

## ARTICLE 9

### CONSTRUCTION REQUIREMENTS

#### PART C: TECHNICAL STANDARDS AND SPECIFICATIONS

##### **9C-1 SANITARY SEWER COLLECTION SYSTEM DESIGN (PUBLIC).**

**9C-1-1**        **General** This publication provides requirements relative to the design and construction of sanitary sewer systems within South Arapahoe Sanitation District and should be used in conjunction with the District's Rules and Regulations. These specifications are generally written for sanitary sewer mains less than 15-inches in diameter or "collection facilities". The District's Rules and Regulations may be obtained at the office of Kennedy/Jenks Consultants, 143 Union Boulevard, Suite 600, Lakewood, Colorado 80228 or online at [www.southarapahoe.org](http://www.southarapahoe.org). In these specifications where reference is made to "District Engineer", the "District Engineer" shall mean any representative of the District's Consulting Engineering firm or other individual designated by the District who provides review observation of sanitary sewer system plans and construction. Where reference is made to specific detailed drawings it shall refer to those drawings included in Section 9C-4, Standard Sanitary Sewer Details.

##### **9C-1-2**        **Sanitary Sewer Main Design Criteria.**

###### **9C-1-2.1**      **Flow Design Criteria.**

**Domestic Wastewater.** Sanitary sewer mains shall be designed to transport Average and Peak Flow quantities of domestic wastewater generated by a development and shall comply with the criteria established in these specifications. Domestic wastewater shall be defined in accordance with the City of Englewood's "Wastewater Ordinance" publication.

Roof drains, foundation drains, sump pumps or storm water drains shall not be connected to the sanitary sewer system. The criteria in Table I shall be considered as minimum criteria and at the discretion of the District, higher unit flow factors may be required for the design of specific facilities such as, but not limited to, auto service stations, car wash, laundries, and shopping centers with restaurant facilities.

**Non-Domestic Wastewater.** Sanitary sewer mains designed to transport quantities of non-domestic sewage shall comply with the criteria established in these specifications. In addition, any and all conditions of the City of Englewood's "Wastewater Ordinance" publication shall also be followed.

**TABLE I -  
QUANTITIES OF WASTEWATER**

<b>Type of Use</b>	<b>Unit Flow Factor</b>
Residential: Single Family (1.0 EQR)	260 gpdu
Residential: Multi-Family (0.7 EQR)	182 gpdu
Residential: Multi-Family (0.6 EQR)	156 gpdu
Retail	0.20 gpd/sf
Office	0.10 gpd/sf
Restaurant	1.50 gpd/sf
Schools	
with Cafeteria & Gym	25 gpsd
without Cafeteria & Gym	15 gpsd
Hospitals	250 gpbd

Any use not addressed above shall be analyzed on a case-by-case basis. Standards developed for any use not listed above will be added to this Regulation by amendment.

EQR	Equivalent Residential Units
gpdu	Gallons per day per unit
gpd/sf	Gallons per day per square foot
gpsd	Gallons per student per day
gpbd	Gallons per bed per day
du	Dwelling Unit

**Definitions:**

Single Family: Detached residential home with 4 bedrooms or fewer.  
(1.0 EQR)

Multi-Family : Townhome or condominium with 3 bedrooms or fewer.  
(0.7 EQR)

Multi-Family : Apartment with 2 bedrooms or fewer.  
(0.6 EQR)

**9C-1-2.2 Hydraulic Design.** Sanitary sewers shall be designed to carry the peak discharge and to transport suspended material such that debris does not accumulate in the sewer. Sewers shall be designed to carry Peak Sanitary Sewer Flow, as follows:

<p><b>Peak Sanitary Sewer Flow = Domestic Flow + Infiltration/Inflow</b> where <b>Domestic Flow = Average Daily Flow x Peak Factor</b></p>
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**Average Daily Flow**

$$\begin{aligned} &= (\text{gal/SFE/day}) \times (\# \text{ SFE's}) && \text{residential} \\ & && \text{or} \\ &= (\text{gal/sf}) \times (\text{area in sf}) && \text{commercial} \end{aligned}$$

**Peak Factor**

$$\begin{aligned} \text{Residential} &= 5/(\text{Population}/1000)^{0.2} = (\text{Babbitt Formula-ASCE}) \\ \text{Max P.F.} &= 4.0 \end{aligned}$$

**Peak Factor for Other Uses**

Retail, Office	2.5
Restaurants	4.0
Hospitals	4.0
Schools	4.0

**Infiltration/Inflow**

shall be 10% of Average Daily Flow

It is essential that the sewer have capacity for the peak annual wastewater flow and adequate velocity at minimum wastewater flows.

Sewer mains shall be designed in order to provide velocities at peak flow of not less than 2 feet per second nor more than 10 feet per second based on Manning's formula:

$$V = \frac{1.49(R^{2/3})(S^{1/2})}{n}$$

Where:            V = mean velocity (ft./sec)  
                      R = hydraulic radius (ft.)  
                      S = slope (ft./ft.)  
                      n = Mannings "n" roughness coefficient

("n" = 0.013 for ductile iron, PVC pipe, or AWWA C-900 PVC pipe.)

The maximum depth of flow in the pipe at peak flow shall not exceed 83% of the diameter for lines without services connected to them, and 50% for lines with services connected to them.

Although the hydraulic characteristics shall be calculated for each portion of a sanitary sewer main, the following slopes are generally permissible for sewer mains:

Size of Sewer (Inches)	Minimum Slope foot/foot	Maximum Slope foot/foot
8	.0040	.150

10	.0028	.120
12	.0020	.110

Note that sewer mains with minimal flow, such as dead-end mains, shall be designed with minimum slopes of at least .01 foot/foot.

Sanitary sewer main sizing shall be dictated by the minimum line size on the lowest portion of the system. Line sizing may only be decreased going uphill - an "upsized" main may not be used to accommodate a flat slope unless all the main line downstream is of equal size or larger.

The minimum diameter for a public sanitary sewer main shall be 8 inches.

**9C-1-2.3 Location and Alignment.**

Streets. Sanitary sewer mains shall be located within dedicated rights of way along an alignment that generally parallels the roadway eight (8) feet inside of the flowline or ten (10) feet from centerline as further referenced in Section 9C-32.1. On streets running north and south, the sanitary sewer line shall be placed on the west side of the street.

On streets running east and west, the sanitary sewer line shall be placed on the south side of the street. On roadways which "meander" in each direction, the sanitary sewer line shall not "zigzag" across the street, but rather a location shall be selected and followed for these types of streets.

**9C-1-3 Easements.** Whenever possible, sanitary sewer mains should be located within dedicated streets. However, when such an alignment is not feasible, sanitary sewer mains shall be located within a deeded easement of a minimum width of thirty (30) feet. In some instances additional width may be required. All easements and associated required information shall be submitted by the Developer/ Owner in accordance with Article 6, Section 6-3 Deeded Easements.

The sanitary sewer main shall be placed along the centerline of the easement with a minimum depth of cover of four and one-half (4.5) feet. Manholes shall be placed at each end of the easement at a location that permits access by large, tandem wheel maintenance vehicles. "Jogs" in sanitary sewer mains with manholes that are located in the backs of lots shall not be permitted. Manholes may be located in dedicated "open space" or "common" areas, provided that access is available along the easement with slopes not exceeding 4:1. The maximum change in direction of a sanitary sewer main through a manhole located within an easement is forty five degrees (45°). Curvilinear sanitary sewer mains are not permitted within easements.

**9C-1-4 Alignment With Other Utilities.** Sanitary sewer mains shall be located whenever possible at least ten (10) feet horizontally from any

water main or appurtenance. This distance shall be measured between the outside diameters of the pipes. In the event that such a separation is not possible, the maximum possible separation shall be designed with the absolute minimum separation being five feet. All of the above variances shall be submitted and approved by the District prior to use.

In the event that a sanitary sewer main must cross a water main, the following criteria shall apply:

**9C-1-4.1**      **Sanitary Sewer Main Crossing Below a Water Main.** If the vertical clearance exceeds 18", no special provisions apply. If the vertical clearance is less than 18", the sanitary sewer main shall be encased in concrete for ten feet on each side of the crossing. See "Concrete Encasement Detail," Drawing Number PUB-18.

**9C-1-4.2**      **Sanitary Sewer Main Crossing Over a Water Main.** If the vertical clearance exceeds 18", no special provisions apply. If the vertical clearance is less than 18 inches, one length of PVC pipe at least 18 feet long shall be centered over the water main. The closest joints between the sewer pipe and the crossing shall be encased in a concrete collar at least 6" thick and extending at least 6" either side of the joint.

In the event that a sanitary sewer main must cross a storm sewer line, the following criteria shall apply:

**9C-1-4.3**      **Sanitary Sewer Line crossing Over a Storm Sewer Line.** If the vertical clearance is less than 18", encase the storm sewer joints 10' each side of the crossing.

**9C-1-4.4**      **Sanitary Sewer Line Crossing Below a Storm Sewer Line.** If the vertical clearance is less than 18", encase the sanitary sewer line 10' each side of the crossing. Polylined ductile iron pipe with polywrap or PVC AWWA C-900 may be used in lieu of an encasement for the sanitary sewer line.

**9C-1-5**      **Curvilinear mains.** Curvilinear mains shall not be allowed. All sanitary sewer mains shall follow horizontally straight alignments between manholes.

**9C-1-6**      **Depth.** All sanitary sewer mains shall be designed so that a minimum of four and one-half (4-1/2) feet of cover shall exist over the top of pipe after final grade has been established, unless otherwise approved by the District.

**9C-1-7**      **Manholes.**

**9C-1-7.1**      **Spacing.** Manholes shall be installed at the end of each line; at all changes in grade, size or alignment, at all junctions or

intersections of sewer mains. Manholes shall be spaced at distances not greater than 400 feet for 8 through 12 inch sewers with a straight horizontal alignment. Horizontal spacing on larger diameter mains shall be reviewed and approved on an individual basis.

**9C-1-7.2**      **Type and Sizing.** Manholes shall be constructed of a poured in place or precast concrete base, precast concrete barrel sections and an eccentric cone section. All precast concrete base sections require approval by the engineer prior to their use in design and construction.

The inside dimension of the manhole shall not be less than 48 inches for sewer mains 8" to 12" in diameter. Cast iron rings and covers shall be provided in accordance with Section 9C-3-4.2; "24" Manhole Ring and Cover Detail," Drawing Number PUB-8. All manholes shall have a 24" diameter ring and cover unless otherwise requested by the District. Manholes on sanitary sewer mains 12" diameter and smaller shall have steps in accordance with Section 9C-3-4.2; "Aluminum Step Detail" or "Plastic Step Detail"; Drawing Numbers PUB-6 and PUB-7, respectively.

**9C-1-7.3**      **Hydraulic Design.** Manholes shall have a minimum drop across the manhole of 0.2 feet along the flow channel. At manholes where there is a change in pipe diameter, the crown elevation of the pipes shall match unless otherwise requested by the District.

Manholes with two or more inlets shall be designed in such a manner to provide a minimum of 0.2 feet vertical separation of the inlet inverts. The inlet carrying the lesser flow shall be raised above the high volume inlet so as not to impede the flow.

**9C-1-7.4**      **Drop Manholes.** Installation of drop manholes shall be avoided wherever possible. However, in any manhole where the invert between the inlet and outlet exceeds 18 inches, an outside drop manhole shall be constructed. Drop manholes shall be constructed in accordance with Section 9C-3-4.3; "Outside Drop Manhole For Pipe 15" and Smaller Detail", Drawing Number PUB-14.

**9C-1-8**      **Service Connections To Manholes.** In most situations, sewer service lines less than 8" diameter shall not be connected directly to a manhole. Services which follow an alignment "behind" a deadend manhole shall be connected to the system by means of a five foot stub of 8" main which is extended beyond the manhole and has a wye or tee fitting for the service line. No more than one service line may be connected behind a manhole.

**9C-1-9**      **Grade Adjustments For Manhole Cover.** Manholes shall be constructed to permit grade adjustments by use of precast concrete adjusting donut risers not to exceed a total height of 12 inches. In open space or landscaped areas, manhole rims shall be set four inches above grade to prevent infiltration from surface runoff.

**9C-1-10**      **Underdrain Systems.** Underdrains shall not be considered part of the sanitary sewer system and the District has no ownership or responsibility for underdrains. Underdrains are not required by the District, and shall only be permitted to convey groundwater which may accumulate around building foundations. Roof drains and other surface water collection systems shall not discharge into an underdrain system.  
(Cross reference: Appendix 4, SASD Sewer Notes, Note 27)

The underdrain system shall be designed by the Owner's Consulting Engineer in conjunction with the recommendations of the Owner's geotechnical engineer. Typical details have been provided in Drawing Numbers PUB-21. These drawings are to be verified with the Owner's Engineer for design requirements and are intended to be minimum requirements. The type of underdrain (i.e.: gravel, solid or perforated pipe, etc.) as well as the capacity and sizing shall be selected by the Owner's Consulting Engineer and submitted to the District for review.

A detailed drawing of the underdrain cross-section shall be included on the sanitary sewer plans. In all cases the pipe materials selected for the underdrain shall equal or exceed those of sanitary sewer mains.

The underdrain system shall be designed and constructed as a groundwater conveying system independent of the sanitary sewer line foundation and bedding material. No allowance shall be taken for the porosity of the sewer main bedding material in calculating the underdrain capacity. Along the plane where the underdrain system and the sewer foundation bedding meet, a barrier material such as polyethylene or mirafi fabric shall be installed in order to prevent the migration of the sanitary sewer bedding material into the underdrain trench and to prevent water from the underdrain from entering the pipe zone.

The underdrain system shall have adequate daylight points to permit the groundwater to drain freely from the system. When a daylight line leaves the underdrain trench, a clay cutoff wall should be constructed immediately downstream in the underdrain trench in order that the groundwater can be collected and transitioned into the daylight line.

When passing around manholes, underdrain systems shall be constructed of a solid wall pipe in order to prevent water from accumulating around the manhole.

Under no circumstances shall a sump condition exist below the manhole base. Cutoff walls may be required upstream of the manhole.

Underdrain cleanouts shall not be permitted to be installed in sanitary sewer manholes.

**9C-1-11**      **Sewer Main Cleanouts.** Cleanouts shall only be permitted on sanitary sewer mains in situations where a main has been extended beyond a manhole as part of a phased construction project. Cleanouts are regarded as temporary and shall only be permitted when reviewed plans specify the location and profile of the main to the next future manhole. Cleanouts shall only be permitted on sewer main stubs of less than 150 feet and where there are no service lines upstream more than five feet from the last manhole. A specific cleanout detail shall be submitted with the plans for review.

**9C-1-12**      **Special Applications.** Special applications or designs of sanitary sewer systems, such as: lift stations, siphons, elevated pipelines, etc. are generally not permitted. Any situations which dictate the need for such an application shall be presented in the form of a written request and preliminary design to the District.

## **9C-2 SANITARY SEWER SERVICE (PRIVATE).**

**9C-2-1**      **General.** The information contained in Section 9C-2 entitled, Sanitary Sewer Service (Private) is intended to control the design, materials for construction and construction procedures on all sanitary sewer services. In providing this information, the District and its agents are in no way responsible for the operation and maintenance of any private sewer service as further detailed in Article 3, Section 3-4-1 of these Rules and Regulations.

The District's concern regarding sanitary sewer services as set forth above is to insure that service connections do not jeopardize the public sanitary sewer facility in any way.

Design, materials of construction and construction procedures shall conform to the methods set forth hereafter and as represented in the latest edition of the Uniform Plumbing Code or whichever regulation is most stringent, or as required by the District and the District's Engineers.

**9C-2-2**      **Sanitary Sewer Service Design Criteria.**

**9C-2-2.1**      **Flow Design Criteria.** Flow design criteria for residential and non-residential sanitary sewer service lines shall be based on the estimated peak flow in accordance with these specifications and shall comply with the latest edition of the Uniform Plumbing Code.

**9C-2-2.2**      **Hydraulic Design.** Service lines shall be designed to carry the peak discharge and transport suspended materials from the "building sewer" to the collection main. Service lines shall be laid to a constant grade between the collection main and the outlet of the "building sewer". In

situations where the collection main is extremely deep (greater than 20 feet), the service line may be laid at a constant slope to a point where an angle fitting is installed to make a relatively steep (45° - 60°) connection to the collection main.

Although the hydraulic characteristics of each sanitary sewer service line shall be calculated by the Developer's Engineer, the following slopes are generally permissible for service lines:

Diameter	Minimum Slope Foot/Foot	Minimum Fall Inch/Foot
4"	0.0208	1/4
6"	0.0104	1/8

The minimum diameter for a sanitary sewer service line shall be 4 inches. It is not permissible to use a 6" service or larger on single family homes to minimize slopes due to solids separation concerns.

**9C-2-3**      **Location and Alignment.** Each single family residential detached and attached dwelling unit shall have a separate sanitary sewer service line and tap. Townhomes, condominiums and apartments which are designed to utilize common plumbing within the structure may have a service line that serves more than one dwelling unit. However, in these situations provisions must be established by the Covenants, or Development Guidelines to provide for maintenance and cleaning of the common facilities to protect the individual users.

Service lines shall follow a straight horizontal alignment between the outlet of the building sewer and the connection to the collection main.

Sanitary sewer service lines shall be located within the limits of the property it serves, or within public rights-of-way.

**9C-2-4**      **Depth.** All sanitary sewer service lines shall be designed so that a minimum of four and one-half (4.5) feet of cover exists over the top of pipe after final grade has been established, unless otherwise approved by the District Engineer.

**9C-2-5**      **Manholes.** All manholes on sanitary sewer service lines 8-inch diameter and smaller, must be reviewed and approved by the District. Manholes for sanitary sewer service lines 8" diameter and larger, shall comply with the District's Standards and Specifications.

**9C-2-6**      **Underdrain Systems.** Underdrain systems which are installed in conjunction with sanitary sewer service lines shall comply with all provisions of the above section referring to underdrains. Drawing Number PUB-21 shall be used only as a minimum requirement.

These underdrain details shall be reviewed by the Owner's engineer for adequacy.

**9C-2-7**      **Sewer Service Cleanouts.** Cleanouts shall be installed on sewer service lines per the latest revision of the Uniform Plumbing Code or at points of horizontal and vertical deflection which exceed 135 degrees; or on service lines which exceed 100 feet in length. The cleanout diameter shall match the nominal diameter of the service line and shall be constructed in accordance with "Inline Cleanout Detail," Drawing Number PRI-4. Care shall be taken to locate cleanouts at a point where surface water does not accumulate. When cleanouts are to be located in existing or future landscaped areas, the cleanout cover shall be placed 4-6 inches above finished grade.

**9C-2-8**      **Sand/Oil And Grease Interceptors.** When a grease and/or sand trap is required under Section 9A-3 hereof, the Property Owner shall, at his own cost and expense, install the required trap on the sewer service line. The sizing of the grease trap shall be determined by the Owner's Engineer in accordance with Section 9C-3-10.5 and submitted to the District for review. The "Low and High Rate Commercial Grease Interceptor", and the "Low and High Rate Oil and Sand Interceptor", Drawing Numbers PRI-7 and PRI-8, respectively, shall be used as a guideline for design and construction. However, the ultimate ownership and maintenance of the grease interceptor shall be the responsibility of the Owner. Bypasses shall not be permitted around the grease interceptor.

Facilities which discharge any quantities of sand, oil or other inert debris into the sanitary sewer system shall have a sand/oil interceptor installed on the sewer service line. Examples of such facilities include, but are not limited to: automobile service station, mechanical repair shop, car wash, garden nursery, warehouse, and garages with floor drains for parking vehicles. The sizing of the sand/oil interceptor shall be determined by the Owner's Engineer and submitted to the District for approval. Ownership and maintenance of the sand/oil interceptor shall be the responsibility of the Owner. Bypasses shall not be permitted around the sand/oil interceptor.

Although a facility may not have been originally constructed with a sand/oil or grease interceptor, the District may require that one be installed in the event of a change in the type of use of the facility. All costs shall be borne by the Owner.

**9C-2-9**      **Lift Stations.** Lift stations shall be permitted to provide service to a individual unit in the event that gravity service is not possible by any other means. Lift stations shall not be used as an alternative to extending a gravity service line which may be longer or deeper than "normal".

Lift stations shall be designed by the Owner's Engineer and shall include a commutator or grinder for all solids. The force main shall be

sized based on the maximum discharge flow of the pump, 3-inch minimum.

All proposed lift stations and their connection to the private sewer service system shall be submitted to the District for review and approval. Direct connection of force mains to public sanitary sewer facilities will not be permitted. The private force main must transition from a pressurized application to a standard gravity system for a standard connection to the public sanitary sewer facility.

Approval for the use and design of the lift station shall also be obtained from the local Building Department and Tri County Health Department.

All costs, maintenance and operation of the lift station, force main and gravity service line shall be the sole responsibility of the Owner.

- 9C-2-10**      **Industrial Waste Pretreatment.** Any development which generates industrial wastewater (i.e. nonresidential wastewater) shall be required to provide pre-treatment of the wastewater prior to the wastewater entering the public sanitary sewer system. It shall be the responsibility of the Owner to be in compliance with the City of Englewood's "Wastewater Utility Ordinance". The Owner shall contact the Treatment Plant to determine the type and degree of pretreatment required.

### **9C-3 MATERIALS, TESTING AND INSTALLATION.**

#### **9C-3-1      Purpose and General Requirements.**

- 9C-3-1.1**      **Scope.** All sanitary sewer mains, services and related facilities within the South Arapahoe Sanitation District, or for future connection to the South Arapahoe Sanitation District, shall be designed and operated in accordance with these Rules and Regulations. Any deviation from these standards shall be approved in writing by the District.  
(Cross reference: Appendix 4, SASD Sewer Notes)

All sanitary sewer construction shall be in accordance with construction plans prepared under the direction of a Professional Engineer registered in the State of Colorado and which have been reviewed and signed by the District.

#### **9C-3-1.2      General Requirements.**

- (1) A pre-construction meeting shall be arranged by the District and held prior to the start of any work. The District Engineer, Contractor, Soils Engineer, Surveyor, and Developer or Developer's Engineer must be represented at the meeting, which shall be held at the construction site or at the District Engineer's office.

- (2) Contractors shall notify the District of their construction schedule at least 48 hours prior to the start of construction.
- (3) Reviewed plans which have been signed by the District Engineer and a copy of these specifications shall be kept on the project site by the Contractor at all times.
- (4) All materials not conforming to the requirements of these Specifications shall be considered defective. Whether in place or not, such material shall be removed immediately from the project site. Rejected material which has been subsequently corrected shall not be used until the District has reviewed the material and found it to be in acceptable condition.

The District shall not consider conveyance and acceptance of a facility in which the contractor has failed to comply with any requirement the District made under the provisions of this section.

- (5) The District shall provide final determination of any and all questions which may arise during construction as to the quality and acceptability of the materials furnished, work performed and quality of workmanship for all sanitary sewer construction performed on the District's sewer facilities.

The District, its representative, and/or the District Engineer, is not a guarantor of the construction Contractor's obligations and performance of contract.

Observations of work in progress and onsite visits are not to be construed as a guarantee by the District or District Engineer, of the Contractors' performance.

The District and/or District Engineer, is not responsible for safety in, on or about the project site, nor for compliance by the appropriate party of any regulations relating thereto.

The District and/or District Engineer, exercises no control of the safety or adequacy of any equipment, building components, scaffolding, forms, or any other work aids used in or about the project, or in the superintending of the same.

## **9C-3-2      Location of Lines.**

- 9C-3-2.1      Sanitary Sewers in Streets.** When sanitary sewers are to be located in streets, they shall be placed as follows:

- (1) On streets running generally north and south, the sewer line shall be placed 10' (ten feet) west of the street centerline.
- (2) On streets running generally east and west, the sewer line shall be placed 10' (ten feet) south of the street centerline.
- (3) 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 location shall be as determined by the District. Curvilinear sewer mains shall not be allowed. Designs shall attempt to minimize the number of manholes.
- (4) In no case shall the sewer line be installed closer than 5'0" to the lip of a crossspan or gutter.

**9C-3-2.2**

**Record Drawings.** The Contractor shall maintain on the job site, a full-scale set of Construction Plans indicating the field installed conditions. These drawings shall be current and maintained at all times until completion of the work and shall be available for review by the District at all times. All variations previously reviewed which differ from the signed and reviewed Construction Plans, for whatever reason, including those occasioned by optional materials, and those required by coordination between trades, shall be indicated. These variations shall be shown in the same general detail utilized in the original design. Upon completion of the work, the as-recorded drawings shall be furnished to the District for review. After the District has reviewed the as-recorded drawings, the drawings shall be returned to the Owner's Engineer. The Owner's Engineer shall use the as-recorded plans to prepare half sized (12" x 18" or 11" x 17") mylars, and a CD in AutoCad format.

The following construction information shall be added to the mylars at a letter and pen size that will be legible after reduction is completed.

Date Installed: \_\_\_\_\_  
 Contractor: \_\_\_\_\_  
 Field Engineer: \_\_\_\_\_  
 Soils Engineer: \_\_\_\_\_  
 Surveyor: \_\_\_\_\_

The finalized half-size drawings must be presented to the District prior to final testing and acceptance of the project.

**9C-3-2.3**      **Sanitary Sewers in Easements.** When sanitary sewers are to be located in easements, they shall be located within the easements shown on the construction drawings. Easements shall be minimum of 30' (thirty feet) in width, and shall be prepared in accordance with the District Rules and Regulations. No sanitary sewer line shall be located less than 10' (ten feet) from the edge of the easement.

Sewer lines in unpaved easements shall be AWWA C 900 Class 200 PVC, polyvinyl chloride pipe per Section 9C-3-3.4. "Y" fittings for service connections shall be AWWA C-900 Class 150.

**9C-3-3**      **Pipe.**

**9C-3-3.1**      **General.** No public sanitary sewer line shall be less than 8 inches in diameter. Private sewer services may be 4 or 6 inches in diameter. No service line shall be less than 4 inches in diameter. The minimum and maximum slopes for sewer lines shall be as shown in Table II below. The slope between manholes must be uniform.

**TABLE II**

Size of Sewer (Inches)	Minimum Slope Feet per Hundred Feet	Maximum Slope Feet per Hundred Feet
4 (Service Lines)	2.08	25
6 (Service Lines)	1.04	20
8	0.40	15
10	0.28	12
12	0.20	11
15	0.15	8.5
18	0.12	6.5

**NOTES:**

1. Where it is necessary to design or install sewers with greater slope than the maximum indicated in Table II, special provisions shall be made to protect against pipe displacement and corrosion. Prior approval is required from the District Engineer in any case involving such slopes. The table is based on 2.0 fps minimum and 10 fps maximum velocity and Manning's  $n = 0.013$ .

Minimum slopes for pipe sizes greater than 18" require review and approval of the District Engineer.

2. Sewer mains with minimal flow, such as dead-end mains, shall be designed with minimum slopes of at least .01 foot/foot.
  - (1) Vitrified Clay Pipe (VCP) is not accepted by the District for use in new construction. Where new construction or maintenance requires connection to existing VCP. All connection material and/or couplings shall be reviewed by the Engineer prior to use.

### **9C-3-3.2**

#### **Polyvinyl Chloride Pipe (PVC).**

- (1) Material - All plastic pipe shall be polyvinyl chloride (PVC) and shall meet the requirements of ASTM D 1784 "Rigid Poly (Vinyl Chloride) and Chlorinated Poly (Vinyl Chloride) Compounds" and ASTM D 3034 SDR 35, (sizes 4" through 15") or ASTM F 679 SDR 35 (18" through 27"), " Polyvinyl Chloride (PVC) large diameter plastic gravity Sewer Pipe and Fittings" latest revision. Pipe and fitting markings shall include the appropriate ASTM and Cell Classification Numbers (12454-B or 12454-C or other ASTM approved classifications). Unmarked pipe and fittings will be rejected. Any pipe material for sizes greater than 15 inches shall be reviewed on an individual basis.
- (2) Straightness - Maximum allowable curvature as measured from the concave side of the pipe shall not exceed 1/16" per foot of length.
- (3) Deflection/Internal Diameter - Pipe shall be installed so that the internal diameter does not decrease by more than 5 percent. Contractor's attention is called to Section 9C-3-7 "Installation of Sewer Pipe" and Section 9C-3-9 "Tests and Construction Observation" of these specifications.
- (4) Pipe Installation and Field Testing - Pipe shall be installed in full compliance with the recommended practice for "Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity Flow Applications" ASTM D 2321 and in accordance with Section 9C-3-7, "Installation of Sewer Pipe" of these specifications.
- (5) Final Acceptance – Prior to start of Contractor's workmanship and warranty period, pipelines constructed of flexible materials shall be measured for vertical ring deflection by a Go-No-Go gauge. Maximum ring deflection of the pipeline shall be limited to 5

percent of the vertical internal pipe diameter. All pipe exceeding this deflection shall be considered to have reached the limit of its serviceability and shall be replaced and retested prior to final acceptance.

The District shall determine the footage to be tested, but in no case shall the test section be less than 400 feet or the distance between successive manholes, whichever is less. The Go-No-Go gauge shall be approved by the District prior to testing.

**9C-3-3.3**     **Ductile Iron Pipe.** (DIP) - Ductile iron pipe furnished under this specification shall be manufactured in strict accordance with AWWA C 151 latest revision with the following additional requirements.

- (1)     Size of Pipe - This specification shall include ductile iron pipe 12" (twelve inches) in diameter and smaller.
- (2)     Joint Type - Ductile iron pipe joints shall be "Push-on joint single gasket" or "Mechanical joint single gasket". The rubber gasket shall conform to the requirements of AWWA C 111 latest revision.
- (3)     Thickness Class - Pipe furnished shall be minimum Class 50 for sixteen inch (16") diameter and smaller pipe and minimum Class 51 for eighteen inch (18") diameter through twenty four inch (24") diameter pipe. Specific site conditions or special design considerations may require an increase in pipe class.
- (4)     Laying Length - Pipe furnished shall have a normal laying length of eighteen feet (18') or twenty feet (20').
- (5)     Grade of Iron - Iron used in the manufacture of pipe shall have 60/42/10 physical properties.
- (6)     Lining - All pipe furnished shall have Polyethylene lining (Polybond) complying with ASTM 1248 bonded to the pipe wall 40 mil minimum thickness.
- (7)     Polyethylene Wrapping - All ductile iron pipe shall be installed with an 8 mil thick polyethylene wrapping. The polyethylene wrapping shall conform to AWWA C 105 latest revision.

**9C-3-3.4**     **AWWA C 900 Polyvinyl Chloride Pipe (PVC).**

- (1)     General - All AWWA C 900 polyvinyl chloride pipe (PVC) furnished under these Specifications, shall be manufactured in strict accordance with AWWA

Standard Specifications C 900, latest revision, with the following additional requirements:

- (2) Size of Pipe - This Specification includes PVC pressure class pipe eight inches (8") through twelve inches (12").
- (3) Thickness Class - Pipe furnished under this Specification shall be a minimum of Class 200, SDR 18 with a minimum sustained pressure requirement of 500 psi and a burst pressure requirement of 755 psi at 73.40 F. "Y" fittings shall be C-900 Class 150.
- (4) Laying Lengths - Pipe shall have a normal laying length of twenty feet (20'), or ten feet (10') where designated for curved roads or easements. Random lengths shall not be acceptable.
- (5) Joint Type - Pipe joints shall be made using an integral bell and spigot type elastomeric gasketed push-on type joint. Solvent cement joints are strictly prohibited. Gaskets shall conform to ASTM F-477.

#### **9C-3.3.5**

**Connection Joints.** The connecting joints shall be full circumference compression couplings and shall conform to the requirements outlined in ASTM C 594 for chemistry, weight and permissible variations in dimensions. This joint shall be used when connecting dissimilar pipe materials or as a sewer line repair clamp.

- (1) Shear Ring - All couplings shall have an adjustable stainless steel shear ring.
- (2) Bushings - Bushings shall be used as required when changing pipe materials. The bushing shall be made of the same material as the compression coupling.
- (3) Use solid sleeve couplings to perform PVC pipe repairs in order to maintain pipe grade and alignment.

#### **9C-3.3.6**

**District Statement.** PVC is the pipe material preferred by the District for use in sanitary sewer construction. Pipe materials proposed for use in the transportation of raw wastewater not included in these specifications must be reviewed by the District.

### **9C-3-4**

#### **Manholes.**

##### **9C-3-4.1**

**General.** Manholes shall be a minimum of 48" (forty-eight inches) in diameter (reference standard manhole detail for required manhole diameter sizing) and shall be installed at the end of each sewer line project, and at all changes in grade, size, or alignment. Manholes shall be installed at distances not

greater than 400' for sewers 15" (fifteen inches) in diameter or less. All manholes in excess of 20' (twenty feet) in depth, measured from cover to invert, shall have an intermediate platform located at the center of the depth, in accordance with the "Intermediate Platform Detail", Drawing Number PUB-5.

**9C-3-4.2**

**Standard Manhole Design.** Manholes shall have an inside diameter at least 2' greater than the outside diameter of the sewer pipe or pipes entering and leaving the manhole, but in no case shall any manhole have an inside diameter less than 4'. Where a second, smaller sanitary sewer line enters a manhole, the invert in of the smaller line shall be a minimum of 0.2' higher than the invert in of the main line. As a rule of thumb, where smaller lines connect to outfall lines, the crown of the smaller line shall match the crown of the outlet sewer line. In all cases, capacity and hydraulics of connection must be reviewed by the District to ensure a smooth flow transition has been provided. The bench shall slope 1 inch per foot towards the center of the manhole. In no case shall a second line be allowed to intersect with the main line at an angle less than 90°, with the outlet portion of the main line. A minimum drop of 0.20' through the manhole will be required from inlet to outlet.

- (1) Cast-In-Place Concrete Bases - The base on all manholes shall be a minimum of 8" below the pipe O.D. and the overall outside base dimensions shall be one foot (1') greater than the outside diameter of the pipe.

The base shall be constructed of premixed concrete composed of a mix of well-graded, well washed, calcareous aggregate, ranging from sand to gravel one and one-half inches (1-1/2") in maximum diameter. The mix shall contain five (5) sacks of Type II cement to the cubic yard and only enough water shall be used in the mix to give it a slump test of 2". Air entrained in the mix when placed shall be between 3 and 5 percent. Cylinders taken from the mix shall, in 28 days, have not less than 3,000 pounds per square inch compressive strength. Base reinforcing steel (#4 rebar at 12" on center each way) shall be in accordance with the "Standard Manhole Detail", Drawing Number PUB-3. Bases shall be poured monolithically with the adjoining barrel section and shall be reinforced with #4 bars on 12 inch centers each way.

(Cross reference: Appendix 4, SASD Sewer Notes, Note 12)

- (2) Precast Concrete Bases - Precast bases furnished under this specification shall be manufactured in

accordance with ASTM C 478, latest revision with the following additional requirements.

Precast concrete bases require written approval from the District's Engineer prior to the completion of the design.

Concrete used in precast bases shall use Type II cement and yield 4,500psi compressive strength within 48 hours of manufacture.

After base section forms are stripped, the base shall be reviewed for cracks and honeycombs. Cracks and honeycomb areas shall be patched and resurfaced prior to final curing. Cored pipe openings in bases shall be reviewed for exposed reinforcing steel. Any exposed reinforcing steel shall be coated with coaltar or epoxy paint.

Manhole steps shall be installed in the base/barrel sections after they are loaded on the truck for delivery: Manhole steps shall be MA Industries, Inc. PS2-PF CO polypropylene plastic - encapsulated grade 60 steel steps.

Forsheda F 910 gaskets shall be used to join 4-inch through 18-inch ASTM D 3034 PVC pipe to precast bases. For PVC pipe over 18 inches, or AWWA C- 900 Class 200 pipe, a specific gasket submittal is required as Forsheda does not manufacture gaskets for pipe greater than 18 inches in diameter. Prior to placing the pipe through the Forsheda gasket, a 1-inch thick bead of bently resin Corseal CS 102 or CS 202 concrete sealant shall be placed between the pipe and core hole.

Bases shall be set on 12 inches of 1-1/2 inch crushed rock bedding for leveling and structural stability. Key lock lifting inserts shall be filled with grout prior to backfilling.

- (3) Precast Concrete Manhole Sections - Concrete manholes shall be constructed of precast concrete barrel sections composed of concrete meeting ASTM C 33. Cement used shall meet ASTM C 150. The concrete mix shall be made with Type II cement with a cement factor of five (5) sacks per cubic yard. Course aggregate shall be no less than 40% of the combined mix. The minimum core strength in 28 days shall be 4,500 psi. Top section, "cone section" shall be eccentric and shall be approximately one foot (1') below finished grade of the street so the ring and cover can be brought to the finished grade with one (1) brick course

or one concrete ring riser section (precast concrete donut) when final grade of the street is established.

Manhole barrel sections shall be embedded in bituminous mastic (Ram-Neck or approved equal) and shall be water tight. All inside joints shall be filled with a mixture of mortar and Type II cement.

- (4) Manhole Steps - Aluminum or plastic steps in accordance with "Aluminum Step Detail," or "Plastic Step Detail;" Drawing Numbers PUB-6 and PUB-7, respectively, and shall be firmly embedded in the walls of all manholes and be placed in a straight line 12" O.C. vertical on the straight side of the manhole. Only aluminum and plastic steps shall be used. Steps must be positioned to allow no more than 18" spacing from the rim to the first step, and 12" spacing thereafter, the bottom step shall be 8" above the bench.
- (5) Ring and Cover - Manhole covers shall be of close-grained gray iron solid cover design conforming to the "24" Manhole Ring and Cover Detail", the "30" Manhole Ring and Cover Detail", or the "Double Manhole Cover Detail", Drawing Numbers PUB-8, PUB-10 and PUB-11. Manhole frames and covers shall be dipped in a coaltar varnish. They shall be equal to the City of Denver Standard Traffic Pattern and weigh approximately 400 pounds. Covers shall be solid, and shall be machined so that they will not rock under traffic. Aluminum manhole rings and covers are not allowed. Where final manhole rim elevations are below the 100 year flood plain water surface elevation, a watertight bolt-down ring and cover shall be provided in accordance with the "24" Ring and Bolt-Down Cover Detail", Drawing Number PUB-9. Pick holes shall be constructed so water may not pass through the pick hole and enter the manhole. The word "Sewer" shall be boldly cast in a readily visible location on the cover. Where ring and cover must be bricked up to finished street grade, a maximum of four (4) courses of brick or precast concrete doughnut shall be used. If greater than 12" is necessary to bring the manhole to finished grade, additional concrete barrel sections shall be added. Final cover elevation shall be in accordance with Arapahoe County Standards and the "Standard Manhole Detail", Drawing Number PUB-3.
- (6) Flat Top Cover - Flat top covers shall be used with written permission of the District. Flat covers shall be a minimum of 8" thick and designed to with-stand a minimum H-20 traffic loading.

- (7) Interior Lining - All outfall manholes, drop manholes, or other manholes as determined by the District, shall have an interior lining acceptable to the District.

Color selection shall be reviewed by the District. (Typically a gray or light color is acceptable.)

- (8) Exterior Coating - When required by the District, exterior joints of all manhole structures shall be coated with a waterproof bituminous membrane, or equal. The membrane shall be applied after the joints are grouted and shall lap the joint a minimum of six inches (6"). The Contractor shall submit material specifications for the bituminous membrane to the District for review prior to construction. The exterior coating shall be applied per manufacturer's recommendations.

- (9) Final Grade Adjustments - Final grade adjustments shall be made using a minimum of four inches (4") of concrete grade rings. Concrete grade rings (concrete donuts) shall make up the riser section providing the riser section does not exceed twelve inches (12") vertically.

Brick courses and steel grade rings are allowed for vertical adjustment. If the riser section exceeds the vertical limitation, the riser and eccentric cone section shall be removed and the appropriate sized barrel section added, followed by cone and grade ring replacement. Slanted final grade adjustments, to account for street cross slopes, shall be made using brick chips and cement mortar. Street paving modifications for overlay asphalt will allow for steel grade ring use.

- (10) Marker Posts - Marker posts are required adjacent to manholes or other appurtenances installed outside of paved rights-of-way in order to provide a physical reference for field location.

Marker posts shall be one of the following materials:

1. 3-inch or 4-inch diameter Diameter Steel Post, painted yellow, and filled with concrete.
2. 4"x4" or 6"x6" Redwood Post
3. Green/Flat Type Carsonite Post

. The appurtenance description, size, type, and distance from the post shall be stenciled directly on the

marker post in the case of a steel post, routed in the case of a redwood post, or placed with a label in the case of a carsonite post. .

Marker posts shall be installed at the locations indicated on the reviewed and signed plans and at other locations requested by the District during construction. Marker post installation shall be performed in accordance with the details, found in Section 9C-4, Drawing Numbers PUB-15, PUB-16, and PUB-17 of these Specifications.

**9C-3-4.3**      **Drop Manholes.** Sanitary sewer lines shall be designed to eliminate drop manholes wherever possible. Should a drop manhole be required, it shall conform to "Outside Drop Manhole for Pipe 15" and Smaller Detail," Drawing Number PUB-14, and be submitted to the District for review prior to start of construction.

Drop manhole bases shall be constructed large enough to form a base for the concrete encasing the sewer pipe drop entering the bottom of the manhole. The drop entering the manhole shall be completely encased in concrete up to the springline of the pipe of the main sewer line. All manholes with a drop of 18" or greater must be constructed with an outside drop. The maximum amount of vertical drop allowable in a drop manhole shall be 6 feet. A pipe access must be placed in the manhole and shall be constructed in accordance with the "Outside Drop Manhole for Pipe 15" and Smaller Detail, Drawing Number PUB-14. All drop manholes must be completely lined with Strong Seal or equal as approved by the District Engineer.

**9C-3-4.4**      **Underdrain.** If the developer or his geotechnical engineer deem it advisable to install an underdrain, he shall do so and include all installation details in the Standard Details, PUB-21, PRI-5, and PRI-6. In no case will underdrains be allowed to connect to the sanitary sewer system. Pipe used in underdrains shall be of the same quality and pipe class as the sanitary sewer. Cut off walls of expansive clay or concrete shall be used to terminate pipe underdrains from the sewer trench before daylighting to a drainage course previously approved by the appropriate drainage authority or jurisdiction. Underdrains are not to be construed as a part of the sanitary sewer system and are not subject to maintenance by the District.

**9C-3-5**      **Cleanouts.** Cleanouts on public sewer lines will not be permitted. Cleanouts shall be installed on private sewer services under the following guidelines and in accordance with the "In-Line Cleanout Detail", Drawing Number PRI-4.

**9C-3-5.1**      At all changes in direction requiring bends.

**9C-3-5.2** Not more than 100' of continuous sewer service line shall be installed without at least one cleanout per 100-ft section.

**9C-3-5.3** Cleanouts shall be located such that all portions of the line can be cleaned by rodding or jet cleaning.

**9C-3-6** **Encasements and Casings.**

**9C-3-6.1** Concrete Encasements - Concrete encasements shall be installed where approved by the District Engineer, 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.
- (2) At all locations where infiltration is likely to occur.
- (3) At locations where vertical cover in stream beds could be reduced due to stream bed erosion.
- (4) At potable water supply crossings. See Section 8, and the "Sewer Crossing Detail", Drawing Number PUB-20.
- (5) At any other location designated by the District.

Concrete encasements shall be reinforced in accordance with the "Concrete Encasement Detail", Drawing Number PUB-18, and shall be of a length to completely span the condition encountered. Special attention to existing soils conditions, structural sections, and compaction effort for the encasement must be provided. Based on site specific information, encasement design and construction shall be considered by the District on a case-by-case basis at the discretion of the District.

**9C-3-6.2** **Pipe Casings.** Pipe casings shall be used where bores or protective installations are required. All pipe casings shall be constructed to conform with the "Pipe Casing and Sled Detail", Drawing Number PUB-23, and shall be subject to review by the District.

**9C-3-7** **Installation of Sewer Pipe.**

**9C-3-7.1** **Excavation.** Excavation for pipelines, fittings, and appurtenances shall be an open trench excavation to the depth required by the approved Construction Drawings. Any water which may be encountered or may accumulate in the excavation shall be pumped out or otherwise removed to keep the bottom of the excavation free and clear of water during the progress of the work.

Tunneling may be permitted where dictated by economy of construction or necessity of preserving existing improvements. It is the Contractor's responsibility to employ necessary safety precautions when tunneling. In all cases tunneling shall be reviewed by the District prior to start of construction.

**9C-3-7.2**      **Limit of Excavation.** Except by expressed written permission of the District, the maximum length of open trench shall be 600 feet or the distance necessary to accommodate the amount of pipe installed in a single day, whichever is smaller. The distance is the collective length at any location, including open excavation, pipe laying and appurtenances, construction and backfill in pavement which has not been temporarily resurfaced. The trench shall not be left open when the Contractor has left the project site and is not engaged in construction operations.

**9C-3-7.3**      **Trench Width.** Trench width at the ground surface may vary with and depend upon depth, type of soils, and position of surface structures. In general, the minimum clear width of the trench, sheeted or unsheeted, measured at the top of the pipe should be one foot (1') greater than the outside diameter of the pipe. The maximum clear width of the trench at the top of the pipe should not exceed a width equal to the outside pipe diameter plus two feet (2'). If the above defined trench widths must be exceeded or if the pipe is installed in a compacted embankment, the pipe embankment should be compacted to a point of at least 2.5 (two and one-half) pipe diameters from the pipe on both sides of the pipe or to the trench walls, whichever is less.

Where the trench width, measured at the top of the pipe, is wider than the maximum set forth above, and at the direction of the District, the trench area around the pipe shall be backfilled with 2500 psi concrete to form a cradle for the pipe in accordance with the "Special Bedding Details", Drawing Number PUB-2. Special care shall be used when pouring the concrete cradle around the pipe so pipe movement does not occur.

**9C-3-7.4**      **Excavation Below Grade.** The trench shall be excavated to a depth six inches (6") minimum below specified grade. Before the pipe is laid, the subgrade shall be prepared by backfilling with bedding material in six inch (6") layers. The layers shall be thoroughly tamped so as to provide a continuous bearing and support for the pipe at every point between couplings or pipe ends. Disturbing and otherwise damaging the finished surface over a maximum length of eighteen inches (18") near the middle of each length of pipe by the withdrawal of pipe slings or other lifting tackle shall be permitted. The finished subgrade shall be prepared accurately by means of hand tools.

**9C-3-7.5**      **Correction of Faulty Subgrades.** Where excavation is inadvertently carried below subgrade and/or foundation elevations, suitable provision shall be made at the expense of the Contractor for adjustment of same to meet requirements incurred by the deeper excavation beneath pipe or structures. Over-depth backfilling with approved crushed gravel, shall be compacted to provide a firm and unyielding subgrade and/or foundation, as directed by the District.

**9C-3-7.6**      **Trenching By Hand or Machine.** Hand methods for excavation shall be employed in locations directed by the District. The Contractor shall use whatever equipment or hand methods necessary to protect all existing utilities.

**9C-3-7.7**      **Bracing Excavations.** All excavations shall be properly supported in the manner as required by OSHA Code of Federal Regulations Vol. 37, No. 243, Sub-part P, Section 1926.652 and other related sections or as required by state laws and municipal ordinances and as may be necessary to protect life, property, and the work.

Excavations shall be so braced, sheeted and supported that they will be safe, and the ground alongside the excavation will not slide or settle. Excavations shall be so braced or sheeted so as to provide conditions under which workmen may work safely and efficiently at all times. The sheeting, shoring and bracing shall be so arranged as not to place any stress on portions of the completed work until the general construction thereof has proceeded far enough to provide ample strength.

Care shall be exercised in the withdrawing or removing of sheeting, shoring, bracing and timbering to prevent the caving or collapsing of the excavation faces that are being supported.

**9C-3-7.8**      **Grading and Stockpiling.** The Contractor shall control grading in a manner to prevent water from running into excavations. Obstruction of surface drainage shall be avoided and means shall be provided whereby storm and waste water can be uninterrupted in existing gutters, other surface drains or temporary drains.

**9C-3-7.9**      **Dewatering.** The Contractor shall provide and maintain at all times during construction, ample means and devices with which to promptly remove and properly dispose of all water from any source entering the excavations or other parts of the work. Dewatering shall be accomplished by methods that will ensure a dry excavation and preservation of the final lines and grades of the bottoms of excavations. Said methods may include well points, sump pumps, suitable rock or gravel placed below the required bedding for drainage and pumping

purposes, temporary pipelines and other means, all of which shall be subject to review/ approval by the District.  
(Cross reference: Appendix 4, SASD Sewer Notes, Note 23)

Dewatering for the sewer lines shall commence when groundwater is first encountered, and shall be continuous until such time as water can be allowed to rise in accordance with the provisions of this section.

The Contractor shall dispose of the water from the work site in a suitable manner without damage to adjacent property. No water shall be drained into the work site, whether built or under construction, without prior consent of the District. Note that a discharge permit for the Contractor could be required by the State of Colorado.

**9C-3-7.10**     **Foundations in Poor Soil.** If excessively wet, soft, spongy, unstable or similarly unsuitable material is encountered at the surface upon which the bedding material is to be placed, the unsuitable material shall be removed to a depth as determined in the field by the District Engineer and be in accordance with the "Special Bedding Details", Drawing Number PUB-2.

**9C-3-7.11**     **Foundations in Rock.** Where rock is encountered, it shall be removed below grade. The trench shall be backfilled with clean imported bedding material to provide a compacted foundation cushion, with minimum allowable thicknesses of 6" (six inches) under the outside diameter of the pipe bell or coupling and 9" (nine inches), under the pipe barrel. The District shall determine whether or not the foundation material is to be considered as rock.

**9C-3-7.12**     **Pipe Clearance in Rocks.** Ledge rock, boulders, and large stones shall be removed to provide a minimum clearance of at least 6" (six inches) below the pipe and fittings.

**9C-3-7.13**     **Bedding Procedure.** - The pipe shall be carefully bedded as shown in the "Standard Bedding Details", Drawing Number PUB-1. The Contractor shall be responsible for accurately shaping the pipe subgrade to fit the bottom of the pipe for the width shown on the bedding detail. Use of a drag template shaped to conform to the outer surface of the pipe will be required if other methods do not give satisfactory results.

Each joint shall be recessed in bedding material as required by the bedding detail in such a manner as to relieve the bell of the pipe of all load and to ensure continuous bearing of the pipe barrel on the pipe subgrade.

Clean, imported sand, squeegee, or 3/4" (three-quarter inch) crushed rock, pipe bedding shall be compacted by approved methods to a Relative Density of 70 percent. When the

bedding material is imported sand, the pipe bedding backfill shall be brought to optimum moisture content and shall be placed by hand in layers not exceeding 6" (six inches) to the springline (centerline) of the pipe. Each layer shall be solidly tamped with the proper tools so as not to injure, damage or disturb the pipe.

Bedding material shall meet the following specifications. Test results shall be submitted by the owner's geotechnical engineer to the District's Engineer for review.

Class A Bedding - Class A bedding shall be used for the bedding of ductile iron and PVC sanitary sewer lines at depths of cover less than 16 feet. Class A bedding shall consist of placing select bedding material (known as "squeegee") defined as follows, from six inches (6") under the pipe to a point twelve inches (12") above the top of pipe.

Class A bedding material shall conform to the following:

Sieve Size	Total Percent Passing by Weight
3/8"	100%
No. 8	65% - 100%
No. 50	10% - 30%
No. 100	0% - 10%
No. 200	0% - 5%

Class B Bedding - Class B bedding shall be used where designated by the District for stabilization for the bedding of PVC sanitary sewer main at depths of cover between 16 feet and 22 feet. Class B bedding shall consist of placing crushed aggregate, as defined below, from eight inches (8") under the pipe to a point twelve inches (12") above the top of the pipe.

Class B bedding shall be clean crushed aggregate conforming to ASTM D 448, as follows:

Sieve Size	Total Percent Passing by Weight
1"	100%
3/4"	90% - 100%
3/8"	20% - 55%
No. 4	0% - 10%
No. 8	0% - 5%

Backfilling shall proceed simultaneously on each side of the pipe to assure proper protection of the pipe.

The area, shown on all bedding details from trench bottom to 12" (twelve inches) above the pipe shall be referred to as the "pipe zone".

**9C-3-7.14 Installation of the Sanitary Sewer Lines.**

- (1) General - All pipe shall be laid without grade break from structure to structure, with the bell ends of the pipe upgrade. Pipe shall be laid to the line and grade shown on the approved plans and in such a manner as to form a close concentric joint with the adjoining pipe to prevent sudden offsets of the flow line. The interior of the sewer pipe shall be cleaned of all dirt and superfluous material of all descriptions as the work progresses.

At all times when pipe laying is not in progress, the open end of the pipe shall be closed with a tight fitting cap or plug to prevent the entrance of foreign matter into the pipe. These provisions shall apply during the noon/lunch hour and breaks as well as overnight and on holidays. In no event shall the sewers be used as drains for removing groundwater that has infiltrated into the trenches.

- (2) Alignment and Grade - The sewer line shall be laid and maintained to the required lines and grades as shown on the plans.

Whenever obstructions not shown on the plans are encountered during the progress of the work which interfere to such an extent that an alteration in the approved plans is required, the District Engineer shall have the authority to change the plans and order a deviation from the proposed line and grade.

- (3) Placing of Sewer Pipe in the Trench –

- (a) When placing sanitary sewer pipe in the ditch, the ASTM specification or Uni Bell specification for installing sewer pipe shall be used. Laser beam equipment shall be used to provide line and grade control.

Pipe shall be protected during handling against impact shocks and free fall. No pipe which has been damaged while lowering into the trench shall be placed in the trench. Bell holes shall be dug under the bells of all pipe, regardless of the type of bedding used and the entire length of barrel of all sewer pipe shall rest firmly on the bedding material. In no case shall the weight of the sewer pipe be supported by the bells of the

pipe. Under no circumstances shall the sewer pipe be dropped or dumped into the trench.

After lowering into the trench, both the bell and spigot shall be thoroughly cleaned and be free from any foreign material.

- (b) When manufacturer's prefabricated joints are used in the laying of sanitary sewer lines, such lines shall be joined using lubricants, primers, adhesives, solvents, etc., recommended by the pipe manufacturer. All factory fabricated joints shall be placed, fitted, joined and adjusted in such a manner as to obtain the degree of water tightness required and be in compliance with recommended methods of manufacturer.
- (c) Where ductile iron sewer pipe is used in a sanitary sewer system, it shall be as designated under Section 9C-3-3 "Pipes". The method of placing and joining ductile iron sanitary sewer pipe in the trench shall be in accordance with specifications of the pipe manufacturer.

#### (4) Pipe Fittings

- (a) General - Pipe fittings shall include branches of every type and plugs. Fittings shall be furnished and installed in conformance with the Construction Drawings and these specifications. Branches shall be installed in accordance with the Standard Details.
- (b) Branches - Branches of the type shown on the plans shall be furnished with connections of the sizes specified and shall be securely and completely fastened to the barrel of the pipe during manufacturing. Tee branches shall have their axis perpendicular to the longitudinal axis of the pipe. Wye branches shall have their axis approximately 45 degrees (unless otherwise specified on the plans) to the longitudinal axis of the pipe, measured from the socket end. All branches shall be of sufficient length to permit making a proper joint when the connecting pipe is inserted in the branch socket.

The quality of pipe fittings shall conform to the applicable provisions of these specifications designated under Section 9C-3-3 "Pipe". Joints for fittings shall be of the same type used for the adjacent pipe material.

- (b-1) Installation of Branches - Pipe wyes, tees and other types of branches shall be furnished and installed along with the sanitary sewer line. Wyes of the size(s) specified on the plans shall be installed for all sanitary sewer service connections as shown on the plans, or as specified in the detailed project specifications. The longitudinal barrel or branch fittings to be placed in line and grade with the sanitary sewer mains shall be of the same diameter, quality and type as the adjoining sewer line.

Installation, earthwork and bedding for branches shall conform to the applicable provisions set forth for the sewer line. Unless otherwise specified, the branch of wye fittings shall be inclined upward at an angle not greater than 45 degrees from a horizontal line. If so shown on the plans, tees with standard tee foundations shall be substituted for wye branches. No wye or tee for a sanitary sewer service connection branch may be placed closer than 5 feet, to the upstream or downstream side of the centerline of any structure, or 3 feet from another service connection, or 3 feet from the bell or spigot end of a pipe section, and shall be in conformance with the "Service Connection to New Construction," and the "Service Connection to Existing Construction;" Drawing Numbers PRI-2 and PRI-2, respectively. The Contractor shall hand tamp the backfill under every tee or wye branch when installed.

- (c) Plugs - Pipe plugs shall be 3/4" in thickness and shall have a factory-made plasticized polyvinyl chloride compound joint material cast and bonded to the pipe. The material shall be molded and cured to a uniform hardness and compressibility, and form a tight compression coupling when assembled. The material used for the compression joint shall conform with the type of pipe material specified.

Neoprene (synthetic rubber) plugs shall be equal to those manufactured by Gladding McBean and

Company or approved equal. The joint formed by the plug and pipe shall be a tight compression coupling when assembled.

All joints for plugs shall be adequate to withstand the internal pressure of the leakage and/or infiltration test; however, joints shall be made in such a manner that they may be removed without injury to the socket.

- (5) Pipe at Manholes or Structures – A pipe joint of the same inside diameter as the adjoining pipe shall be placed at the inlet(s) and outlet to each manhole or structure as shown on the Construction Drawings.

Pipe bells shall not be cast into manholes or structures. The bell shall be cut off so that the plain end of the pipe is flush with the inside wall of the manhole or structure, or as otherwise shown on the Construction Drawings.

#### **9C-3-7.15      Backfilling.**

- (1) General - All trenches shall be backfilled after pipe, fittings and appurtenances have been installed and reviewed for conformance with the Project Specifications by the District Engineer. Bedding and "pipe zone" backfill shall be installed in accordance with Section 9C-3-7.13 of these specifications.

Whenever a compaction requirement value is specified herein, the optimum moisture content and density shall be determined in accordance with the appropriate ASTM specification.

- (2) Procedure Above "Pipe Zone" – In street rights-of-way, the portion of the trench above the "pipe zone" to the finished roadway surface, shall be backfilled, compacted and/or consolidated by methods reviewed by the District Engineer to obtain a Standard Proctor Density of 95% (ninety-five percent) or equivalent relative density. In easements, landscaped areas and other areas outside street rights-of-ways, the remaining portion of the trench above the "pipe zone" shall be backfilled, compacted and/or consolidated by methods approved by the District's geotechnical consultant to obtain a Standard Proctor Density of 90% (ninety percent) or equivalent relative density. Backfilling shall be done with acceptable quality sand or gravel. No oil cake, bituminous pavement, concrete, rock or other lumpy material shall be used in the backfill unless these materials are scattered and do not exceed 6" in any dimension. No material greater than 4" in any

dimension shall be placed within 1 foot of any pipe, manhole or structure. All backfill material shall be subject to review by the District.

- (3) **Compacted Fill** - Acceptable compaction equipment shall be vibratory equipment, tamping rollers or other mechanical tampers of the type and size approved by the District's Geotechnical Consultant. The backfill shall be placed in horizontal layers of depth specified by the District for the type of compacting equipment being used with maximum 1-foot vertical lifts. Each layer shall be evenly spread, properly moistened and compacted to the density specified in Section 9C-3-7.15 (2). Any damage to the pipe as a result of Contractor's operation shall be repaired and/or replaced.
- (4) **Consolidated Fill** - The method of consolidating or compacting of fill shall be determined by the contractor and reviewed by the District. Flooding, pooling, or jetting shall not be allowed unless approved by the District's Geotechnical Consultant prior to construction. When approved, consolidation of fill shall be accomplished by flooding, pooling or jetting so as to obtain a density of the fill material at least equal to that specified in section 9C-37.15 (2). When flooding, pooling or jetting methods are used, material for use as backfill shall be placed and compacted in layers not exceeding 3 feet in thickness. Consolidation shall be supplemented by the use of vibratory or other compaction equipment when necessary to obtain the required density. Care shall be taken in all consolidating operations to prevent the movement or floating of the pipe. In the event there is movement or floating, the Contractor shall re-excavate, relay and backfill all pipe so affected. Consolidation methods shall not be used when the backfill material is not sufficiently granular in nature to be self-draining during and after consolidation or if foundation materials are softened or otherwise damaged by applied water.

**9C-3-7.16**      **Compaction Tests.** Compaction tests shall be taken by an approved testing laboratory at random locations. All expenses involved in these tests will be borne by the Developer/Owner.

Copies of test results must be submitted to the District. In all cases where the test results indicate compaction less than that required in these specifications, additional compaction and tests will be required until the appropriate specifications are met. Probationary acceptance of the sewer lines by the District will be contingent upon receiving satisfactory compaction test results. All compaction tests must be taken and results must be reviewed and accepted by the District prior to flushing,

deflection, low pressure air and lamp testing. Re-tests shall be made by the Developer/Owner until the tests results are accepted by the District Engineer. Even with passing compaction tests and probationary acceptance of the work, the District is not responsible for settlement should it occur.

- 9C-3-7.17**     **Temporary Handling of Wastewater.** Certain work in connection with tying into the existing sanitary sewer facilities may require the temporary handling of sewage either by bypass pumping, bulk heading at low flows, or other means to be approved by the District.

Wastewater so diverted shall be handled in a manner so as not to create a public nuisance or health hazard. All handling of wastewater shall conform, and be acceptable to current Colorado Department of Health requirements and/or applicable City/County Health Department requirements.

- 9C-3-7.18**     **Traffic Control.** Traffic shall be maintained at those locations throughout the project area in order to maintain an efficient and orderly vehicular and pedestrian traffic flow. All traffic control, construction signing, and residential access, etc., shall be handled in conformance with the Uniform Traffic Control Manual and the appropriate City, County, or State Highway Department Standards.

The Contractor shall furnish, construct, maintain, and finally remove detours, road closures, lights, signs, fences, barricades, flares, miscellaneous traffic devices, flagmen, drainage facilities, reconstruct paving and such other items and services as are necessary to adequately safeguard the public, both traveling and otherwise, from hazard and inconvenience. He shall erect and maintain such warnings and directional signs as may be required by the City, County, or State Highway Department.

- 9C-3-7.19**     **Final Clean Up.** After backfill has been completed, the right-of-way shall be graded smooth and left in a neat and presentable condition to the satisfaction of the District and appropriate State, County or local government agency.

**9C-3-8**         **Protection of Water Supplies.**

- 9C-3-8.1**       **Water Supply Interconnections.** 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 wastewater or non-potable water into the potable water supply.

- 9C-3-8.2**       **Relation to Water Works Structures.** While no general statement can be made to cover all conditions, it is generally recognized that sewer alignments and structures must be kept

remote from public water supply wells or other water supply sources and structures in accordance with the applicable Colorado State and/or County Health Department Standards.

**9C-3-8.3**      **Relation to Water Mains.** Sewers shall be located a minimum of 10 feet horizontally from existing or proposed water mains (centerline distance). Where sewer lines cross water mains, the sewer pipe shall be a minimum of 18" clear distance vertical separation from the water line. (Cross reference: Appendix 4, SASD Sewer Notes, Note 14) If this clear distance is not feasible, the crossing must be designated and constructed so as to protect the water main. minimum protection shall consist of the installation of an impervious and structural sewer. For example:

- (1) One length of polyethylene lined ductile iron pipe at least 18 feet long centered over the water main. Joints between the sewer pipe and the ductile iron pipe shall be encased in a concrete collar at least 6" thick and extending at least 6" either side of the joint.
- (2) PVC sewer pipe with reinforced concrete encasement. Encasement shall be in accordance with the "Concrete Encasement Detail", Drawing Number PUB-18 in and extend a minimum distance of 10 feet on each side of the water main.

In all cases, suitable backfill or other structural protection shall be provided to preclude settling and/or failure of either pipe. All sewer crossings shall be in accordance with the "Sewer Crossing Detail", Drawing Number PUB-20.

**9C-3-8.4**      **Protection of Existing Sanitary Sewer Facilities.** If a contractor damages an existing sanitary sewer line or manhole during construction, he shall immediately notify the District. The contractor shall provide by-pass pumping, at his own cost, until the District reviews the damage and proposes remedial measures. All costs to repair the sanitary sewer line or manhole shall be borne by the Contractor. Proposed sewer line repair shall be reviewed on a case-by-case basis and repairs shall be made by the contractor to the satisfaction of the District and the District Engineer.

**9C-3-9**      **Testing and Construction Observation.**

**9C-3-9.1**      **Visual Pipe Testing Prior to Construction.**

- (1) General - Before being used in any work under these specifications, pipe shall be cause for rejection upon failing the following visual tests.

Any cracks, lumps, blisters, pits or flakes on the exterior or interior surface of a pipe or fittings.

When the bore or socket of the pipe varies from a true circle more than 3% of its nominal diameter.

When a pipe or fitting, designated to be straight, deviates from a straight line more than 1/16" per linear foot. The deviation shall be measured from a straight edge at a point midway between the ends of the pipe.

A piece broken from either the socket or spigot end.

### **9C-3-9.2 Pipe Testing Procedures After Construction.**

(1) General - Post construction testing shall be completed in the following sequence and as further detailed in subsequent sections:

(Cross reference: Appendix 4, SASD Sewer Notes, Notes 3 and 28)

- (a) Backfill compaction tests (See Section 9C-3-7.16)
- (b) Concrete tests (If required)
- (c) As Recorded Information (See Section 9C-3-2.2)
- (d) Flush and Clean System
- (e) Deflection Tests
- (f) Low Pressure Air Test (PVC Pipe)
- (g) Infiltration/Exfiltration Tests (Concrete Pipe)
- (h) Lamp Tests (if required) and Post Construction Videotaping
- (i) Deficiency "Punch" List.

**9C-3-9.3 Flushing.** Prior to any testing, the lines shall be thoroughly flushed and balled to remove debris, dirt or other foreign matter. The lowest manhole (or manholes) within the project shall be plugged with a watertight plug (Pollard or equal) on the downstream outlet of the manhole and all water, silt and debris shall be pumped from this manhole and disposed of properly.

**9C-3-9.4 Pipe Deflection Tests.** All sanitary sewer systems constructed of PVC pipe shall be tested for vertical ring deflection using a deflectometer, properly sized "go, no-go" Mandrel, or sewer ball. Maximum allowable vertical ring deflection is five percent (5%) of the pipe's inside diameter. The following Table . III outlines the acceptable Mandrel diameter for different sizes of PVC pipe.

TABLE III

5% DEFLECTION MANDREL DIMENSIONS

Nominal Size Inches	Base Inside Diameter Inches	5% Deflection Mandrel
8"	7.665	7.28
10"	9.563	9.08
12"	11.361	10.79
15"	13.898	13.20
18"	16.976	16.13
21"	20.004	19.00
24"	22.480	21.35
27"	25.327	24.06

**9C-3-9.5**

**Low Pressure Air Tests.** All low pressure air tests shall be done in accordance with the latest revision of the UNI-BELL, UNI-B-6-98 Specification, or latest version. Each section of sanitary sewer line between two successive manholes shall be tested by plugging all pipe outlets with suitable test plugs. Air shall be slowly added until the internal pressure is raised to 4.0 psi. A continuous monitoring gauge with a minimum division of 0.10 psi and an accuracy of +/-0.04 psi shall be used. The compressor used to add air to the pipe shall have a blowoff valve set at 5 psi to assure that at no time the internal pressure in the pipe exceeds 5 psi. The internal pressure of 4 psi shall be maintained for at least two minutes to allow the air temperature to stabilize after which the air supply shall be disconnected and the pressure allowed to decrease to 3.5 psi. The time in minutes that is required for the internal air pressure to drop from 3.5 psi to 3.0 psi shall be measured and the results compared with the values listed in the following Table IV. If the line being tested is in a groundwater condition, the internal air pressure value of 4.0 psi shall be increased to include the addition of groundwater pressure on the pipe.

The additional pressure shall be calculated by adding 0.433 psi internal air pressure for each foot of water over the sealed pipes, invert, but the maximum allowable internal air pressure in the pipe shall not exceed 9.0 psi. Therefore, the low pressure air test may be used in a groundwater condition as long as the average depth of water over the line does not exceed 11.5 feet. Should the average groundwater depth exceed 11.5 feet, the infiltration test shall be performed in accordance with Section 9C-3-9.6 of these Specifications.

TABLE IV

MINIMUM DURATION FOR AIR TEST PRESSURE DROP

Pipe Diameter (Inches)	Min. Time (min. sec.)	Min. Time (FT)	Length for Minimum Time In Sec. for 0.5 PSI Drop
8	3:47	298	.760L (Between MH)
10	4:43	239	1.187L (Between MH)
12	5:40	199	1.709L (Between MH)
15	7:05	159	2.671L (Between MH)
18	8:30	133	3.846L (Between MH)
21	9:55	114	5.235L (Between MH)
24	11:20	99	6.837L (Between MH)
27	12:45	88	8.653L (Between MH)
30	14:10	80	10.683L (Between MH)
33	15:35	72	12.926L (Between MH)
36	17:00	66	15.384L (Between MH)

If the pressure drop from 3.5 psi or 3.0 psi occurs in less time than the above tabulated or calculated values, the pipe shall be repaired and, if necessary, replaced and relayed until the joints and pipe shall hold satisfactorily under this test. (Follow UniB-10-98 or latest revision for groundwater correction factor).

**9C-3-9.6**

**Infiltration Tests.** If, in the construction of a section of the sewer between structures, excessive ground water is encountered, the test for low pressure air described in Section 9C-39.4 shall not be used, but instead, the end of the sewer at the upper structure shall be closed sufficiently to prevent the entrance of water, and pumping of groundwater shall be discontinued for at least three days after which the section shall be tested for infiltration. The infiltration shall not exceed 0.04 gallons per hour, per inch of diameter, per 100 feet of sewer line being tested or as indicated in Table V and does not include the length of service connections entering that section. Where any infiltration in excess of this amount is discovered before completion and acceptance of the sewer, the sewer shall be immediately uncovered and repaired as necessary to reduce the amount of infiltration to within the specified amount of infiltration before the sewer is accepted, at the expense of the Contractor. Should, however, the infiltration be less than the specified limit, the Contractor shall stop any individual leaks that may be observed when directed to do so by the District. The Contractor shall furnish all labor and materials for making the tests required. All tests must be completed before the street or trench is resurfaced, unless otherwise directed by the District.

TABLE V

ALLOWABLE LIMITS OF INFILTRATION  
50 Gal/Inch Dia/Mi/Day

or 0.04 Gal/Inch Dia/100'/Hr

Diameter of Sewer (inches)	Infiltration Gal/Hr/100' (Gallons)
8	0.32
10	0.40
12	0.48
15	0.60
18	0.72
21	0.84
24	0.96
27	1.08
30	1.20
33	1.32
36	1.44

If the infiltration and/or exfiltration rate as shown by the tests specified herein is greater than the amount specified in Tables V and VI, respectively, the pipe joints shall be repaired, grouted, or, if necessary, the pipe shall be removed and re-laid by the Contractor. The sewer line will not be considered acceptable until the leakage and/ or infiltration rate, as determined by test, is less than the allowable amount.

The Contractor may at his option air test or water test for leakage except where a) in the opinion of the District, excessive groundwater is encountered, then the infiltration test shall be made, and b) where the difference in elevation between the invert of the upper structure and the invert of the lower structure is more than 10 feet, then the air test shall be made.

**9C-3-9.7**

**Exfiltration Tests.** Sanitary sewer lines between two successive structures shall be tested by closing the lower end of the sewer line to be tested and the inlet of the upper structure with plugs or stoppers and filling the pipe and structure with water to a point 4 feet above the invert of the open sewer in the upper structure, or to a height 10 feet above the invert of the sewer in the lower structure, whichever gives the least hydrostatic pressure on the lower structure.

The total exfiltration shall be the decrease in volume of water in the upper structure. The leakage shall not exceed 0.04 gallons per hour per inch of nominal diameter of pipe per 100 feet of sewer pipe being tested or as indicated in the following Table VI. The length of service connections shall not be used in computing the length of sewer main being tested.

TABLE VI

ALLOWABLE LIMITS OF EXFILTRATION  
(LEAKAGE)  
50 Gal/Inch Dia/Mi/Day (at 10' Head)  
or 0.04 Gal/Inch Dia/100'/Hr

Pipe Diameter (Inches)	Maximum Allowable Loss in Gal/Hr/100' of Pipe
8	.32
10	.40
12	.48
15	.60
18	.72
21	.84
24	.96
27	1.08
30	1.20
33	1.32
36	1.44

**9C-3-9.8**

**Lamp Tests.** After the pipe has been installed, backfilled, compacted, deflection, low pressure air and exfiltration and/or infiltration tested, and manholes raised to grade, the District will "lamp" or survey all new lines prior to paving, to check alignment. All lines shall be flushed in accordance with Section 9C-3-9.3 and manholes cleaned by the Contractor prior to "lamping". Grades will be reviewed by surveying pipe inverts at manholes and by lamping. The full diameter of the pipe should be visible when viewed between consecutive manholes. All defective portions of the new facilities will be noted to the Contractor after the lamping operation is complete.

If requested by the District, the Contractor shall supply workers to assist in lamping. If, as a result of lamping, the District has questions pertaining to the alignment and/or grade, the District may request that a video tape inspection be conducted to permit a closer inspection of the line. Sags, high points or other alignment or grade problems shall be repaired by the Contractor to the District's satisfaction.

In cases where the condition of the sewer line is still questionable, the District may require that video taping be taken of the interior of the sewer line under question. If, by the District's and Contractor's interpretation of the video taping, the sewer line is determined to be defective, the cost of taking the video taping shall be borne by the Contractor. Should the sewer line be interpreted as being in an acceptable condition.

Probationary acceptance of the lines will not be granted or placed into active service or operation until all tests are successful and all items listed for correction by the District have been accomplished. Deflection testing per Section 9C-3-9.4 will be required for flexible pipe material (plastic).

**9C-3-10**      **Sewer Services.**

**9C-3-10.1**      **General.**

- (1) 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 observed by the District. The Contractor shall notify the District at least 48 hours prior to installation.
- (2) Sewer wyes or tees shall be used to make the connection on the District's sewer mains whenever possible. Wyes shall be installed during the construction of the sewer main in compliance with Section 9C-3-7.14 (4). The location of all sewer wyes shall be shown on the as-constructed sewer main plans.

Wherever wyes or tees are not used, connections shall be made by mechanical tap using a service saddle in accordance with these specifications.

- (3) No sewer service taps shall be made prior to the acceptance of the complete main line by the District. The Contractor must keep accurate records indicating the exact location of sewer line taps. Installation of service line must conform to these specifications.

**9C-3-10.2**      **Location.**

- (1) Sewer services shall be located a minimum of ten feet (10') from water services and will generally be located on the downhill side of the water service. Service lines shall be installed in a continuous straight line perpendicular to the main and shall enter the property a minimum distance of five feet (5') from the nearest lot corner. The main to be tapped must extend a minimum distance of fifteen feet (15') along the front lot line of the property to be served.

For lots at the end of cul-de-sac streets, the service pipe between the main and the property line shall be in a continuous straight line and shall enter the property a minimum distance of five feet (5') from the nearest lot corner.

- (2) See the "Service Connection to New Construction," and "The Service Connection to Existing Construction," Drawing Numbers PRI-1 and PRI-2, respectively, for the permitted location and for the spacing of taps.
- (3) In general, sewer service lines will not be allowed to connect to manholes. However, one service line will be allowed to connect to a manhole located at the end of a cul-de-sac street. The service line must be installed prior to placing the manhole base and the crowns of the pipes shall match.

**9C-3-10.3 Materials.**

- (1) PVC shall be used in all instances unless otherwise reviewed by the District prior to installation. All joints for services shall be bell and spigot type with the appropriate gaskets included. Solvent weld joints are not acceptable. All methods of joining the sewer service to the existing wye or tee at the sewer line, or to the ground iron stack at the building must be reviewed by the District prior to connection. In all cases where existing wyes or tees cannot be met, or are not available, mechanical methods must be used to tap the sewer line.

(Cross reference: Appendix 4, SASD Sewer Notes, Note 15)

- (2) Fittings - Sewer tap fittings and material shall meet material requirements established in these specifications.
- (3) Tapping Saddles - Tapping saddles shall be fabricated to insure that no protrusions of the saddle will extend into the sewer being tapped and shall fit the contour of the sewer. The saddles shall be molded plastic or other accepted material. Stainless steel clamp bands shall be used to secure the saddle to the main. Saddles joined to PVC pipe shall be constructed of molded PVC.

Gasket type saddles shall be installed on direct tap connections only.

- (4) Joint Material - Joints between existing wyes or tees and sewers shall be watertight. All saddles shall be joined to the sewer main by use of an epoxy material accepted by the District. Saddles joined to PVC pipe shall be solvent welded and double banded to the PVC pipe and gasket sealed for direct taps.

**9C-3-10.4 Construction.**

- (1) Damaged Conditions - If damaged sewer line wyes or tees are encountered, these wyes or tees shall be permanently repaired as to prevent dirt, roots, or ground water from entering the sewer.

Concrete encasement of sewer lines will not be construed as water-tight fabrication and shall not be substituted as a formed joint nor will it be used to repair damaged joints or pipe.

- (2) Service Connections to New Construction - New main line construction shall use PVC in-line wye fittings for 4" and 6" service connections, or manholes for 8" service connections. Construction shall be in conformance with this Section and the "Service Connections to New Construction", Drawing Number PRI-1, construction detail found in Section 9C-4.

All in-line PVC wye fittings shall be of equal pipe class to the PVC ASTM 3034 SDR35 materials and PVC C900 Class 200 mains and PVC C900 Class 150 fittings used in public main line construction. Fitting material shop drawings shall be submitted to the District for review prior to construction.

In-line wye fittings shall be installed at the locations indicated on the reviewed and signed plans. The wye shall be rotated to provide entrance into the main line at the "ten" or "two" o'clock position. The Contractor shall record the connection invert elevation and distance from the nearest downstream manhole immediately upon installation. This information shall be shown on the record drawings.

- (3) Service Connections to Existing Construction - Service connections to existing sanitary sewer lines shall be made using either a "tee" or wye saddle depending on the existing main line material. Construction shall be in conformance with this Section and the "Service Connections to Existing Construction", Drawing Number PRI-2, construction detail found in Section 9C-4.  
(Cross reference: Appendix 4, SASD Sewer Notes, Note 5)

Connection to existing PVC material shall be made using a wye saddle with double stainless steel straps. The existing PVC sewer line shall be marked and cut to the shape of the wye using a template approved by the saddle manufacturer. The hole shall be cut with a hole cutter or keyhole saw and cleanly machined by hand to remove all burrs, rough edges, and debris. The exterior of the main shall be wiped clean and prepared with an

approved solvent prior to the installation of the saddle. The saddle shall be solvent welded to the pipe and drawn tight against the pipe using double stainless steel straps.

Upon completion of the tap, the main line, tapping saddle and service line within the sanitary sewer line trench shall be bedded per Section 9C-3-7.13 and hand tamped prior to backfilling.

Connection to existing concrete or clay sewer lines shall be made using a PVC tee saddle and gasket with double stainless steel straps. When connecting to an existing concrete or clay main, a long-body style PVC tee saddle shall be used. The sewer main shall be "core drilled" with a circular bit. Necessary precautions shall be taken so that the removed circular segment is not lost in the sanitary sewer main. Percussion tapping is not allowed.

The circular hole shall be cleaned by hand to remove all rough edges and debris. The exterior of the main shall be wiped clean and prepared with an approved solvent prior to the installation of the gasket tee saddle. The saddle shall be drawn tight against the gasket and existing line by means of double stainless steel straps.

Upon completion of the tap, the tapping saddle shall be reinforced with a concrete collar, 6" minimum width, placed all around the fitting connection. The main and tapping saddle shall be bedded with materials per Section 9C-3-7.13 and hand tamped prior to backfilling.

- (4) Backfill and Paving - Backfill material, compactive effort and paving requirements for sewer connections will conform to the appropriate sections concerning the above items of sewer main installations contained in these Specifications and the requirements of City, Arapahoe County or governing agency.
- (5) Street Repair - Street repair or replacement work which results from sewer line or manhole placement shall meet minimum City, Arapahoe County, or governing agency Standards. Substandard or deficient repair/replacement of paving etc., shall be redone at the expense of the Developer.

#### **9C-3-10.5 Grease, Oil and Sand Interceptors.**

- (1) Requirements: Refer to Section 9A-3 for when Grease and Sand Interceptors are required.

- (2) Engineering Review - Three (3) sets of plans and specifications, including complete mechanical and plumbing sections with interceptor detail and calculations shall be submitted to the District for review prior to construction. This submittal will be accompanied by a narrative explanation of the operation or process from which the interceptor will be receiving drainage. Interceptor designs must meet the criteria set forth in the following paragraphs and in accordance with the appropriate sections in the District's Rules and Regulations.
- (3) Grease Interceptor Sizing Criteria - The minimum capacity for a grease interceptor is 750 gallons.

The basic formula is:

**(turn-over rate) x (categorical use factor) x 2.5 (gal. of water) x (seating capacity)**

The varying sizing applications have been broken into the following categories:

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CATEGORY A  
RESTAURANTS/CAFETERIAS

**FORMULA:**  
**2.0 x 1.25 x 2.5 x Seating**

- Full or limited service with the capability to serve or prepare 100 meals per day.
- Plumbing fixtures: one pot sink, one 2 or 3 compartment sink, one hand sink, one mop sink, one floor sink, one dishwasher, one garbage disposal – (garbage disposal shall be connected to the grease interceptor)
- Equipment: one grill, one fryer, one to three ovens.

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CATEGORY A-1

**Same criteria as Category A with these additions:**

- Plumbing fixtures: For each additional garbage disposal and dishwasher that is directed to the grease interceptor, there will be a factor of 0.25 added to the categorical use factor.
- Equipment: For each additional “wok” stove, deep fryer and grill, there will be a factor of 0.50 added to the categorical factor.

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**CATEGORY A-2**  
(No seating capacity, strictly take-out)

**FORMULA:**  
**A x B x C x D = Interceptor Size (liquid capacity)**

A. Meals Served at Peak Hour

B. Waste Flow Rate

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a. With dishwashing machine.....	6 gallon (22.7 L) flow
b. Without dishwashing machine.....	5 gallon (18.9 L) flow
c. Single service kitchen.....	2 gallon (7.6 L) flow
d. Food waste disposal.....	1 gallon (3.8 L) flow

C. Retention

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a. Commercial kitchen waste (Dishwasher).....	2.5 hours
b. Single service kitchen (Single serving).....	1.5 hours

D. Storage Factors

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a. Fully equipped commercial kitchen	
1. 8 hour operation.....	1
2. 16 hour operation.....	2
3. 24 hour operation.....	3
b. Single service kitchen.....	1.5

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**CATEGORY B**  
**HOSPITALS, SCHOOLS, INSTITUTIONS and CARE FACILITIES**

**FORMULAS:**  
**HOSPITALS/SCHOOLS = 2.0 x .75 x 2.5 x bed usage or seating\***  
**INSTITUTIONS/CARE FACILITIES = 2.0 x 1.0 x 2.5 x seating or bed usage\***

These formulas will be adjusted by the following when necessary:

- A value of .25 will be added to the Categorical Use Factor for each dishwasher or garbage disposal directed to the Grease Interceptor above the number of one each.
- A value of .50 will be added to the C.U.F. for each additional deep fryer or grill above the number of one each.

\* Which ever is greater.

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CATEGORY C  
DELI STORES, SUPERMARKETS BUTCHERS and BAKERIES  
(with meat cutting capabilities)

**FORMULA**  
**(hours of operation) x 4.0 x 10**

For each of the following conditions, a factor of .50 is to be added to the C.U.F. value of 4.0 when dealing with meat cutting:

- more than one floor drain
- complete cooking of meats

When dealing with retail-type bakeries or supermarkets that have bakery facilities in addition to a deli and/or meat cutting, the bakery shall be sized separately using the same formula as above with the deletion of the .50 adjustment for the cooking of meats.

There is an adjustment of an addition of 1.5 to the C.F.U. when dealing with bakeries that are wholesale only, or are of the industrial classification.

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CATEGORY E  
COMMISSARIES, COMMERCIAL KITCHENS, AND CATERERS

These must be sized on an individual basis. However, it should be noted that the minimum acceptable size for a commercial kitchen shall be 1,500 gallons.

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CATEGORY F  
FOOD MANUFACTURERS

Each case shall be evaluated separately. Whenever a manufacturing operation is evaluated, it must be noted that a Control Manhole will be required in most cases in addition to a minimum of 1500 gallon Grease Interceptor.

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CATEGORY G  
COMMON OR SHARED GREASE INTERCEPTORS FOR MULTIPLE FACILITIES

Each case shall be evaluated separately. All restaurants that will be connecting to the common Grease Interceptor shall be sized individually using the appropriate sizing category and added together to determine that proper size interceptor.

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CATEGORY H  
"ASSEMBLE YOUR OWN MEALS" FOOD PREPARATION FACILITIES

Each case shall be evaluated separately. If the facility does not prepare meals for consumption on the premises and has no seating capacity, a "No Significance" determination can be made; a Grease Interceptor is not required. However, good kitchen or best management practices shall be implemented in these facilities to minimize the generation and contribution of oil and grease to the sanitary sewer.

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- (4) Location - All interceptors shall be located outside the building on private property.
- (5) Connections
  - (a) All drains from the kitchen, food preparation, and dishwashing areas shall be connected to the grease interceptor.
  - (b) Garbage grinders not connected to the grease interceptor, shall not be used for disposal of grease. However, the District, at its discretion, may require any garbage grinder to go through the grease interceptor.
  - (c) All drains from automotive servicing areas will be connected to oil and sand interceptors.
- (6) Maintenance - The responsibility of cleaning and maintaining the grease interceptor in efficient operating condition shall be the Owner's and/or lessee's responsibility. Grease interceptor shall be accessible and shall be inspected on a periodic basis by representatives of the District.

**9C-3-10.6 Ownership and Maintenance.**

- (1) Ownership - The sewer service line, including the connection on the District's main, shall be owned by, and installed at the expense of the tap permit purchaser.
- (2) Maintenance - The customer shall maintain all service pipe between the structure being served and the District's sewer main, including the connection on the District's main.