conformance: ASTM A48

(2) Applicable Items: Manhole rings and covers with non-slip surface with "SEWER" cast in the cover. Combined weight will not be less than 310 pounds. Ring shall be a minimum of 4 inches in height and 22" minimum diameter clear opening.

3.06 Steps. All manholes shall NOT have steps installed unless otherwise specifically directed by the District.

3.07 Cement Mortar

Conformance: ASTM A270, Type M.

3.08 Cement Grout

a. Cement

Portland Cement in accordance with ASTM C150, Type II or II LA

b. Sand

Clean, well-graded, natural sand in accordance with ASTM C33

c. Proportioning

One part Portland Cement, 2½ parts sand, by weight, with minimum water required for placement and hydration

3.09 Non-Shrink Grout Approved commercial factory mix product made especially for intended use. Utilize non-metallic chemical grout for non-shrink applications.

3.10 Dampproofing Material

a. Coal tar solution type coating; Tnemec "47-461 Foundation Coating," International "Intertuf 100," Carboline "Bitumastic Super Service Black" or similar approved material

b. External concrete joint wrap; elastomeric protective film wrap; Henry Company Sealants Division, "RUB'R-NEK External Concrete Joint Wrap" or similar approved material

ARTICLE IV
PIPE INSTALLATION

4.01 Subgrade Preparation

See Part III of these regulations.

4.02 General Requirements

- a. A pre-construction meeting must be arranged by the contractor and held prior to the start of any work. The District Engineer, Contractor, and Owner or Owner's Engineer must be represented at this meeting, which shall be held at the office of the District.
- b. All contractors must notify the District at least 24 hours prior to start of construction.
- c. Approved plans and a copy of these specifications must be kept on the job site by the contractor at all times.

4.03 Pipe Laying

- a. Prior to the start of any work where sewer mains to be installed tie into existing District sewer systems, the nearest manhole to the point of tie-in shall be plugged with a plumber's plug on the outlet side by the contractor. This plug shall remain in place until final acceptance by the District. Its purpose is to prevent any mud, water, or other materials from entering the existing line during construction. The contractor shall be responsible for pumping and cleaning these manholes and removing the plug when so instructed by the District Engineer.
- b. Begin pipe laying at the lowest point, unless directed otherwise by the District, and install the pipe with the spigot ends pointing in the direction of flow.
- c. Unless required or directed otherwise by the District, lay all pipe straight between changes in alignment and at uniform grade between changes in grade or slope.
- d. As each length of pipe is placed in the trench, the joint shall be completed in accordance with the pipe manufacturer's recommendations and the pipe shall be brought to the correct line and grade. The offset at the invert shall be less than 1% of the inside pipe diameter.
- e. If approved, the length of joints for curvilinear sewer shall be determined by the radius using joint deflection or radius of curvature not exceeding the manufacturer's recommendations, three degree couplings or a combination of both.
- f. Secure the pipe in place with Class B bedding material tamped under and around the pipe. Do not walk on small diameter conduit or otherwise disturb any conduit after jointing has been completed. Refer to bedding and backfill requirement for thickness of bedding layers.

- g. All foreign matter or soil shall be removed from the inside of the pipe before it is lowered into its position in the trench and shall be kept clean at all times during and after laying. All openings along the line of the sewer shall be securely closed and during suspension of work at any time, suitable pipe plugs or closures shall be placed to prevent water, soil or other materials from entering the pipeline.

4.04 Fittings, Couplings, Wyes and Saddles

- a. Fittings, couplings, wyes and saddles shall be the same material as the pipeline or as specifically manufactured for a particular installation.
- b. Jointing of dissimilar materials shall be permitted only with approval of the District representative. Jointing of such dissimilar materials shall be through the use of fittings, couplings, wyes, saddles, adapters or adhesives specifically manufactured for such transitions.

4.05 Service Lines

- a. Prepare subgrade in accordance with Part III of these regulations.
- b. Installation of any and all service lines whether from the main line to the property line or from property line to the building, must be inspected by the District, who shall be notified by the contractor at least 24 hours prior to installation.
- c. The type of service line connection fitting to be utilized when connecting to an existing main line shall be at the discretion of the District.
- d. Service line connections in new mains shall be constructed with an in-line wye fitting with the branch oriented in the top one-half of the sewer main. Connections made in the lower half or at mid-point of the main shall have prior approval of the District and may require the installation of a backflow prevention device on the service line.
- e. Connection of service lines to existing mains
 - 1) Tee saddles with rubber gaskets to be placed between the saddle and the main line of pipe, secured in place with stainless steel bands are required when a new connection to an existing main is required.
 - 2) Connection to the main line piping with a tee shall be made by cutting a hole using the appropriate hole template, tapping machine or hole saw no more than ¼-inch larger in diameter than the template outline.
 - 3) A 45° or 22-1/2° bend shall be used from the tee fitting to attain the desired grade and slope for the service line piping.
 - 4) The tee saddle shall be furnished with an integral rubber gasketed bell.

- f. All service line piping between the main line and the property line of the property to be serviced shall be pipe in accordance with these specifications with integral rubber gasketed push-on joints.
 - 1) In general, no change in horizontal alignment will be permitted between the connection at the main line and the property line of the property being serviced.
- g. Service line connections shall be separated by a minimum of 3 feet measured center to center along the main.
- h. Plug all service line stubs with water and air tight cap or plug unless the service line will be immediately connected to a building sewer.

Where new street construction is proposed immediately following construction of sanitary sewer facilities, extend the service line to 5 feet inside the property line, install the appropriate plug and mark with a vertical wood marker extending above the surface and having dimensions of 2" x 4" minimum.

- i. Conform to the installation requirements for sewer mains for the installation of sewer service lines in the public right-of-way or easement. Class B bedding shall be required.
- j. The Contractor and/or Developer shall provide complete as-built information on each service line connection installed within his/her work. As a minimum this information shall include the location of the connection to the main referenced to the nearest manhole or other permanent improvement, the location of the end of the service line stub, the direction of the service line as it relates to surrounding permanent surface improvements, the size, the material of construction and the date and name of the installer. All such information shall be provided to the District's representatives for incorporation into the District's permanent records.
- k. Connection of service lines and service line construction shall be accomplished by experienced, qualified personnel with adequate equipment. The District's representative shall have authority to reject work and may not permit work to be accomplished unless done by qualified personnel.
- l. Inspection by the District representative shall be required of each service connection prior to commencing any backfill.

4.06 Manholes

- a. Cast-in-place concrete manhole base
 - 1) Prepare the subgrade and excavation in accordance with the specifications.
 - 2) Provide reinforcing, grade 60 reinforcing bar, No. 4 at 12-inches on center each way for manholes 12-feet or less in depth. Place steel at 8-inches on center each way on manholes in excess of 12 feet in depth.

- 3) Place concrete against undistributed soil to the depth, thickness and other dimensions shown on detailed drawings.
 - 4) Finish and cure the cast-in-place concrete for a minimum period of 24 hours prior to placing precast manhole sections on the cast-in-place base.
 - 5) Maintain ground water below the bottom of the cast-in-place concrete for a minimum period of 24 hours following placement of concrete by maintaining pumping equipment in operation below the subgrade of the manhole base.
 - 6) Concrete shall contain a minimum of 564 lbs of Type 2 portland cement per cubic yard (6 sacks mix), be placed with a maximum slump of 2 inches with maximum size coarse aggregate of ¾-inch (ASTM C33).
- b. Provide segmental precast concrete barrel sections a maximum of 4 feet in length with preformed flexible gasket material between each barrel section as jointing material or install rubber gaskets in precast R-4 joint grooves per manufacturer's recommendations.
 - c. Provide dampproofing of all manhole joints.
 - 1) Provide interior dampproofing consisting of a 3/8" to ½" thick layer of cement grout extending a minimum of 4" each side of all manhole segment joints. Work the cement grout in the joint to completely fill all voids.
 - 2) Provide exterior dampproofing consisting of a 3/8" to ½" thick layer of cement grout extending a minimum of 4" each side of all manhole segment joints. Work the cement grout in the joint to completely fill all voids.
 - 3) When ground water is present or potentially present in the opinion of the District representatives, an application of cold tar epoxy dampproofing material shall be applied to the completed manhole structure after installation of cement grout and prior to backfilling. During construction of all dampproofing measures ground water shall be maintained below the subgrade elevation in the manhole excavation during the time sufficient for all materials to properly cure, no less than 24 hours.
 - d. Provide one, one (1) foot high barrel section beneath a reducing ring or cone cap to bring the manhole ring and cover to within 6 inches of desired grade.
 - e. Provide precast concrete 2-inch-high grade adjustment rings to bring the ring and cover to desired grade. A minimum of one (1) 2-inch adjustment ring is required with a maximum of three (3) grade adjustment rings being permitted.
 - f. Where the manhole base is constructed from cast-in-place concrete, the sewer pipes entering the base shall be cut to length to match the inside of the manhole barrel and set to grade. Manhole gaskets shall be placed over the pipe and centered between the end of the pipe and the outside of the cast-in-place base. The cast-in-place base shall then be constructed to the lines and grades required by the District's

standard specifications and the accepted plans. Sewer pipe shall not be laid through the manhole base and the concrete base and/or invert placed around the pipe.

Where preformed rubber "boots" such as Kor-N-Seal boots are used in precast manhole bases, manhole gaskets on the pipe are not required.

- g. Where intersecting pipelines or pipelines requiring deflections at manholes require that the invert of the manhole be shaped to match the pipe cross sections, such construction shall be accomplished in accordance with the detail drawings of these specifications. Form the flow line configuration of intersecting pipes to allow for free uninterrupted flow of sanitary sewage through and out of the manhole. All channel inverts shall be finished smooth by steel troweling. All inverts shall be placed and finished with a single pour of cast-in-place concrete. Placement of grout and/or other material to repair and/or reshape the manhole invert shall not be permitted unless specifically approved by the District's representative.
- h. Cast-in-place bases for manholes shall be constructed in a manner to provide for a smooth level surface on which vertical barrel sections shall be placed. Completely watertight joints shall be made utilizing preformed flexible gasket material or a precast concrete base section may be utilized. The manhole shall be constructed such that no single section varies from true vertical by more than two percent of the section length.
- i. All manholes constructed in the District shall have the ring and cover elevations set at final street grades or at a point not more than 6 inches above the existing ground in non-traffic areas unless directed otherwise by the District. The Developer/Contractor shall be responsible for adjusting the manhole rings and covers to the final elevations.
- j. In areas where street paving will be placed, the manhole ring adjustment shall be accomplished in a two-step process prior to placement of pavement. The manhole ring shall be constructed 0.5 feet below finished pavement surface elevation. Pavement shall then be placed in accordance with the applicable rules, regulations and specifications. Following completion of paving, the sanitary sewer manhole rings will be raised by the Developer/Contractor to finished grade in accordance with the specifications of the District.
- k. The ring shall be adjusted with precast concrete rings a maximum of 12 inches in height. Cement grout shall be placed to adjust the ring to conform to the surface. A concrete collar shall be placed around the adjusting rings and the ring of the manhole up to a point 2 inches below finished grade. Paving material shall then be placed over the concrete and match the surrounding pavement surface. Tack coat material shall be placed between new and existing asphaltic concrete surfaces, the manhole casting and the concrete collar.

ARTICLE V

TESTING OF PIPELINES AND APPURTENANCES

5.01 Infiltration. Use where ground water may be above the pipeline invert.

- a. Infiltration tests shall be conducted on each segment of the sanitary sewer system where it could be anticipated that ground water may rise above the flow line of the pipeline. Tests shall be conducted by placing an approved calibrated V-notch weir in the line just above the next lower manhole and plugging the line just above the next higher manhole. Sufficient time will be allowed to permit the water level behind the weir to stabilize before reading. Any foreign material hanging to the weir will be dislodged before reading. Successive readings shall be taken until consistent results are obtained.
- b. The maximum allowable infiltration shall be 100 gallons per day per inch of pipe diameter per mile of pipe.
- c. Each segment of pipeline between manholes or other major appurtenances must satisfy and pass the infiltration tests.
- d. Should it be determined that the infiltration rate is in excess of that permitted by these regulations, any repair and/or replacement of pipelines, manholes or other appurtenances shall be at the Contractor's and/or Developer's expense. Satisfactory repair and replacement shall be accomplished prior to the consideration of acceptance of any facility by the District.
- e. The Contractor and/or Developer will furnish all labor, equipment and materials required to accomplish such testing.

5.02 Air Test. All segments of sanitary sewer mains shall be subjected to an air pressure test. Where ground water levels are above the conduit, increase the test pressures given below to compensate for the pressure on the conduit from the ground water.

- a. The Contractor may conduct an initial air test of the sewer main line after compaction of the backfill but prior to the installation of any service lines. Such tests shall be considered for the Contractor's convenience in quality control of the project construction. Final consideration for acceptance of the sanitary sewer by the District shall be based on satisfactory completion of testing with all service line stubs installed.
- b. Preparation of Tests: Flush and clean the sewer line prior to testing in order to wet the pipe surfaces and produce more consistent results. Plug and brace all openings in the main sewer line and the upper end of any connections. Check all pipe plugs with a soap solution to detect any air leakage. If leaks are found, release the air pressure, eliminate the leaks and start the test procedure over again.
- c. Procedure of Test: Add air until the internal pressure of the sewer line is raised to approximately 5.0 psi gage at which time the flow of air shall be reduced and the

pressure maintained between 4.5 and 5.0 psi gage for a sufficient time to allow the air temperature to come to equilibrium with the temperature of the pipe.

- d. After the temperature has stabilized the pressure shall be permitted to drop to 4.5 psi gage at which time a stop watch or a sweep second hand watch shall be used to determine the time lapse required for the air pressure to drop to 4.0 psi gage.
- e. If the time lapse is less than that shown in the table, the Contractor shall make the necessary corrections to reduce the leakage to acceptable limits.
- f. If the time lapse exceeds that shown in the table, the pipe shall be presumed to be within acceptable limits for leakage.

Pipe Dia.(in.)	Minimum Time (min:sec)	Length For Minimum Time (ft.)	Time for Longer Length (L, ft.) (sec)	LENGTH (ft.)			
				100	200	300	400
4	1:53	597	0.190L	1:53	1:53	1:53	1:53
6	2:50	398	0.427L	2:50	2:50	2:50	2:51
8	3:47	298	0.760L	3:47	3:47	3:48	5:04
10	4:43	239	1.187L	4:43	4:43	5:56	7:54
12	5:40	199	1.709L	5:40	5:42	8:33	11:24
15	7:05	159	2.671L	7:05	8:54	13:21	17:48
18	8:30	133	3.846L	8:30	12:49	19:14	25:38
21	9:55	114	5.235L	9:55	17:27	26:11	34:54
24	11:20	99	6.837L	11:24	22:48	34:11	45:35
27	12:45	88	8.653L	14:25	28:51	43:16	57:42

Safety: The air test may be dangerous if proper precautions are not taken. All plugs must be sufficiently braced to prevent blowouts and the pipeline must be completely vented before attempting to remove the plugs.

As a safety precaution, pressurizing equipment shall be provided with a regulator setting of 5 psi to avoid overpressurizing and damaging an otherwise acceptable line.

5.03 Alignment Testing

- a. Each section of pipeline on a linear alignment between manholes will be subject to testing by lamping by the District's representatives to determine where proper alignment has been accomplished and whether any displacement of the pipe has occurred during construction.

The Contractor and/or Developer shall provide suitable assistance to the District's representative in accomplishing this work. The Contractor and/or Developer shall be responsible for repairing any alignment, displaced pipe or other defects discovered during this testing in accordance with these specifications.

- b. For pipelines installed at grades less than 1%, a minimum of 90% of the full pipe

cross section shall be visible at the opposite end of the segment being observed.

- c. For pipelines installed at grades greater than 1%, a minimum of 75% of the full pipe cross section at the opposite end of the segment shall be observed.
- d. The determination of the acceptability of the pipeline alignment by lamping shall rest solely with the District's representative and his decision shall be final.
- e. Pipelines not meeting the requirements of the alignment tests shall be completely excavated, removed and relaid on prepared bedding material, backfilled and compacted in accordance with these specifications and then subjected to infiltration, air pressure and alignment testing.

5.04 Deflection Tests

- a. Proper construction in accordance with these specifications and the manufacturer's recommendations should result in a vertical deflection of the pipe less than 5% of the internal diameter. At the option of the District, the Contractor and/or Developer may be required to perform testing to determine conformance with this requirement.
- b. Should the District determine that deflection testing is required, the Contractor and/or Developer shall provide all necessary equipment, labor and other facilities. Data supplied by the pipe manufacturer's representative for dimensional quality shall be utilized.
- c. Should the vertical deflection of the pipe be found to exceed 5% of the internal diameter, the Contractor will remove the pipe, install proper bedding, replace the pipeline material and properly place and compact all backfill material in accordance with these specifications. Any areas removed and replaced shall be subject to infiltration, air pressure and alignment testing.

5.05 Manhole Vacuum Test

- a. Manholes may be subjected to a vacuum test prior to acceptance by the District. where site conditions indicate that ground water may exist above the pipe invert.

5.06 Internal Video Inspection

- a. All sewer main construction in the District shall be inspected with internal video camera and recording equipment.
 - 1) Coordination with the District shall be required as to cleaning and/or flushing prior to any internal video inspection.
- b. All costs of the internal video inspection shall be borne by the Contractor and/or Developer.
- c. The individual and/or company and permanent video tape recording shall be subject to the acceptance and approval of the District.