CHAPTER 5

MINIMUM DESIGN CRITERIA

5.1 INTRODUCTION

In order to evaluate the District's existing system and plan for adequate future improvements to the system, it is necessary to define minimum design criteria. Minimum design criteria identified includes; typical domestic wastewater quantities generated by various customer classes and land uses; existing and future capacity requirements for various components of the system; and projected infiltration and inflow rates and peaking factors to be used in the design of facilities.

5.2 MINIMUM DESIGN REQUIREMENTS

The State Department of Ecology's (DOE) "Criteria for Sewage Works Design" (commonly referred to as the Orange Book) was revised on a comprehensive scale in December 1998, in cooperation with the State Department of Health (DOH) and the U.S. Environmental Protection Service (USEPA), and sets forth the standards, guidelines and minimum design requirements for sanitary sewer systems operating within the State of Washington. The Document was revised/updated in 2006, 2007, and 2008, and most recently in 2019. A full list of revision specifications can be found within the up-to-date document (Orange Book), available on the Ecology website.

This Ecology manual, together with the District's documents that dictate the minimum requirements and the District's are as follows:

Rules and Regulations Governing Valley View Sewer District's Sewage Collection Facilities

Valley View Standard Sewer Details

Valley View Standard Specifications

Valley View Developer Extension Manual

These documents are provided in the Appendices and establish the design criteria and construction standards to be used in evaluation and design. In addition, the District is required to comply with the requirements and regulations of the jurisdictions within which it operates. Valley View Sewer District is within the corporate limits of the cities of Seattle, Tukwila, SeaTac, Burien and unincorporated King County, and as such, conducts its operations consistent with the requirements, policies and procedures of those agencies.

5.3 DESIGN PERIOD

In planning sewage facilities, it is necessary to evaluate both present conditions and future service needs and to design a system compatible with variable demands over a given length of time, or design period. A 20-year design period is used in evaluating the system and developing a plan for future system improvements.

5.4 REFERENCE DATUM

The datum used for planning of facilities in this study and for District design work is based on the horizontal datum NAD83 and the vertical datum NAVD88.

5.5 SYSTEM DESIGN

All sanitary sewer systems shall be designed in accordance with accepted engineering practices and by a professional engineer approved by the District and registered in the State of Washington. All pipelines will be designed and constructed in accordance with the latest "Criteria for Sewage Works Design" as published by the State Department of Ecology, the District's sewer extension policies, and the requirements put forth in this Comprehensive Sewer System Plan. All main sewer lines will be constructed under the District's jurisdiction and will be owned and maintained by the District.

Sewer system facilities must be designed with sufficient capacity to carry peak flows from the tributary area at ultimate development, unless other criteria has been established and/or approved by the District. Sewer systems shall be designed and constructed to achieve total containment of sanitary wastes and maximize exclusion of Infiltration and Inflow.

5.5.1 Combined Sewers

No combined sanitary and storm sewers are allowed within the District.

5.5.2 Overflows

No overflows or new overflow structures will be permitted.

5.5.3 Collection Sewers

All new mains are to be a minimum of 8-inches in diameter. Where specifically approved by the District, 6-inch lateral sewers may be installed but must be equipped with clean outs at the end of the main.

Collection sewers and pump stations should be designed for ultimate development of the tributary areas based on the design factors outlined in Tables 5-1 and 5-2, and allowable infiltration and inflow rates.

Gravity sewers are to be used wherever possible. Pump stations will be allowed only after thorough investigation has shown that no other cost effective alternatives exist and require specific District review and approval.

5.5.4 Trunk and Interceptor Sewers

Trunk and interceptor sewers shall be designed with sufficient capacity to carry peak flows at ultimate development conditions based on the criteria established in Tables 5-1 and 5-2. This flow represents the sum of several loadings calculated separately for each section of sewer or tributary area. The loadings consist of peak wastewater flows, groundwater infiltration, surface water inflow, and any other quantities which are unique to the individual pipeline.

5.5.5 Flow Rates

Flow in a sanitary sewer system is comprised of domestic, commercial and industrial wastes, groundwater infiltration and surface water inflow. All portions of the sanitary sewer system must be capable of carrying the peak volumes from these sources. Table 5-1 identifies the typical flows associated with various land use types.

TABLE 5-1: ESTIMATED SEWER FLOWS BY LAND USE TYPE

Land Use	Population Equivalents	Building Area/ Land Area Factor	Average Daily Flow
Single Family	persons/unit	Per Zoning	75 gal/capita/day
Multi-Family	persons/unit	Per Zoning	75 gal/capita/day
Retail/Commercial		0.3 SF/GSF	0.15 gal/SF
Office Space		0.45 SF/GSF	0.08 gal/SF
Light Industrial		0.4 SF/GSF	0.015 gal/SF
Heavy Industrial		0.4 SF/GSF	0.5 gal/SF
Manufacturing/Processing			Case by case

1. Average flow rates indicated do not include infiltration and inflow. Infiltration and inflow should be calculated at 1,100 gallons per acre per day.
2. The average amount of developed land on a given lot is estimated by multiplying the gross square footage (GSF) of the lot by the factor indicated per square foot (SF).
3. Manufacturing/processing uses should consider water reuse alternatives.
4. For long range flow projections, flows from non-residential uses can be calculated on a per employee basis, as detailed in Chapter 4.

TABLE 5-2: PEAKING FACTORS (used to convert average daily flows to peak daily flows)

Type of Facility	DOE Standard	K.C. Wastewater Treatment Division Standard	District Standard
Lateral and Local Sewers	4.0	—	4.0
Trunks and Interceptors	2.5	—	2.5
Heavy Industrial	—	2.0	2.0
Light Industrial	—	3.0	3.0
Commercial	—	—	3.0
Pump Stations	—	—	2.0

Peaking Factors indicate the multiplier to be used to determine peak flows.
Peaking factors do not apply to infiltration and inflow

5.5.6 Infiltration and Inflow

Infiltration is groundwater, which enters sewer systems through pipe joints, porous pipes or openings in the system. Inflow is surface water, which enters the sewer system through manholes or illegal connections such as footing drains, roof drains or area drains. Inflow and Infiltration (I/I) are significant elements in any sanitary sewer system analysis and are particularly critical in wet weather climates such as the Pacific Northwest. I/I can cause overloading or surcharging of the sewer system and compromise system capacity resulting in unnecessary treatment costs and in extreme cases, environmental damages. Limiting infiltration and inflow is a primary goal of Valley View Sewer District due to these issues.

Infiltration and inflow, or I/I, is expressed in units of gallons per acre per day (gpad). Although new sewers are constructed of materials and methods to eliminate I/I, some allowances must be made for the future deterioration of facilities and potential illegal connections to the system. Typical values to compensate for infiltration/inflow in system evaluation and design are 600 gpad for infiltration and 500 gpad for inflow. These typical values must be adjusted accordingly to suit site conditions. For example, older facilities are determined on a case-by-case basis and can be as high as 1,200 gpad for infiltration and 2,500 gpad for inflow. Valley View Sewer District recognizes the need to address Inflow and Infiltration within the system.

The District has historically participated in the King County I/I study/program and also conducted analyses to determine I/I flow rates throughout the District by drainage basins. The District's data and King County data for I/I monitoring at various locations throughout the District show that basin-wide I/I rates range from approximately 1,100 gpad to greater than 2,500 gpad. Sub-basins may go beyond 2,500 gpad as noted in Section 3.5.

Although it was assumed that I/I should be maintained at 1,100 gallons per day per acre in the systems analysis, the results from the various analyses indicate that some locations may require more attention then others. The District will continue to develop other programs or projects in attempt to reduce I/I impacts.

In 2007, an initiative was undertaken within the District, involving the rehabilitation of approximately 80 Manholes in the McMicken basin. This undertaking was tracked using the McMicken Pump Station logs, providing a comprehensive record of the project's performance. The endeavor proved successful over an extended period, delivering positive outcomes. However, recent winters have brought about a set of challenges for our field team stationed at that site. Despite the incorporation of new connections, it seems that this expansion alone may not be the root cause of the capacity issues. If the resurgence of Inflow and Infiltration (I&I) is the underlying issue, a plausible explanation could be the behavior of cementitious grout, which exhibits expansion and shrinkage as the seasons shift from wet to dry. It's worth noting that historical knowledge suggests that certain older grout products remained effective for around ten water table cycles,

offering intriguing insight into the potential factors influencing the present challenges faced by the District.

In efforts to combat the persistent challenge of I&I, the District has proactively adopted a strategy involving the installation of Pipe Patch 2' Cured-In-Place Pipe (CIPP) Liners. These specialized liners are strategically placed on joints exhibiting severe Inflow and Infiltration issues. Importantly, these problematic mainline faults are identified through the careful examination of Closed-Circuit Television (CCTV) footage, showcasing the District's commitment to employing cutting-edge methods for problem identification and resolution.

In 2010, the District secured a loan from the Public Works Trust Fund (PWTF). This financial support facilitated the rehabilitation of approximately 200 stubs extending from the mainlines to property boundaries. The primary goal of this initiative was to mitigate the I&I issue. In preparation for this undertaking, the District conducted multiple TV surveys of the mains, revealing that the mainlines were not the source of the I&I. Contrary to this, the flow monitoring data consistently indicated the presence of I&I. To accurately pinpoint the source, the District conducted smoke testing within the basin, leading to the revelation that Inflow and Infiltration originated from privately owned side sewers. This revelation was pivotal in guiding the District's decision to replace over 200 stubs, effectively addressing the identified points of I&I ingress. It's important to acknowledge that while these efforts have yielded promising results, the availability of dependable post-project flow monitoring data remains uncertain, emphasizing the ongoing need for comprehensive and accurate assessment.

5.5.7 Pipe Materials

Plastic (PVC) pipe may be used for gravity sewer lines where soil foundation conditions permit and for slopes less than fifteen percent and depths less than 22 feet, unless otherwise approved by the District. A PVC pipe shall meet extra strength minimum requirements of ASTM D 3034 SDR 35 or ASTM F 789. Joints for PVC pipe shall conform to ASTM D3212 using restrained gasket conforming to ASTM F 477. Provisions shall be made for construction and expansion of each joint with a rubber ring. The bell shall consist of an integral wall section with a slid cross section rubber ring. Size and dimensions shall be as shown on the drawings. Standard pipe length shall be 12.5' and 20'.

The ductile cast iron pipe shall be Class 50 or 52 per ANSI A 21.51 or AWWA C 151. The pipe inside shall be lined with Protecto 401TM in accordance with specifications provided by Protecto 401 Ceramic Epoxy Company. The Pipe shall NOT have cement mortar lining. Coat exterior of pipe intended for below grade installation with an asphaltic material approximately one (1) mil thick. Cement lined ductile iron pipe is required for all other areas and for force mains. Ductile iron pipe placed in peat soils or potentially corrosive areas shall be polyethylene encased.

All rigid pipes must pass standard crushing, flexural and fill tests to insure the installation will be watertight and able to withstand projected earth loads.

High Density Polyethylene (HDPE) pipe with thermally fused joints is to be used for all pipe bursting and directional drilling sanitary sewer installations.

5.5.8 Sewer Locations

In general, trunk and interceptor sewers are to be located in existing street rights-of-way or proposed street areas. Where required to utilize natural drainage course and topography, specific pipes may be located within easements.

5.5.9 Depth

Minimum depth of cover for a sewer line in street right-of-way is six feet. Minimum depth of cover for sewer lines installed in easements is three feet. Shallower depths may be used if pipe crush strength analyses are provided; although in no case shall the depth of cover be less than 30-inches. Forcemain shall have a minimum cover of 4 feet except as approved by the District.

5.5.10 Separation

Wherever possible, a minimum horizontal separation of ten feet, measured edge to edge, is required between gravity sanitary sewers and any existing potable water line. Sewer lines crossing water lines are to be laid below the water lines to provide a separation of at least 18 inches between the invert of the water line and the crown of the sewer pipe. Where the required separation of lines can not be achieved, sewer lines are to be constructed as specified in the DOE Criteria for Sewage Works Design.

5.5.11 Roughness Coefficient

An "n" value of 0.013 shall be used in Manning's formula for the design of sewer facilities.

5.5.12 Slope

All sewers shall be designed and constructed to give mean velocities at design flow of not less than 2.0 feet per second (fps). The required minimum slope of pipes are indicated in Table 5-3, although slopes greater than that are sometimes required to allow for higher velocities which will reduce maintenance requirements.

In side sewers, flows at less than super-critical depth are to be avoided because the associated shallow water depths often leave solids in the pipe. Over sizing sewers with respect to capacity in order to allow the use of flatter slopes should be avoided as this may result in operational capacities below sedimentation velocity (2 fps).

Sanitary sewers are to be laid with uniform slope between manholes. Sewers with slopes greater than 15% are to be anchored securely with concrete anchors or retaining gaskets. Sewers with slopes in excess of 40% or with change in velocity greater than 5 fps at any structure shall be equipped with an approved energy dissipater. Any such devices shall be reviewed by the District on a case-by-case basis.

TABLE 5-3: MINIMUM REQUIRED PIPE SLOPES

Pipe Size	Min. Slope/ 100 Feet	Pipe Size	Min. Slope/ 100 Feet
4-inch	2.00%*	16-inch	0.14%
6-inch	1.00%*	18-inch	0.12%
8-inch	0.50%**	21-inch	0.10%
10-inch	0.28%	24-inch	0.08%
12-inch	0.22%	27-inch	0.07%
14-inch	0.17%	30-inch	0.06%
15-inch	0.15%	36-inch	0.05%

* 4 and 6-inch pipe allowed for side sewers only
** District Standard

5.5.13 Alignment

Gravity sewers shall be designed with straight alignment between manholes.

5.5.14 Downsizing

Downsizing of sewer lines, or the installation of a smaller diameter line downstream of a larger diameter line, will not be allowed, except where grade and velocity warrant and downsizing is specifically approved by the District.

5.5.15 Grinder Pump Stations

The District's intention is to provide public sewers within the District's service area so that no homeowner has to connect to public sewer via a grinder pump station. However, when no public sewer is within the vicinity for the homeowner to connect to, the homeowner may be approved by the District to connect via a grinder pump station.

Should a homeowner within the District boundary connect to the sewer system through a grinder pump station, the District must approve the type and manufacturer of the pump. Currently, the District has approved the Environmental One pump and the District will maintain spare parts for these pump systems.

The homeowner shall grant an easement to the District for operation and maintenance access. The costs associated with operation and maintenance of the grinder pumps will be covered by the homeowner.

5.6 MANHOLES

Manholes are to be installed at the end of each line, at all changes in grade, size, or alignment, at all intersections and at distances not greater than 400 feet. (Unless approved by District).

The minimum diameter of manholes is 48 inches. The minimum clear opening in manholes shall be 23 inches. For incoming pipes that are larger than 24 inches in diameter the manhole

diameter shall be 54 inches or greater. Larger size manholes may be required to accommodate special requirements.

Drop connections are discouraged in the District and shall be kept to an absolute minimum. If allowed by the District, it should be provided for a sewer entering a manhole at an elevation of 24 inches or more above the manhole invert. Where the difference in elevation between the incoming sewer and the manhole invert is less than 24 inches, the invert should be channeled to prevent deposit of solids.

FRAMES AND COVERS

Manhole frames and covers shall be dense gray cast iron conforming to the Districts Standard Details.

Covers shall have a non-skid type surface and shall have the word "SEWER" in large raised letters. Covers shall be provided with one pick hole one inch in diameter. Seating surfaces of frames and covers shall be machined finished or ground so as to assure interchangeability and non-rocking it in any position. Cover shall be bolt down type with 3 bolts. Frames and covers shall be ductile iron and all covers shall be the locking type.

5.7 PUMP STATIONS

Design and construction of sewage pump stations and force mains is to be accomplished in accordance with the following minimum design criteria:

5.7.1 Location and Flood Protection

Sewage pump stations will be located as far as practical from present or proposed built-up residential areas, and all weather road access shall be provided to all pump stations. New pump stations and rehabilitations to existing pump stations are to be submersible type. Noise control, odor control, and station architectural design must be considered in the locating and design of sewage pump stations. Sites for pump stations must be of sufficient size to accommodate expansion of facilities to meet projected build-out conditions.

Operational components must be located at elevations above established 100-year flood/wave action or shall be adequately protected against such action. All pump stations must be designed to remain fully operational during 100-year flood conditions.

5.7.2 Pumping Rate and Number of Units

At least two pumps must be provided at each pump station and each must be capable of handling the anticipated maximum flow. Where three or more pumps are provided, they shall be designed to fit actual flow conditions and must be of such capacity to handle anticipated maximum flow with the largest pump out of service.

5.7.3 Pump Cycle Ratios

A pump cycle ratio represents the percentage of time during which a pump can be expected to run. Recommended pump replacement sizes are based on cycle ratios of 70% for theoretical peak day flows as generated for the design period conditions. Pump station peaking factors of 2.5 are used to arrive at peak flows from average day figures. Conversely, average day flows represent approximately 40% of peak design flows, so that pumps sized according to recommendations operate approximately 30% of the time. These cycle ratios were selected to provide a margin of safety against pump overheating and subsequent wet well flooding which might happen if mechanical problems were to occur at or near peak flow conditions. In addition, lower cycle ratios imply less running time and, therefore, longer pump life. Pump cycle ratios must be appropriate to provide a margin of safety against pump overheating and subsequent wet well flooding.

5.7.4 Pumps

Pumps shall be capable of passing spheres of at least 3 inches in diameter. Pump suction and discharge openings shall be at least 4 inches in diameter.

Pumps shall be placed so that under normal operating conditions they will operate under a positive suction head (unless otherwise approved).

5.7.5 Controls

Air operated pneumatic controls, float switches or ultrasonic controls will be used for all sewage pump stations. Provisions should be made to automatically alternate pumps in use. Pump stations with motors and/or controls below-grade should be equipped with a secure external disconnect switch. Controls must be designed and approved by the District prior to installation.

5.7.6 Site Water

Pump stations shall provide site water service with a required backflow prevention device.

5.7.7 Bypass/Storage

On-site or portable power units should be incorporated into station design. Small stations may require a plug-in device for a portable generator unit; however, large stations will require permanent standby power. Where portable generators are used, storage must be provided to permit time for the generator to be delivered and installed.

5.7.8 Alarm System

The District has a computer controlled, monitored alarm system for each District owned and operated pump station. The system checks each station's status hourly, 24-hours a day, for the following conditions: Intrusion; Power failure; Wet dry well; High wet well; Low wet well; Smoke; Operator in trouble; and/or, Line failure. Testing of the circuitry is required for verification prior to operation.

Test circuits should be provided to enable the alarm system to be tested and verified as in good working order.