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CHAPTER 4
SANITARY SEWER SYSTEM

4.00.00 **INTRODUCTION**

All sanitary sewer systems shall comply with the requirements of these STANDARDS AND SPECIFICATIONS and may include special criteria established by the CITY for overall hydraulics of the sanitary sewer system. Special criteria shall be outlined at pre-design meetings, as determined necessary by the CITY.

The DEVELOPER shall analyze any impacts to the existing off-site infrastructure. If there are any impacts, as determined by the CITY ENGINEER, additional analysis, such as hydraulic modeling, will be required at the DEVELOPER's expense. If off-site PUBLIC IMPROVEMENTS are required for the proposed development to be successful, the CITY and the DEVELOPER will negotiate the scope of the PUBLIC IMPROVEMENTS, any phasing, and payment by the DEVELOPER to the CITY for these off-site PUBLIC IMPROVEMENTS.

4.01.00 **USE OF SANITARY SEWER**

The use of sanitary sewers within the CITY of Westminster shall be in accordance with Title VIII, Chapter 8, of the CITY CODE.

4.10.00 **DESIGN CRITERIA**

4.11.00 **SCOPE**

It is the intent of this "design criteria" section to provide sufficient detailed information to enable the DEVELOPER to correctly and efficiently design the overall sanitary sewer system for a particular development. If there is a question or a concern regarding the design of any portion of the sanitary sewer system that is not adequately answered within this chapter, the DEVELOPER shall contact the CITY to get all issues resolved prior to design. Any deviation from these STANDARDS AND SPECIFICATIONS must be approved in writing by the CITY.

The Colorado Water Quality Control Act establishes the statutory framework for design approval of domestic wastewater treatment works (DWWTW) by the Water Quality Control Division. The statute, CRS 25-8-702, states "no person shall commence construction of any domestic wastewater treatment works or the enlargement of the capacity of an existing domestic wastewater treatment works, unless the site location and the design for the construction or expansion have been approved by the Division." DWWTW is defined as a system or facility for treating, neutralizing, stabilizing or disposing of domestic wastewater that has a designed capacity to receive 2,000 gallons per day or more and also includes appurtenances such as outfall sewers (24 inches and larger) and pumping stations and to equipment related to such appurtenances. All plans falling under this criteria shall be submitted to the State Water Quality Control Division for approval prior to construction.

4.12.00

GENERAL

The sanitary sewer system shall be designed by a Professional Engineer registered in the State of Colorado using the most current technical standards along with good, sound engineering judgment throughout the design process. The engineer shall have experience in the design and construction of municipal sanitary sewer systems. The development approval process includes the submittal of a Preliminary Development Plan, an Official Development Plan, utility studies and construction drawings for review and approval by the CITY.

All improvements to the sanitary sewer system shall be planned and designed to provide adequate service for a design horizon of 50 years unless a longer or shorter useful life period is stipulated or approved by the CITY. When approved by the CITY, proposed improvements may be phased over a period of time. For example, future phases of a subdivisions sanitary sewer system may not be constructed until service is required or when the land surface requires improvements.

The utility design process requires a study that falls into one of two categories outlined below. For small projects, such as a single residence that may have little impact on the nearby sanitary sewer system, a study may not be required. Prior approval is required by the CITY.

4.12.01 Utility Studies

A Utility Study may be submitted in various forms depending on the stage of the review process and projected goals for the development. A Master Utility Study may be required at a conceptual stage of a development project in order to assess the feasibility of providing sanitary service to a particular area or various alternates for providing such service and also confirms downstream sanitary pipe capacities. The Master Utility Study is based on CITY zoning requirements and possibly an Overall Development Plan but may not have detailed design flows for particular uses if they are not know at the concept stage in the design process.

A detailed Utility Study is required when specifics for a development project are known and may include flow projections for particular use types (refer to design criteria in sections 4.13.00 through 4.15.00 of these STANDARDS AND SPECIFICATIONS). The submission of a Master Utility Study is not a substitute for a Utility Study.

A Utility Conformance Letter shall be required for all lots or pad sites that are associated with a Master Utility Study. Utility Conformance Letters are an abbreviated report that confirms the site specific sanitary sewer flows for a project are below those projected in an approved Master Utility Study. Utility Conformance Letters shall also confirm there is available capaCITY in the sanitary sewer system downstream of the project based on current flow projections by the CITY in the basin.

4.12.02 Study Requirements

A Utility Study will be required for all projects or developments tributary to the CITY's sanitary sewer system and is required prior to approval of the Overall Development Plan, construction plans or issuance of a land disturbance permit. Analysis of the sanitary sewer can be combined with the analysis of the water system in the Utility Study. This study details the basis for the sewer design and provides the planning information necessary to assess the impact of a particular development on the CITY's sanitary sewer system based on anticipated sewer flows and available sewer pipe capacities.

At a minimum the study shall include the following information and shall be bound in an 8-1/2-inch x 11-inch folder and submitted to the CITY in both hard copy and .pdf electronic format:

- A) Certification statement - shall be included at the beginning of the report and shall read as follows: "This Utility Study for the design of the _____ development was prepared by me or under my direct supervision in accordance with the City of Westminster's STANDARDS AND SPECIFICATIONS and acceptable professional practices of the industry. We acknowledge that the City of Westminster's review of this Utility Study is only for general conformance with submittal requirements, current design criteria and standard engineering principles and practices. We are also aware of the provisions of Section 11-6-5(B) of the Westminster Municipal Code of the City of Westminster." The seal and signature of the Professional Engineer responsible for preparing the report shall follow this statement.
- (B) Report text, which addresses project location and description, project concept, discussion of any information that would affect the CITY's ability to serve the new area, and an analysis of the sanitary sewer system that includes the following at a minimum:
 - a) The area, in acres, which will be served by gravity with the new sewer and shown on a topographic map which delineates the basin boundaries as stated in (f) below.
 - b) The estimated population densities and total population based on land use projections to be served by the new sewer.
 - c) The estimated quantity and quality of any industrial wastes to be discharged to the system.
 - d) Open channel flow analysis using Manning's equation shall be performed for sewer mains 8 - 12 inches in size. Design flow rates, pipe capacities, flow velocities, pipe slopes, infiltration allowances and a detailed descriptions of all assumptions shall be provided in the report text such that all calculations can be verified.

- e) Sewer mains 15 inches and larger shall be designed using standard industry software that profiles the hydraulic grade line along the pipeline alignment and analyzes head losses through all pipes and structures. A detailed description of the hydraulic analyses and assumptions shall be provided in the report text such that all calculations can be verified. A copy of the resulting hydraulic data shall be provided in an appendix of the report. Peak hydraulic grade lines shall be provided on design drawing profile views of the pipelines and structures.
 - f) The impact of projected flows from the project to a significant sewer outfall connection point downstream. The design engineer shall work with the CITY to establish the adequacy of the downstream sewer capacity based on the size of the proposed development, size of the outfall and capacities demonstrated in master planning studies that may be approved by the CITY.
 - g) Where projected flows for a project exceed those calculated in an approved master planning study from the CITY or if studies are not available, it will be the responsibility of the design engineer to demonstrate the impacts on the sewer system downstream of the project. A capacity analysis may be required at the developers' expense using the CITY wide hydraulic sewer model and CITY designated consultant familiar with development of the model. Flow monitoring may also be required for the analysis and at the developers' expense to determine available capacities in downstream sewers.
 - h) Report conclusions describing the results and how they follow the CITY criteria shall be provided. Any deviations from the CITY criteria shall be described and applicable variances requested.
- (C) For construction plan submittals, design drawings shall include plan and profile figures with the following minimum information. Submittal of plan and profile drawings at the construction plan stage does not preclude the design engineer from verifying that sanitary sewer facilities are not in conflict with other facilities and utility corridors during earlier review stages.
- a) Location of all proposed and existing easements and/or rights-of-way.
 - b) Existing and proposed utilities and appurtenances with sizes, slopes and horizontal and vertical locations.
 - c) Basin delineation and flow design points.
 - d) All other pertinent information that may pose a utility conflict.

- (D) Appendices and Figures - Printed data output from any pipe flow analysis shall be provided in the Appendix and shall correspond with a figure of the pipe network. The Appendix shall also include hand calculations and any other pertinent data. A large size figure (24" x 36") illustrating the existing and proposed utility improvements may be required and should include building finished floor elevations, elevation contours and locations of proposed and existing utility easements and right-of-way as necessary.

4.13.00

DESIGN FLOW

Projected flows used to design the sanitary sewer system for a particular development vary depending on the type of development and land use. Six general categories of development for which typical average flow rates are given below include residential, restaurants, service, retail, office, hotel and industrial uses. For non-residential and non-hotel uses, apply the factor to the total area of the lot. Once the specific type of development is determined, peak design flows are calculated by multiplying the average flow with the peaking factor and then adding infiltration and inflow.

Typical Average Flow Uses:

Restaurants	1.24 Gallons/Minute/Acre*
Service	0.99 Gallons/Minute/Acre*
Retail	0.81 Gallons/Minute/Acre*
Office	0.40 Gallons/Minute/Acre*
Industrial	0.22 Gallons/Minute/Acre*
Hotel	5.16 Gallons/Minute/100 rooms*
R-36 residential zoning	0.07 Gallons/Minute/Unit*
R-18 residential zoning	0.07 Gallons/Minute/Unit*
R-8 residential zoning	0.09 Gallons/Minute/Unit*
R-3.5 residential zoning	0.10 Gallons/Minute/Unit*

Peaking Factor $3.6 \times [\text{Average Flow (mgd)}]^{-0.12}$, maximum value of 4**

Infiltration and Inflow 1000 Gallons/Acre/Day ***

Some development projects may not be considered "typical" as they may be infill type projects and capacities of the downstream sewer may be limited. In these cases, design flows must be calculated using historic flow data available from the CITY for various use types projected and available capacities in the downstream sewers may need to be modeled as described in section 4.12.02 (B) g. Refer to the "Orchard Town Center Sanitary Sewer System Analysis", February, 2013 by J&T.

Flow rates in pipelines downstream of lift stations shall take into account the maximum pumping rate generated by the pump station plus peak daily flow plus Infiltration and Inflow.

- * From "Big Dry Creek Interceptor Sewer Improvements Preliminary Design" HDR, 2019.
- ** This equation was developed by the Metro Wastewater Reclamation District. This equation correlates well with the City's interceptor system
- *** From "1986 Sewer System Master Plan - City of Westminster," Brown and Caldwell.

4.14.00 HYDRAULIC SIZING OF SEWER LINES

4.14.01 General

Sanitary sewer shall be designed to carry the discharge calculated in this section and transport suspended material such that sediment is not deposited in the sewer.

The minimum diameter for sanitary sewer mains shall be 8-inches.

Oversizing of mains may be required by the CITY, and the recovery of the costs of such oversizing shall be in accordance with the Municipal Code.

The minimum diameter for sanitary sewer service lines shall be 4 inches.

4.14.02 Sanitary Sewer Mains

To achieve self-cleaning scour velocity and minimize odor and pipe degradation the "Tractive Force" design approach shall be used for all gravity sanitary sewer mains. Reference ASCE and WEF (WEF Manual of Practice No. FD-5 Gravity Sanitary Sewer Design and Construction, 2007, Section 5.6). This approach results in a self-cleansing minimum design slope associated with the design minimum flow rate (Q_{min}). Design pipe slopes and associated calculations shall be included in the Utility Study:

The following table gives the minimum and maximum allowable design slopes for sanitary sewer mains.

Table 4.14.01 Minimum and Maximum Sewer Main Slope

Pipe Diameter* (inches)	Minimum Slope (%) (Use Greater of Two Values)		Maximum Slope (%)
8	$0.0007760 \times (Q_{min})^{-0.56}$	0.50	19.0
10	$0.0008130 \times (Q_{min})^{-0.56}$	0.50	14.0
12	$0.0008460 \times (Q_{min})^{-0.56}$	0.22	11.0
15	$0.0008870 \times (Q_{min})^{-0.56}$	0.15	8.2
18	$0.0009221 \times (Q_{min})^{-0.56}$	0.12	6.4

* Note that the design of sewers greater than 15 inch requires special attention. Slopes shown are intended for general guidance.

Sewers must be designed at slopes great enough to produce a minimum flow velocity of two feet per second (2 fps) at the peak flow rate. Sewers must also be designed at slopes that produce maximum flow velocities less than eight feet per second (8 fps) at the peak flow rate. Open channel flow (non-submerged) conditions must apply and use Manning equation with $n = 0.013$ for PVC pipe. Note that sewer pipes near dead ends typically require a greater minimum slope due to limited peak flows in these segments and must be designed accordingly.

The maximum design depth of flow to pipe diameter ratio for build-out peak flow (including I & I) shall be as follows (from URS, 2007):

- $d/D = 0.60$ Pipe diameters 12 inch and smaller.
- $d/D = 0.80$ Pipe diameters 15 inch and greater.

The design of pressure sanitary sewers is not covered in these specifications. Design, review and approval of this infrastructure shall be performed on a case-by-case basis.

4.14.03 Sanitary Sewer Service Lines

The following table shows the minimum and maximum allowable slopes for sanitary sewer service lines.

TABLE 4.14.03 Minimum and Maximum Sanitary Sewer Service Slope

Pipe Diameter* (inches)	Minimum Slope (%)	Maximum Slope (%)
4	2.08	8.0
6	1.04	6.0

4.15.00 SYSTEM LAYOUT

4.15.01 General

All mains shall be installed in dedicated rights-of-way or public easements. Public sanitary sewer mains shall not be installed parallel to and directly below any concrete such as sidewalks, curbs or gutters, unless approved otherwise by the CITY in writing. Where parallel to concrete such as sidewalks, curbs, and gutters, the centerline of the sanitary sewer shall be placed a minimum of 10 feet horizontally from the edge of the concrete.

Sanitary sewer mains shall be straight between manholes, both in horizontal and vertical alignment. Sewer mains will terminate in a manhole.

Sewer mains will typically have a minimum of eight feet of cover to finished ground surface. Where less than ten feet of elevation difference results between residential building finished floors and the extended sewer service invert, plans will indicate that the lot is served by a "shallow sewer" and appropriate elevation information will be given.

Sewer mains shall have a maximum cover of no more than 15 feet, unless approved otherwise in writing by the PWU.

Sanitary sewer mains shall be laid a minimum of ten feet horizontally from any existing or proposed utility, measured from outside edge of pipe to outside edge of pipe. Upon written approval by the CITY, a sanitary sewer main may be laid closer than ten feet to a parallel water main if it is laid in a separate trench and if the elevation of the invert of the water main is at least 18 inches above the crown of the sewer main, and in addition polyvinyl chloride pressure pipe is used for the sewer main.

When the sanitary sewer main passes under a highway, railroad or drainage or irrigation ditch, there shall be a minimum of 3-1/2 feet of cover and steel casing shall be installed in accordance with the detail drawings in the Appendix of this chapter. The steel casing shall extend the entire width of the right-of-way or easement of the crossing structure or as directed by the CITY. A cathodic protection system shall be designed for the casing pipe.

All-weather access shall be provided to all sanitary sewer manholes or other sewer appurtenances. All-weather access is defined as a paved road, concrete path, or crushed rock surface with depth capable of supporting maintenance machinery weighing up to 10 tons.

Public sewers may not be placed behind fences unless approved otherwise by the CITY. Any such fence approved by the CITY shall have gates that are accessible by utility maintenance staff at any time.

Sewer manholes shall be located such that storm water will not pond or infiltrate into manhole lids. Sewers shall not be placed within detention or retention ponds.

4.15.02 Water Line Crossing Over Sanitary Sewer Line

When there is less than 18 inches of vertical clearance between the water main and the sanitary sewer pipe, or water main pipe joints extend less than 10 feet each side of the sewer pipe, one of the following secondary containments shall be required for the water or sewer pipe:

1. Utilize Pressure Pipe AWWA C900.
2. Concrete or flowable fill encasement extending to any joints within 10 feet of the crossing.

Note that if joint-less pipe, such as fusible PVC or welded steel, is used for the water or sanitary sewer pipe then secondary containment will not be required. However, structural support of the water or sewer main using flowable fill may be required to prevent settlement and permit maintenance of both utilities.

Minimum criteria is presented in this section, and applies to both public mains and private service lines.

4.15.03 Sanitary Sewer Line Crossing Over Water Line

When there is less than 18 inches of vertical clearance between the water main and the sanitary sewer pipe, or water main pipe joints extend less than 10 feet each side of the sewer pipe, one of the following secondary containments shall be required for the water or sewer pipe:

1. Utilize Pressure Pipe AWWA C900.
2. Concrete or flowable fill encasement extending to any joints within 10 feet of the crossing.

Note that if joint-less pipe, such as fusible PVC or welded steel, is used for the water or sanitary sewer pipe then secondary containment will not be required. However, structural support of the water or sewer main using flowable fill may be required to prevent settlement and permit maintenance of both utilities.

Minimum criteria is presented in this section, and applies to both public mains and private service lines.

4.15.04 Storm Sewer Line Crossing Over Sanitary Sewer Line

When there is less than 18 inches of vertical clearance between the sanitary sewer line and the storm sewer line, the sanitary sewer line shall be encased in concrete a minimum of nine feet on each side of the centerline of the crossing, or PVC pressure pipe (AWWA C900) may be used for the sanitary sewer pipe. However, structural support of the sanitary or storm sewer using flowable fill main may be required to prevent settlement and permit maintenance of both utilities.

4.15.05 Sanitary Sewer Line Crossing Over Storm Sewer Line

When there is less than 18 inches of vertical clearance between the sanitary sewer line and the storm sewer line, the sanitary sewer line shall be encased in concrete a minimum of nine feet on each side of the centerline of the crossing, or PVC pressure pipe (AWWA C900) may be used for the sanitary sewer pipe. However, structural support of the sanitary or storm sewer main

using flowable fill may be required to prevent settlement and permit maintenance of both utilities.

4.15.06 Limits on Vertical Separation

Under no circumstances shall the vertical clearance between any lines involving a waterline, sanitary sewer line, or storm sewer be less than 12 inches without prior written approval from the CITY.

4.15.07 Sanitary Sewer Lines in Alleys

The construction of sanitary sewer lines and fittings are not allowed in private alleys. The CITY ENGINEER shall consider the following criteria when reviewing requests for sanitary sewer installation in alleys:

1. There are unique physical circumstances or conditions, such as irregularity in size and shape of property to be developed, exceptional topographical, or other physical conditions peculiar to the affected property.
2. Special conditions and circumstances do not result from the present or prior actions of the applicant
3. Reduction of planned lots or other financial-related circumstances shall not be considered in this evaluation

See Standard Detail R4 for additional information.

4.16.00 EASEMENTS

All sanitary sewer mains shall be in an easement which has a width of at least two times the depth to the pipe invert. The minimum easement shall be 20 feet in width for one utility, 30 feet in width for two utilities and 40 feet in width for three utilities. Site-specific circumstances may dictate the need for wider easements. The main shall be located a minimum of ten feet from and parallel to the edge of the easement and shall be centered within the dedicated easement area. All easements shall be for the exclusive use of the CITY.

Restrictions on above-grade uses include most landscaping and permanent structures. If approved by the CITY grasses, annuals, perennials, and shrubs less than 24 inches will be allowed in utility easements. Trees and permanent structures (i.e., fences, mailboxes, sheds, buildings, etc.) are prohibited within utility easements.

Private utilities are prohibited within the easement with the exception of service lines from the main to the edge of the easement. Private storm sewers may cross CITY utilities within the easement in a perpendicular alignment, however storm sewer structures are prohibited within the utility easement.

The easement agreement shall state that any structures placed in the easement shall be removed by the owner of the land when requested by the CITY so that

maintenance can be performed. The owner of the land shall agree to hold the CITY harmless for any replacement of structures removed from the easement. The following statement shall appear on all Official Development Plans and all Final Plats:

“All public water, storm sewer and sanitary sewer mains and appurtenances located in public right-of-way shall be maintained by the City of Westminster Public Works Department. All public water, storm sewer, sanitary sewer mains and appurtenances located outside of public right-of-way shall be located in utility easements. City is responsible for maintenance of these water, storm and sanitary sewer facilities. City is not responsible for repair or replacement of private drive, curb and gutter or landscaping damaged during utility repair or maintenance.”

4.17.00 FUTURE CONNECTIONS

Manholes shall have pipes stubbed out which are sized to accommodate flows from the upstream basin whenever a future extension of the sanitary sewer main is anticipated. The main line stub-out shall be capped and sealed.

4.18.00 SERVICES

4.18.01 Location and Alignment

Sanitary sewer service lines are private and shall be constructed on the shortest and straightest route possible from the sewer main to the building being served. At no time shall service lines be closer than 5 feet to the side property line, and no service line may be constructed through or in front of an adjoining property. Typically, the service line shall be located five feet toward the low side of the lot from the centerline of the lot and at least ten feet horizontally from a water service or water main. Each structure shall be served by a separate service line.

Six inch and larger sewer services shall require connection to sewer mains with a manhole. Any sewer services tying into sewer mains larger than fifteen inch shall also be made in a manhole.

The CITY shall not be responsible for locating sewer service lateral stub-outs for future connections.

Design of sewer services shall follow the criteria of the International Plumbing Code, as required by the CITY’s Building Division. As such, two-way cleanouts may be required at all bends and every 100 feet minimum along the pipeline. Cleanouts are also recommended on all sewer services exterior to buildings.

4.18.02 Residential Service

Each unit with a CITY water meter is required to have a separate sewer service line. For multi-family housing such as townhome units, individual private sewer service lines may connect to a Home Owner Association (HOA) owned private sewer service and the HOA shall be responsible for the maintenance, repair, and replacement of these services. With the exception of HOA maintained lots, individual services shall not cross other privately owned lots.

4.18.03 Non-Residential Service

Each privately owned lot shall have a separate service line. For multiple tenants or units of a building on a common lot, individual private sewer service lines may connect to a building owner maintained private sewer service and the building owner shall be responsible for the maintenance, repair, and replacement of these services. With the exception of building owner maintained common lot, sewer services shall not cross other privately owned lots.

4.19.00 SERVICE TAPS

All four inch diameter sewer service connections to the sanitary sewer main shall be made using "wye" fittings, unless otherwise approved by the CITY.

When the diameter of the sewer service is six inches or larger, a manhole shall be constructed at the sewer main in place of a wye fitting. A sewer service tying into a manhole must be a minimum of six inches in diameter. Sewer service four inches in diameter are not allowed to discharge into public manholes. Benches shall be constructed in manholes to accommodate sewer service flow such that the flow transitions smoothly into the flow of the main.

Concrete sewer mains shall not be tapped for sewer services. A manhole shall be constructed at the concrete sewer main in place of a wye fitting and a six inch or larger service line will be required.

4.20.00 UNLAWFUL CONNECTIONS

It shall be unlawful to discharge roof drainage, foundation drainage, sump pumps, surface drainage, underdrains, RV dump sites or any other non-acceptable wastes to the sanitary sewer which would violate any of the provisions of Section 8-8-4 of the CITY CODE.

4.21.00 SANITARY SEWER PRE-TREATMENT

4.21.01 Sewer Monitoring Manhole

Any new building to be constructed in an industrially-zoned area with a floor space greater than five thousand square feet, or with a water meter size greater than three-quarter inch, or if otherwise required by the CITY, shall install a sewer-monitoring manhole prior to final building inspection approval. The monitoring manhole shall be situated outside of the building on the user's premises. If the industrial user's service line ties into an existing CITY manhole and such manhole allows for safe sampling and isolation of the industrial user's discharge, the CITY may allow said manhole to serve as the industrial user's monitoring facility.

4.21.02 Grease Interceptors General

Gravity Grease Interceptor (GGI) are permitted by the CITY. GGI is defined as a large tank or retention device constructed to separate, trap, or hold fats, oil, grease, and grit (FOGG) substances from the sewage discharged from a facility in order to prevent their entry into the sanitary sewer collection system. GGIs are located outside of the building and must be readily accessible to outside inspections. CITY approved GGIs must be gravity flow without any flow control.

Hydromechanical Grease Interceptor (HGI) shall be prohibited in the CITY. HGI, also referred to as grease trap, is defined as a tank or retention device installed inside a building to separate, trap, or hold fats, oils, grease, and grit (FOGG) substances by flow control to prevent their entry into the sanitary sewer collection system. HGIs can also be found within the floor of the building with access hatches for maintenance purposes. The use of HGIs for new development, expansion, or redevelopment shall be prohibited by the CITY.

A GGI is required for all non-residential establishments where food or beverages will be processed, cooked, or prepared. Examples include, but are not limited to, businesses containing a commercial kitchen, restaurants, coffee shops, ice cream and frozen yogurt shops, smoothie shops, and commercial pet grooming facilities. An individual GGI shall be provided for each building, and in most cases, for each individual unit that meets the CITY's requirement criteria. In all cases, the determination of whether or not a GGI is required shall be reviewed and approved by the PWU as part of the building permit process.

All kitchen and/or food and beverage preparation waste lines shall be routed through an approved GGI prior to entering the public sewer system. Domestic waste from sanitary fixtures such as toilet and urinals shall not be allowed to enter the GGI. GGIs shall not serve more than one business establishment, unless specifically approved by PWU.

All GGIs shall be located outside the building on private property and as close as possible to the fixtures it serves. GGIs shall be readily accessible at all times for maintenance and inspection and shall not be placed in drive-through aisles or under trash cans / dumpsters. The use of ladders, unapproved placement, or the removal of equipment in order to service or inspect GGIs shall constitute a violation of accessibility, and can result in fees against the business. Accessibility is subject to review and approval by the PWU.

Venting for GGIs shall be located and designed such that odors emitted will not disturb nearby businesses or the public. Venting design is subject to review and approval by PWU.

4.21.03 Grease Interceptor Sizing

The permitted capacity of the GGI shall be determined by both the minimum allowable volume and the calculated volume based on fixture flow rates, whichever is greater. No individual GGI shall be less than 750 gallons in capacity. No shared GGI shall be less than 1,400 gallons in capacity.

All submittals must include the calculated capacity prior to approval by the PWU. See equation below for calculation guidelines.

The calculated volume of the GGI is based on the maximum flow rate into the GGI from plumbing fixtures in the kitchen and food preparation area as well as other fixtures that may receive FOGG-containing waste. The GGI capacity, in gallons, is calculated as the maximum flow rate of all fixtures discharging into the GGI multiplied by a detention factor of 8 minutes. Table 4.21.03 establishes the maximum flow rate, in gallons per minute (GPM), for various pieces of equipment and plumbing fixtures requiring connection to the GGI.

$$\text{GGI Capacity (gallons)} = 8 \text{ Minutes} \times \text{Sum of Maximum Flow Rates (GPM)}$$

Garbage Disposals: All garbage disposals shall discharge into a GGI. GGIs shall be sized for all plumbing fixtures plus the garbage disposal flow rate. Refer to Table 4.21.03 for the GPM rating to be added for each garbage disposal discharging into the GGI.

Table 4.21.03 Typical Flow Rate for Plumbing Fixtures

TYPE OF FIXTURE	TRAP & TRAP ARM SIZE	RATE OF FLOW (GPM)
Floor Drains:		
Discharging into interceptors for grease, oil, solids, etc.	2"	15
	3"	20
Discharging into non-vehicle wash sand & oil interceptors	2"	20
	3" or 4"	45
Discharging into vehicle wash sand & oil interceptors	3" or 4"	60
Sinks:		
Commercial bar sinks	1-1/2"	15
Restaurant kitchen sinks (single compartment)	1-1/2"	20
Restaurant kitchen sinks (three compartment)	1-1/2"	40
Restaurant hand sinks	1-1/2"	15
Service sinks (mop sinks)	2"	20

Dishwashers:		
Up to 50 gal. capacity	-	20
Over 50 gal. capacity	-	40
Garbage Disposals:		
Any size garbage disposal	-	35

4.21.04 Sand/Oil Interceptors General

To protect the wastewater collections system, sand/oil interceptors shall be installed on wastewater service lines serving facilities that may introduce sand, grit, metals, petroleum, and/or oil. This includes, but is not limited to, car wash facilities, automotive shops, machine shops and parking garages. Existing facilities that received approval from the City for waiving the requirement to install a sand/oil interceptor, or those that received approval of a sand/oil interceptor that does not meet current sizing standards, may be required to improve their system to meet current standards.

The owner and/or lessee shall be responsible for cleaning and maintenance of the sand/oil interceptor. It shall be completely cleaned when solids are within 8 inches of the bottom of the outlet tee. Maintenance records for the last three years shall be kept on site and made available to the Utilities Operations Division upon request.

4.21.05 Sand/Oil Interceptor Sizing

Sand/oil interceptors shall be sized per the following table, and have a minimum liquid capacity of 6 cubic feet or 45 gallons. They shall have two compartments, separated by a baffle wall.

Sand/Oil Interceptor Capacity (cubic feet) = Facility Service Area (square feet) ÷ Treatment Capacity factor from table

Type of Facility	Treatment Capacity per Cubic Foot of Sand/Oil Interceptor
Car Wash, Trucks or Heavy Equipment	15 Square Feet
Car Wash, Automatic Bay or Conveyor	50 Square Feet
Car Wash, Hand Held Spray	75 Square Feet
Automotive Shop or Machine Shop	100 Square Feet
Parking Garage	4,000 Square Feet

4.21.06 Sand/Oil Interceptor Design

Sand/oil interceptors shall be located outside of the building and be readily accessible for inspection, cleaning and maintenance.

Portions of car wash facilities that are exposed to precipitation shall not be connected to the wastewater collection system. Portions of car wash facilities that are covered and have floor drains shall be directed to a sand/oil interceptor. Car wash facilities without recycled water shall have floor drains directed to a sand/oil interceptor before connection to the wastewater main.

Car wash facilities with recycled water may have a sand/oil interceptor either upstream or downstream of the recycled water system, but must be installed before connection to the wastewater main. Hose bibs are not allowed on recycled water piping systems. Drinking water sources, playgrounds, eating areas and similar facilities shall be protected from recycled water use and over-spray. Signage indicating recycled water usage is required at the point of use to inform workers and the public. Recycled water pipes, valves, valve boxes, and fittings shall be properly color-coded and labeled "NOT POTABLE WATER - DO NOT DRINK" in English and any other dominant language that may be spoken at the site.

For automotive shops and machine shops, the sand/oil interceptor shall have a minimum depth of 2 feet below the invert of the outlet pipe and the outlet pipe shall have a minimum water seal of 18 inches.

Parking garages exposed to precipitation shall not have that portion connected to the wastewater collections system. This includes, but is not limited to, the roof of the parking garage and trench drains placed at the entrance and exit. Portions of a parking garage that are covered and have floor drains shall be directed to a sand/oil interceptor and then to the wastewater collections system.

4.21.07 Abandoning FOGG Devices

FOGG devices can only be abandoned with permission of PWU. FOGG devices that are approved to be abandoned in-place shall be cleaned of all grease, oil and debris. The inlet and outlet pipes shall be plugged at each end of the abandoned FOGG device and the device filled with sand, gravel, flash fill or flow fill. Access covers shall be sealed.

4.22.00 APPURTENANCES

4.22.01 Manholes

The maximum spacing between manholes shall be four hundred (400) feet. Manholes shall be located in areas that allow direct access by maintenance vehicles when it is not feasible to locate the manhole in the public street.

Manholes shall not be located in areas that are subject to flooding from surface runoff.

All manholes located outside of paved roadways shall be designed and constructed with a locking and hinged type cover in accordance with the details in the appendix of these STANDARDS AND SPECIFICATIONS.

To delineate the location of manholes in non-paved areas they shall be marked using a 3 foot tall steel marker post set in concrete, painted green and located within ten (10) feet of the manhole. Lettering shall be provided on the post to indicate the distance to the manhole and the lettering shall face the direction of the manhole (Example: SSMH-7').

Manholes constructed with 24 inch and larger sewer mains shall require 30 inch nominal diameter ring and cover assemblies. Manholes constructed with sewer mains smaller than 24 inch shall require 24 inch nominal diameter ring and cover assemblies, unless larger assemblies are required by the CITY for maintenance.

Chemical and gas resistant manhole interior linings shall be required on all newly constructed sewers fifteen inches and larger or other manholes downstream of a discharge source that are determined by the CITY to be at risk of deterioration. High levels of hydrogen sulfide gases (H₂S) and other corrosive discharges, such as from brewery's and downstream of sewer force mains, contribute to the degradation of manholes and warrant interior linings. The number of manholes requiring lining shall be evaluated by the CITY on a case-by-case basis.

Bituminous coatings shall be required on manhole exteriors on all newly constructed sewers in order to waterproof manholes and reduce infiltration.

4.22.02 Drop Manholes

Drop manholes will be required when a sewer main enters a manhole at an elevation greater than twenty-four inches above the manhole invert and must be approved in writing by the CITY. Drop manholes will only be allowed when the design engineer demonstrates that alternate vertical pipe alignments to reduce the vertical drop within the manhole and maintain acceptable pipe velocities is not feasible. No vertical invert drop within a manhole shall exceed ten feet. Drop manholes shall be constructed in accordance with the detail drawings in the Appendix of this chapter.

Inside drop manholes shall be used on sewer mains twelve inches and smaller. Minimum manhole diameters shall be constructed in accordance with the detail drawings in the Appendix of this chapter for various sewer main sizes. A larger manhole than that specified in the details may be required in order to provide a smooth transition for drop flows converging at an angle with main pipe flows.

Outside drop manholes shall be used on sewer mains greater than 15 inches and shall be installed in accordance with the detail drawings in the Appendix of this chapter.

When connecting sewers with vertical drops of twenty-four inches or less, a smooth transition or “beaver slide” shall be constructed to reduce turbulence in the flow.

Sewer service connections shall not be made using an inside drop. Sewer services six inch and larger shall use an outside drop manhole and four inch services shall connect directly to the sewer mains.

4.22.03 Underdrains

Underdrains are privately owned infrastructure and are not a CITY-maintained utility. The DEVELOPER shall receive written approval from the CITY prior to installation of underdrains near CITY-maintained utilities. Under no circumstance shall the underdrain be connected to the sanitary sewer. Perforated underdrain pipe shall be white or black in color wrapped in geofabric and shall have a marker tape installed two feet above the pipe labeled “Underdrain.”

4.30.00 CONSTRUCTION SPECIFICATIONS

4.31.00 EXCAVATION AND TRENCHING

Excavation, trenching and backfilling shall be done in accordance with Chapter 9 of these STANDARDS AND SPECIFICATIONS.

4.32.00 BEDDING

4.32.01 General

In the event unstable trench conditions are found at pipeline grade, a minimum of one and one-half inch uniformly graded, washed rock shall be used for trench stabilization. Depth of stabilization shall be as approved by the CITY. Pipe bedding shall be done in accordance with Sections 4.32.02 of these STANDARDS AND SPECIFICATIONS and the detail drawing in the Appendix of this chapter.

4.32.02 Granular Bedding

Granular Bedding is defined as that method of bedding in which the pipe is set on granular material meeting the requirements of Chapter 9 of these STANDARDS AND SPECIFICATIONS and the detail drawing in the Appendix of this chapter. Bedding shall be placed to a depth below the bottom of the pipe equal to one-fourth of the outside pipe diameter but not less than four inches. In rock excavation this minimum depth shall be six inches. Bedding material shall be placed around the sides of the pipe and to a minimum of nine inches above the top of pipe.

4.33.00

PIPELINE INSTALLATION

4.33.01 General

The CITY shall be notified at least 48 hours in advance of any pipe installation. No pipes shall be backfilled until they have been inspected by the CITY. Alignment and grade of the pipe and the location of fittings, and manholes shall be staked under the supervision of a professional surveyor registered in the State of Colorado. When constructing sewers at or near the minimum design slope, survey confirmation should be performed on a daily basis so that pipelines installed incorrectly can be readily corrected prior to backfill. Refer to minimum design slope requirements in section 4.14.02 of this Chapter.

Proper implements, tools and facilities shall be provided and used by the CONTRACTOR for the safe and convenient execution of the work. All pipe fittings, and manhole sections shall be carefully lowered into the trench by means of a derrick, ropes or other suitable tools or equipment to prevent damage to sanitary sewer line material. Under no circumstances shall sanitary sewer line materials be dropped or dumped into the trench.

All pipe fittings shall be carefully examined for cracks and other defects immediately before installation. The groove in the bells of the pipe shall be full and continuous or the pipe will be rejected. Defective pipe or fittings shall be removed from the job site within 24 hours of notification by the CITY. All foreign matter or dirt shall be removed from the interior and ends of the pipe before they are lowered into position in the trench and prior to connection.

Every precaution shall be taken to prevent foreign material and trench water from entering the pipe and fittings. During construction, the CONTRACTOR shall provide and maintain adequate equipment to properly remove and dispose of all water entering the trench and any other part of the work.

4.33.02 Pipe

Pipe shall be laid from downstream to upstream with spigot ends pointing downstream. All pipe shall be placed true to line and grade and carefully centered and with a smooth invert at the joint. The joint shall be made in a workmanlike manner and shall be watertight. Immediately before joining two lengths of pipe, the inside of the bell and the outside of the spigot end and the gasket shall be thoroughly cleaned. Caution shall be exercised to ensure that the correct type of gasket is used. A thin film of gasket lubricant shall be applied to the inside face of the gasket and the spigot end of the pipe. The spigot end of the pipe shall be placed in the bell with care to prevent the joint from contacting the ground. The joint shall be completed by pushing the pipe home with a slow steady pressure, without jerky or jolting movements. Pipe furnished without a depth mark shall be marked before assembly to ensure insertion to the full depth of the joint. The pipe shall then be properly set and brought to correct line and grade. The pipe shall then be secured in place by installation of bedding material and backfill, in

accordance with Chapter 9 of these STANDARDS AND SPECIFICATIONS and the detail drawings in the Appendix of this Chapter.

At times when installation is not in progress, the open ends of the pipe shall be closed with a watertight plug. Cutting of pipe for inserting closure pieces shall be done in a neat and workmanlike manner without damage to the pipe or lining, leaving a smooth end at right angles to the axis of the pipe. Pipe ends shall be smooth and beveled with a file or other tools according to the pipe manufacturer's recommendations.

Extra care should be used in handling PVC pipe during cold weather due to the reduced flexibility and impact resistance as temperatures approach and drop below freezing. PVC pipe to be stored outside and exposed to sunlight for more than 30 days shall be covered with an opaque material such as canvas. Clear plastic sheets shall not be used to cover the pipe. Air circulation shall be provided under the covering. Any over-exposed pipe, as determined by the CITY, will not be permitted for installation.

No pipe or appurtenant structure shall be installed upon a foundation in which frost has penetrated or at any time when the CITY deems there is a danger of ice formation or frost penetrations at the bottom of the excavation. No pipe or appurtenant structure shall be installed unless backfilling can be completed before the formation of ice and frost.

4.33.03 Steel Casing for Bores

Steel casing pipe for bores shall be seam welded and have an inside diameter of at least 2 to 3 pipe sizes greater than the outside diameter of the carrier pipe to accommodate casing spacers and joint restraints as required. Spiral welded casing shall not be allowed. The minimum wall thickness of the casing pipe shall be in accordance with the standard detail in the appendix of these STANDARDS AND SPECIFICATIONS.

Carrier pipe material shall be according to Chapter 3 of these STANDARDS AND SPECIFICATIONS. All carrier pipe joints shall be mechanically restrained inside the casing. Casing end seals shall be specified per design engineer recommendations and in accordance with the detail drawing in the Appendix of this chapter. Casing spacers shall be stainless steel with adjustable glass filled polymer runners in accordance with the detail drawings in the Appendix.

4.34.00 MANHOLE CONSTRUCTION

4.34.01 Cast-in-Place Base

Cast-in-place bases may be used for sewer connection to an existing pipe or as approved by the CITY. Typically pre-cast bases shall be installed for new construction. Manhole bases shall be constructed with concrete in conformance with these STANDARDS AND SPECIFICATOINS, placed on

undisturbed ground and in conformance with the detail drawing in the Appendix of this Chapter. Changes in direction of flow through the manhole shall be made with a smooth curved channel having as large a radius as possible. The change in size of channels shall be made gradually and evenly and shall be formed directly in the concrete. The floor of the manhole outside of the channel shall be finished to a brushed surface. Construction of cast in place manhole bases shall be of high quality workmanship.

Concrete bases shall extend at least eight inches below the invert of the pipe and shall be benched to at least two inches over the top of the pipe. The manhole floor between the sewer pipe and the outer portions of the bench shall be flush with the top edges at the pipe spring line and shall slope upward at least two inches per foot.

The shape of the invert shall conform to the lower half of the pipe it connects. Side branches shall be constructed with as large a radius of curvature as possible. Inverts shall be plastered with cement mortar and left smooth and clean. Where called for on the plans, a pipe bell shall be stubbed out and plugged. The bell shall be placed as close to the manhole wall as possible, unless showing otherwise on the approved plans.

Bases shall be reinforced with a grid of #4 rebar on 12 inch centers and bars aligned perpendicular. Reinforcement shall be approved by the CITY prior to installation.

4.34.02 Pre-Cast Base

Pre-cast bases will be allowed by the CITY and shall be in conformance with this section.

The ground surface below the precast concrete base shall be excavated six inches minimum below the elevation of the bottom of the base and backfilled with bedding in accordance with the detail in the appendix of these STANDARDS AND SPECIFICATIONS. The bedding shall be carefully leveled and smoothed to give uniform support to the precast base over its entire area. The precast base shall be set at the proper location to center the manhole over the sewer main.

Inverts shall be poured in bases after it has been set in place and pipes installed. Changes in direction of flow through the manhole shall be made with a smooth curved channel having as large a radius as possible. The change in size of channels shall be made gradually and evenly and shall be formed directly in the concrete. Benches in the manhole shall be brush finished.

The precast base shall also conform to the requirements of Section 4.55.03 of these STANDARDS AND SPECIFICATIONS.

4.34.03 Pre-Cast Barrel

Precast manhole sections shall not be placed on a cast in place base until it has reached sufficient strength to provide support without damage. The joint between the manhole base and barrel section shall be sealed with a flexible butyl resin joint compound.

4.34.04 Manhole Grouting Treatment

The inside horizontal joints between precast manhole sections shall be plastered and troweled smooth with cement mortar. The mortar shall be not less than five eighths inch in thickness over the joint and shall extend at least four inches on either side of the joint. Exterior horizontal joints shall be wrapped with ConWrap joint wrap, or approved equal, and secured to the concrete to provide a watertight seal.

All smooth surface pipes, such as PVC or VCP shall have a manhole water-stop gasket, to be furnished by the CONTRACTOR, firmly attached to the pipe prior to grouting into the manhole. The opening in the manhole wall where a pipe enters or leaves shall be sealed and patched in a neat workmanlike manner, both inside and out with cement mortar. All lifting holes and other imperfections in the interior manhole wall shall be filled with cement mortar.

4.34.05 Adjustment Rings

Precast concrete adjustment rings shall be used on top of the cone to support and adjust the manhole ring and cover to the required final grade. The maximum depth of the adjustment rings shall be twelve inches. If manholes are located in paved areas, the maximum depth from the top of cone to street grade shall be 18 inches and the ring and cover shall be left 1/8 inch below the pavement surface.

If manholes are located in field installations, the ring and cover shall be 12 to 18 inches above final grade. A locking ring and cover shall be provided in all field installations.

4.35.00 CONNECTIONS TO EXISTING MANHOLES

Sewer pipe connections to existing manholes where there is no existing pipe stubbed out shall be made in such a manner that the finished work will conform as nearly as practicable to the requirements specified for new manhole construction. The CONTRACTOR shall core drill a suitable opening in the existing manhole to insert the new sewer pipe. The existing concrete foundation bench shall be chipped to the cross-section of the new pipe in order to form a smooth continuous invert similar to what would be formed in a new concrete base. The downstream invert shall be plugged or otherwise protected during construction to prevent storm and non-sewage flow from entering the system. The CONTRACTOR shall pump out and clean the manhole before removing the plug. Rubber sealing gaskets shall be

installed to provide a water tight seal in accordance with the details in the appendix of these STANDARDS AND SPECIFICATIONS. Cement mortar shall be used to smoothly finish the pipe stub, both inside and outside of the manhole, and form the new invert.

4.36.00 PRESSURE SEWERS

At a minimum, all Chapter 3 requirements of these STANDARDS AND SPECIFICATIONS shall apply to the installation of pressure sanitary sewer lines. All pressure sanitary sewers shall be installed using PVC C-900 per AWWA, or as approved otherwise by the CITY.

Tracer wire shall be attached to the pipeline for future locating. A green plastic identification strip, a minimum of a six-inch wide, continuously labeled "Caution Sewer Line Below" shall be installed directly above the pressure sewer, the full length of the sewer, and shall be buried midway between the top of the pipe and the finished ground surface elevation.

4.37.00 SANITARY SEWER SERVICE LINE CONSTRUCTION

All sanitary sewer service lines which connect to the CITY sanitary sewer system shall comply with these STANDARDS AND SPECIFICATIONS. Sewer services shall be inspected prior to backfill by a CITY INSPECTOR and twenty-four (24) hour notice will be required prior to inspection.

The CONTRACTOR shall place wyes, stubs, and risers where required by the approved plans. Wyes shall be angled upwards so that the upper invert of a one-eighth bend connected to the fitting will have an elevation equal to or higher than the inside crown of the sewer main. Riser connections shall be installed where the elevation of the top of the branch is more than twelve feet below the approved finished grade. Riser connections will ordinarily reach to a grade ten feet below the finished ground surface. Water-tight plugs shall be installed in each branch pipe or stub. As-built measurements shall be made by the CONTRACTOR or his representative to reference the wye or riser connection to the nearest manhole before backfill. Said measurements shall be carefully and accurately made and recorded and shall be shown on the as-built plans furnished to the CITY prior to acceptance.

All installation work shall conform to applicable portions of ASTM C-12 and to the pipe manufacturer's installation instructions. The grooves shall be cleaned free of all foreign materials prior to assembling the joint. The pipe shall be laid with the spigot end pointing in the direction of the flow.

Trenches shall be kept free of water during laying and jointing. Lines shall be laid with a laser, or other means approved by the CITY.

Two-way cleanouts may be required at all bends and every 100 feet minimum along the pipeline as required by the International Plumbing Code. The area around a clean-out shall be graded so water runs away from the clean-out. No clean-outs shall be installed in publicly owned rights-of-way or easements unless approved by the CITY. Cleanouts installed on private property should be protected as to avoid damage to the cap and become a source for inflow and debris.

Service stub-ins shall be extended at a minimum to the edge of RIGHT-OF-WAY and be plugged with a glued cap.

Backfilling shall be in accordance with Chapter 9 of these STANDARDS AND SPECIFICATIONS.

4.38.00 TAPPING EXISTING SANITARY SEWERS

4.38.01 General

Where service wyes were not installed in the sewer main during initial construction, a tapping saddle shall be installed and a hole shall be machine drilled in the main appropriately sized to fit the tapping saddle. The drilling machine, method of drilling and tapping saddle shall be approved by the CITY. The saddle shall provide a water tight seal when attached to the main and held in place with metal straps or other approved methods. The saddle and sewer main shall be encased in concrete a minimum of 6 inches in all directions. The tapping saddle or connection shall not protrude into the main or provide a means to catch debris.

Service taps shall have a minimum spacing along the main of 24 inches so that the strength of the pipe is not compromised, and taps shall be located a minimum of 24 inches from pipe joints.

The CITY INSPECTOR shall inspect the tap and the service line to the building before backfilling. Twenty-four hour notice is required prior to inspection. In the event the tap and service line are covered before it is inspected, it shall be re-excavated by the CONTRACTOR, and cleared allowing for visual inspection of the tap and main. If the sewer main is cracked or broken during the process of locating or tapping, it shall be repaired immediately by replacing the broken section at the CONTRACTOR's expense.

4.38.02 PVC Pipe Tap

Where PVC service wyes have not been installed in the sewer main, a PVC tapping saddle shall be installed according to the manufacturer's recommendations and these STANDARDS AND SPECIFICATIONS. Edges of the tapped hole shall be filed smooth and the surfaces to be jointed shall be wiped clean, etched and the primer applied. With primer still wet, the approved cement shall be applied and saddle install. The saddle shall be drawn down with manufacturer provided stainless steel straps to the

specified torque. The saddle and sewer main shall be encased in concrete a minimum of 6 inches in all directions.

4.38.03 Vitrified Clay or Cast Iron Pipe Taps

Where service wyes have not been installed in the sewer main, a PVC tapping saddle shall be installed according to the manufacturer's recommendations and these STANDARDS AND SPECIFICATIONS. Edges of the tapped hole shall be smooth and the surfaces to be jointed shall be wiped clean. The saddle shall be drawn down with manufacturer provided stainless steel straps to the specified torque. The saddle and sewer main shall be encased in concrete.

4.38.04 Concrete Pipe Tap

Concrete mains shall not be tapped. A manhole according to these STANDARDS AND SPECIFICATIONS shall be installed to provide sewer service.

4.38.05 Tapping Lined Pipe

When a tap is made on a main that has been lined, the sewer host pipe shall be removed around the circumference of the service wye to provide clear access to the liner for securing the tapping saddle. A keyhole, saber saw or shell cutter shall be used to cut a round hole in the liner. Edges of the tapped hole shall be filed smooth and the surfaces to be jointed shall be wiped clean, etched and the primer applied. With primer still wet, the approved cement shall be applied and saddle install. The saddle shall be drawn down with manufacturer provided stainless steel straps to the specified torque. The saddle and sewer main shall be encased in concrete.

4.39.00 TESTS

4.39.01 General

All sanitary sewer mains and appurtenances shall be cleaned, tested and PACP TV inspected after backfill operations have been completed in accordance with these STANDARDS AND SPECIFICATIONS. Compaction test results shall be submitted to and approved by the CITY. If the completed line or any portion thereof fails any of these requirements, the CITY will not accept the work until it is properly corrected by the CONTRACTOR.

The CONTRACTOR shall furnish all labor, materials, tools and equipment necessary to clean the pipe and appurtenances, make the tests and perform all work incidental thereto. Any damages to the pipeline caused by cleaning or testing operations shall be repaired or replaced by the CONTRACTOR at his expense.

4.39.02 Air Pressure Test of Pipe

The CONTRACTOR shall perform these tests with suitable equipment specifically designed for air testing sewers. The line shall be plugged at each manhole with plugs or pneumatic balls. All service plugs shall be secured in place to prevent displacement during testing operations.

Low pressure air shall be introduced into the plugged pipe until the internal air pressure reaches 4.0 psi plus 0.4 psi per foot of water table above the pipe invert, if any. Pressure shall not increase above 9.0 psi. At least two minutes shall be allowed for the air temperatures to stabilize before readings are taken and the timing started.

Once the pressure has stabilized between 4.0 psi and 3.5 psi, timing shall commence to determine the amount of time for pressure to drop 0.5 psi. The test shall pass if the pipe pressure does not drop greater than 0.5 psi from the initial pressure reading within the time requirement listed in Table 4.41.01 below. Refer to Table II of Uni-bell's UNI-B-6-98 "Recommended Practice for Low-Pressure Air Testing of Installed Sewer Pipe" for additional pipe sizes and lengths.

Table 4.39.02 Minimum Time Requirement for Pipe Pressure Testing

Pipe Diameter (in)	Time Requirement for Various Pipe Lengths (minutes:seconds)						
	100 ft	150 ft	200 ft	250 ft	300 ft	350 ft	400 ft
8	3:47	3:47	3:47	3:47	3:48	4:26	5:04
10	4:43	4:43	4:43	4:57	5:56	6:55	7:54
12	5:40	5:40	5:42	7:08	8:33	9:58	11:24
15	7:05	7:05	8:54	11:08	13:21	15:35	17:48
18	8:30	9:37	12:49	16:01	19:14	22:26	25:38
21	9:55	13:05	17:27	21:49	26:11	30:32	34:54

If there has been no leakage after 50% of the time calculated of testing has passed, the test shall end and the section shall be accepted. If the installation fails this test, the testing equipment may be used to determine the location of the pipe leak.

4.39.03 Deflection Test of Pipe

The maximum vertical deflection allowed for PVC pipe is five percent. The CITY may require the CONTRACTOR to perform deflection tests of the pipe before acceptance. Optional devices for testing include calibrated television, photography, properly sized go-no-go mandrel, sewer ball, or deflectometer. The method used shall be approved by the CITY. To insure accurate testing, the line shall be thoroughly cleaned prior to testing. Testing shall be done no sooner than 30 days after the pipe has been backfilled.

The CONTRACTOR shall schedule the test with the CITY 48 hours prior to the test and the CITY shall be present during the test and shall verify the accuracy of the equipment used. The CITY may require the CONTRACTOR to perform another deflection test prior to the end of the WARRANTY period.

4.39.04 Pressure Test for Pressure Sewers

After the pipe has been laid, including fittings, thrust blocks, and backfill in accordance with the specifications, it shall be subjected to a hydrostatic pressure of not less than 150 P.S.I. for one hour. The allowable leakage shall not exceed the following formula:

$$L = \frac{N \times D \times \sqrt{P}}{148,000}$$

L = Allowable leakage in gallons per hour
N = Number of joints in pipe being tested
D = Nominal diameter of pipe in inches
P = Average test pressure in psi.

Each valved section or the entire line if there are no valves, shall be slowly filled with water and the specified test pressure, measured at the highest point of elevation, shall be applied by means of a pump connected to the pipe in a satisfactory manner. The pump, pipe connection, gauges, and all necessary apparatus shall be furnished by the CONTRACTOR. Gauges and measuring devices shall be approved by the CITY and the necessary taps made as required by the CONTRACTOR. Before applying the specified test pressure, all air shall be expelled from the pipe. To accomplish this, brass tapping saddles with corporation stops shall be provided for air release at the highest elevations of the test section and then plugged with brass plugs once the pipeline has passed the test.

Any cracked or defective pipes, fittings, or valves, discovered in the pressure test shall be removed and replaced by the CONTRACTOR with sound material. The test shall be repeated until the pipeline passes the pressure test and is accepted by the CITY.

4.39.05 Manhole Vacuum Test

The CONTRACTOR shall perform these tests with suitable equipment specifically designed for vacuum testing manholes and shall be in accordance with ASTM C1244-05a. The connecting pipes shall be plugged at each manhole with plugs or pneumatic balls and secured in place to prevent displacement during testing operations.

A vacuum of 10 in. of mercury shall be drawn on the manhole. When the vacuum has stabilized, the outlet valve shall be closed and timing shall commence for the test period. Time requirements for minimum test periods are shown in Table 4.39.06 below.

Table 4.39.06 Minimum Time Requirement for Manhole Vacuum Testing

Manhole Depth (ft)	Time Requirement for Various Manhole Diameters (seconds)		
	48 in	60 in	72 in
8	20	26	33
10	25	33	41
12	30	39	49
14	35	46	57
16	40	52	67
18	45	59	73
20	50	65	81
22	55	72	89

The manhole test shall pass if the vacuum does not drop below 9 inches of mercury during the time requirement specified.

4.39.06 TV Inspection of Sewers

Following completion of sewer line work, the CONTRACTOR shall perform and supply the CITY with a copy of the PACP TV inspection. TV inspections shall be performed by a PACP certified inspector that is approved by the CITY and use an approved PACP scoring version. A list of preapproved CONTRACTORs and inspectors is available from the PWU, Utilities Operations Division.

Prior to performing the TV inspection, the sewer improvements must be complete, accessible and cleaned using pressurized water sufficient to allow for a detailed inspection. The CITY will not accept inspections for lines that have not been cleaned.

Following TV inspections and any necessary repairs that the CONTRACTOR may have identified, the CITY will review TV inspections. If TV inspections are determined to be acceptable by the CITY, the work will be eligible for acceptance.

Prior to expiration of the CONTRACTORWARRANTY, the CITY will perform a follow-up TV inspection of the sewer system. Any defects found during the WARRANTY TV inspection shall be corrected by the CONTRACTOR.

4.39.07 Pipe Cleaning Prior to Inspections

Sewer cleaning shall be by high-pressure jet cleaning to remove foreign materials from lines. The jet cleaning machine shall be capable of removing

stones, grit, grease, sludge and other debris from the sanitary lines by the scouring action of high pressure water. **Dumping of large volumes of water from hydrants or tankers into the sanitary sewer system is expressly prohibited.**

The jet cleaning machine must be capable of providing a continuous flow of water at a minimum of 40 GPM and 2000 PSI. At a minimum, the cleaner shall use a 90% interior pipe diameter proofer skid at all times. Cleaning shall begin at the upper end of the system and proceed downstream to the outfall. The hose should be brought back at a proper yet steady speed for appropriate and satisfactory cleaning. If necessary, repeat the process to remove all debris. **All debris removed from the cleaning process shall be captured and disposed of as approved by the CITY such that it does not enter the downstream portion of the collection system.**

Sewers found to be improperly cleaned shall be cleaned and re-inspected at the CONTRACTOR's expense.

4.40.00

ABANDONMENT

The abandonment of existing sanitary sewer facilities must be approved in writing by the CITY. Abandonment plans shall include a detailed site plan, facilities affected, proposed new sewer locations, bypass pumping requirements (if necessary) and construction sequencing of the abandoned facilities. No sanitary sewer shall be abandoned until the replacement sewer has been constructed and tested and all service connections have been reconnected. Any sanitary sewers that will be abandoned in place or removed shall be drained and flushed to remove any remaining debris. Debris shall be disposed of properly and shall not be flushed into the downstream sewer.

4.40.01 Pipes

Sewer pipes can be removed or abandoned in place with lean concrete or flowable fill and shall be plugged upstream and downstream of the abandoned section. If a structure is to be removed completely, all sewer lines shall be plugged upstream and downstream of the removed structure following removal.

4.40.02 Manholes

Manholes to be abandoned in place shall have all pipes either removed or plugged with lean concrete or flowable fill so they are watertight. No sandbags are allowed to be used as permanent plugs. Manhole tops, cone sections and barrel sections shall be removed to at least six feet below final grade, or to a depth as directed by the CITY. The structure shall then be abandoned in accordance with the detail drawing in the Appendix of these STANDARDS AND SPECIFICATIONS.

4.40.03 Services

Sewer services shall be capped at the wye or tee and a minimum of five feet of service pipe removed upstream of the tap. If a tapping saddle exists, it shall be removed from the pipe and a sewer repair clamp installed over the opening. All repairs shall be backfilled with a concrete cap.

If more than one service tap is required to be abandoned along a sewer main and the spacing between these taps is less than 50 feet, then the pipe between and including the sections at the taps shall be replaced.

4.41.00 BYPASS PUMPING OPERATION

The DEVELOPER shall submit to the PWU a bypass pumping plan for review and approval prior to implementation of the bypass. Minimum and maximum anticipated flows shall be considered for bypass pump and pipe sizing. Prior to pumping, an approved back-up pump and generator with equal capacity to the primary unit shall be required on site. Pumps utilized shall be designed to handle the range of flows anticipated at the work site and within their priming capabilities. Bypass pumps shall have a maximum rating of 55 decibels for sound attenuation.

The CONTRACTOR shall plug off and pump down the sewer manhole or line segment in the immediate work area and shall maintain the wastewater system so that surcharging does not occur. Where work requires the line to be blocked beyond normal working hours and bypass pumping is being utilized, the CONTRACTOR shall be responsible for monitoring the bypass operation around the clock.

Adequate containment of potential spills shall also be provided to protect local drainage ways. The CONTRACTOR shall complete the work as quickly as possible and satisfactorily pass all tests, inspections and repair all deficiencies prior to discontinuing bypassing operations and returning flow to the sewer manhole or line segment. Concrete shall have the appropriate cure time prior to reinstating flow into the new sewer system.

The CONTRACTOR shall immediately notify the CITY should a sanitary sewer overflow or spill occur and take the necessary action to clean up and disinfect the spillage to the satisfaction of the CITY and/or other governmental agency with jurisdiction.

The CONTRACTOR shall be responsible for all required pumping, equipment, piping and appurtenances to accomplish the bypass and for any and all damage that results directly or indirectly from the bypass pumping equipment, piping, appurtenances and operation. The CONTRACTOR shall also be liable for all CITY personnel and equipment costs, penalties and fines resulting from sanitary sewer overflows and sewer backups. It is the intent of these specifications to require the

CONTRACTOR to establish an adequate bypass pumping plan regardless of the flow or site conditions.

4.50.00 MATERIAL SPECIFICATIONS

4.51.00 GENERAL

Only those pipeline materials described in this section are approved for sanitary sewer installations. Any other material proposed as an equal shall be reviewed by the CITY prior to construction. All pipe materials to be incorporated in the construction of sanitary sewers shall conform to the requirements specified herein or as modified elsewhere in these STANDARDS AND SPECIFICATIONS. All materials furnished shall be new and undamaged. Everything necessary to complete all installations shall be furnished and installed whether shown on the approved drawings or not, and all installations shall be completed and fully operational. Acceptance of materials or the waiving of inspection thereof shall in no way relieve the developer of the responsibility for furnishing materials meeting the requirements of these STANDARDS AND SPECIFICATIONS.

All materials delivered to the job site shall be adequately housed and protected to ensure the preservation of their quality and fitness for the work.

4.52.00 DEFECTS

The presence of any of the following defects in an individual pipe, or in a shipment of pipe, may constitute sufficient cause for rejection of the pipe. Rejected materials shall be removed from the work site within 24 hours unless otherwise permitted by the CITY.

- Pipe length varying more than two inches from the specified length. Pipe shall not be ordered in random lengths.
- Pipe having a deviation from straight which exceeds the following maximum deviation:

$$\text{Maximum Deviation (inches)} = \frac{\text{Length of Pipe in Feet}}{32}$$

- Pipe damaged during shipment or construction.
- Any deficiencies noted in applicable ASTM Specifications

4.53.00 CERTIFICATION

A manufacturer's certification that material was manufactured and tested in accordance with applicable ASTM designations, together with a report of all test results, may be required by the CITY prior to final acceptance of the WORK.

4.54.00

PIPE

4.54.01 Polyvinyl Chloride Pipe (PVC)

All pipe materials and fittings shall meet the minimum requirements of ASTM D-3034, SDR-35 PVC pipe, latest revision. Sewer pipes deeper than 20 feet from finished ground elevation to pipe invert shall be ASTM D-3034, SDR 26 PVC. Pipe shall be subjected to drop-impact tests in accordance with ASTM D-2444. Pipe stiffness for all pipe sizes shall be tested in accordance with ASTM D-2412. Joint tightness shall be tested in accordance with ASTM D-3212.

The pipe shall have bell and spigot joints with gasketed joints. The spigot end shall be marked so the installer and the inspector can determine when the pipe is properly inserted into the bell. The maximum pipe length shall be twenty feet.

The minimum wall thickness based on pipe diameter is shown in the table below.

Pipe Diameter (Inches)	4	6	8	10	12	15	18
Wall Thickness (Inches)	0.125	0.180	0.240	0.300	0.360	0.437	.536

All fittings and accessories shall be as manufactured and furnished by the pipe supplier and have bell and/or spigot configurations compatible with that of the pipe. PVC pipe and all fittings shall conform to these STANDARDS AND SPECIFICATIONS.

4.55.00

MANHOLES

4.55.01 General

Manholes and traffic lids shall be precast and conform to ASTM Standard Designation C-478. All traffic lids shall be designed for AASHTO H-20 traffic loading. Concrete reducing sections (concentric cones) shall not be used. Concrete extension collars shall be used to bring the manhole ring and cover up to the approved street or ground surface elevation in accordance with the detail drawings in the Appendix of this Chapter.

Concrete used in the manufacturing or construction of manholes shall be a minimum of Class D concrete in accordance with these STANDARDS AND SPECIFICATIONS.

Precast manhole barrel sections and cones shall be manufactured in conformity with ASTM Designation C-478.

Manhole ladder rungs shall meet the requirements of ASTM C-478, AASHTO M-199 and the most current OSHA requirements. Rungs shall be consist of polypropylene coated steel, such as that manufactured by M.A., or equal.

4.55.02 Manhole Rings and Covers

All standard cast iron manhole rings and covers and other iron castings shall conform to the requirements of AASHTO M105/ASTM A48 Class 35B. Ductile Iron castings shall conform to the requirements of AASHTO M105 and M306/ASTM A536.

All castings shall conform to Federal Specification RR-F-621E, for shape and dimension required. Castings shall be free from sand, blowholes, shrinkage, cracks, and other cold shuts and be well cleaned by shot blasting. Runners, risers, fins, and other cast-on pieces shall be removed from the castings and ground smooth. Bearing surfaces between manhole rings and covers shall be cast or machined with such precision that uniform bearing shall be provided throughout the perimeter area of contact. Fittings shall be hot dipped, factory applied, water base, asphalt paint to form a firm and tenacious coating.

Standard manhole covers shall have nominal diameters of 24 inches for sewer mains 21 inches and smaller and nominal diameters of 30 inches for sewer mains 24 inches and larger.

Standard manhole ring and covers shall be EJ as identified in the table below, or approved equal. Refer to the detail drawings in the Appendix of these STANDARDS AND SPECIFICATIONS.

Nominal Cover Diameter (inches)	Actual Cover Diameter (inches)	Product Number Cover/Frame
24"	23-7/8"	EJ 240585/242013
30"	30"	EJ 250843/250811

All manhole ring and covers located outside of paved roadways shall be locking and hinged type and shall be made of ductile iron. Hinged ring and covers shall be ergonomically designed for worker safety and locks shall securely fasten the cover to the ring using a stainless steel cam lock assembly. Covers shall be capable of opening to 120 degrees from the closed position and shall have a safety catch at 90 degrees to prevent accidental closure.

Locking and hinged manhole ring and covers shall be EJ as identified in the table below. Refer to the detail drawings in the Appendix of these STANDARDS AND SPECIFICATIONS.

Nominal Cover Diameter (inches)	Actual Cover Diameter (inches)	Product Number Cover/Frame
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24"	26-3/16"	EJ 1040010L01
32"	32"	EJ 41421092L01

4.55.03 Manhole Bases

Manhole bases shall typically be precast, although cast in place bases may be approved for certain applications such as connections to existing sewer pipes. The base shall be designed to uniformly support AASHTO H-20 traffic loading and any earth loading. The minimum base thickness shall be eight inches below bottom of the pipe and 2-inches above the top of the pipe. Bases shall conform to the detail drawings in the Appendix of these STANDARDS AND SPECIFICATIONS.

4.55.04 Joint Material

Joint material used to set barrel sections shall be a flexible butyl resin joint sealing compound meeting Federal Specifications SS-S-210 (210-A) and AASHTO M 198 75 1 and ASTM C990-09. Ramnek, or approved equal, shall be used.

Interior horizontal joints shall be plastered and troweled smooth with cement mortar.

Exterior horizontal joints shall be wrapped with ConWrap joint wrap, or approved equal, and secured to the concrete to provide a watertight seal.

4.55.05 Mortar

Mortar shall be composed of one part Portland cement and not more than three nor less than two parts of fine aggregate. Hydrated lime or masonry cement shall not be used. Portland cement shall meet the requirements of ASTM C-250, Type II. Fine aggregate shall consist of well-graded natural sand having clean, hard, durable, uncoated grains, free from organic matter, soft or flaky fragments or other deleterious substances. The fine aggregate shall be thoroughly washed and shall be uniformly graded from coarse to fine with a minimum of 95 percent passing a No. 4 sieve and a maximum of seven percent passing a No. 100 sieve.

4.55.06 Interior Coating

Manhole interior coatings shall be required on all newly constructed sewers fifteen inches and larger or any other new or existing sewer manhole downstream of a discharge source that may be determined to be problematic by the CITY. Application of the manhole coating shall follow manufacturer's recommendations.

The following interior coatings have been approved by the :CITY:

Coating Name	Coating Type	Manufacturer
Spectrashield	Poly-Urea Polymer/Polyurethane	CCI Spectrum

4.55.07 Exterior Coating

Bituminous coatings shall be required on all newly constructed manhole exteriors for waterproofing and to reduce infiltration. The entire exterior surface of concrete manholes (whether precast or cast-in-place) shall receive two coats of waterproofing at a minimum thickness of 7 mils per coat and a total thickness of 14 mils. In no case shall the thickness per coat be less than that recommended by the manufacturer. Application shall follow the manufacturer’s recommendations.

The following exterior coatings have been approved by the CITY:

Carboline Bitumastic 300M by SOMAY Products, Inc.
MasterSeal HLM 5000 by BASF.

Equal products to those listed above will be considered for approval.