CHAPTER 3. PLANNING CRITERIA AND METHODS

Chapter 3 presents general information about physical, environmental and cultural conditions that bear on where and how sewerage facilities should be located and designed. It also contains descriptions of the data, assumptions and methods used in formulating of the Unified Sewer Plan. The particular characteristics of drainage and sewerage basins affecting sanitary sewer sewers in the study area can be found within Chapter 4, Existing Conditions and in previous water quality management plans and environmental documents.

Physical and environmental factors which influence the planning and design of sewerage facilities include: geography, topography, geology and soils, climate, ground and surface water, and water quality. In addition, cultural characteristics, such as planned land use and projected population for each sewerage basin, are used to estimate how much wastewater will be generated. All of these factors help sewer utilities to anticipate the volume and strength of wastewater that will have to be conveyed and treated, and to design a collection system for maximum long-term efficiency.

Chapter 3 is organized as follows:

PHYSICAL & ENVIRONMENTAL CONSIDERATIONS

- Topography
- Drainage Basins
- Sewerage Basins
- Geology
- Soils
- Surface Water
- Ground Water
- Water Supply & Well-Head Protection
- Climate

CULTURAL CONSIDERATIONS

- Economic Conditions
- Demographics
- Coordination with other Sewer Utilities
- Service Area & Treatment and Conveyance Capacity Agreements
- On-site Sewer Systems

PLANNING METHODS

- Flow Projections
- Infiltration and Inflow
- Sensitivity Analysis

TREATMENT FACILITIES DESIGN CRITERIA

- Diuranal Variations/Curve
- Wasteload
- Water Quality
- Industrial Pretreatment

3.1 PHYSICAL & ENVIRONMENTAL CONSIDERATIONS

3.1.1 Topography

The topography of Pierce County varies widely. Elevations range from sea level to 14,410 feet at the summit of Mt. Rainier. The Puget Sound lowland is characterized by a relatively flat plain ranging in elevation from 100 to 700 feet above mean sea level rising to approximately 2,000 feet at the base of the Cascade foothills. The Cascade foothills are an undulating belt of benches and low hills. With the exception of Mt. Rainier, the Cascade Mountains range in elevation from 2,000 feet to 7,000 feet above sea level.

Topography dictates the location and pattern of gravity conveyance facilities. It is most cost-effective to follow the slope of the terrain. State of Washington standards dictate a minimum design velocity in a sewer line of two feet per second (fps) and a maximum of about 10 fps, which correspond to a minimum and maximum slope for gravity sewers. A minimum velocity is required to prevent solids from collecting on the inside of pipelines. The maximum slope limit is intended to prevent erosion of pipes. A velocity greater than 10 fps may be possible with proper consideration of pipe material, the abrasive characteristics of the wastewater, turbulence, and thrust at changes of pipe direction.

If the terrain is flat, the slope of the gravity sewer must be steeper in relation to the slope of the terrain in order to maintain the minimum velocity. This increases the depth of excavation and trench excavation costs. If pipeline depth becomes too great, either a pump/lift station is required to raise the wastewater to a higher elevation, or an alternative trenchless construction method is required. Generally, open trench excavation can be used to a depth of 30 feet (depending on soil and ground water conditions). Below 30 feet, trenchless construction technology (for example, jack and boring, directional drilling, and microtunneling) is sometimes necessary.

3.1.2 Drainage Basins (Watersheds and WRIAs)

A drainage basin is a region drained by, or contributing water to, a stream, lake, or other body of water. It is the geographic area within which surface water drains to a common outlet. A drainage basin is synonymous with a watershed. In Washington, the State has designated drainage basins as Water Resource Inventory Areas (WRIAs). WRIAs have been designated by the State for purposes of fostering a statewide water resource program. Pierce County contains all or part of four WRIAs as follows:

WRIA #10, Puyallup-White. The watershed and tributaries of the Puyallup and White Rivers including Commencement Bay.

WRIA #11, Nisqually. The watershed and tributaries of the Nisqually River drainage basin.

WRIA #12, Chambers/Clover. The watershed and tributaries of Chambers and Clover Creeks, plus Puget Sound from the Nisqually Delta to the Tacoma Narrows.

WRIA #15, Kitsap. From the southern tip of the Gig Harbor and Key peninsulas to the northern end of Kitsap County. The Pierce County portion of WRIA 15 includes the Gig Harbor and Key Peninsulas, McNeil Island and Anderson Island.

Because WRIAs are based on drainage patterns and not political boundaries, a given WRIA will often be located in more than one county or city. Table 3.1-1 identifies the counties within each basin/WRIA.

Table 3.1-1. Counties Sharing Drainage Basins

Drainage Basin/WRIA	Counties In Basin
Chambers Creek - Clover Creek	Pierce
Puyallup River	Pierce, King
Nisqually River	Pierce, Thurston, Lewis, Yakima
Kitsap	Pierce, Kitsap, Mason (the Tahuya Peninsula), King (Vashon Island)

3.1.3 Sewerage Basins

A sewerage basin represents the existing and planned area from which wastewater is collected and sent to a specific wastewater treatment plant. For example, the sewerage basin for the Chambers Creek Regional WWTP covers an area running southward from Pt. Defiance (Western Slopes Tacoma) northward from DuPont, Frederickson and Graham, and westward from the ridge above the Orting Valley to Puget Sound. A description of Pierce County sewerage basin characteristics can be found in Chapter 4, Existing Conditions.

Sewerage basins are often confused with watersheds or drainage basins. Because most sewer pipelines are designed for gravity flow, a sewerage basin is primarily defined by the topography of the watershed or drainage basin it is located within. However, a sewerage basin may also include areas within a neighboring watershed. Either flow by gravity in the sewer pipe was possible despite the flow of surface water on the ground above or because developing areas had no other cost-effective recourse than be pumped into a sewer system in another drainage basin.

3.1.4 Geology

Glacial deposits and geologic hazards are the two most important geologic factors in the study area for the Unified Plan. They affect the extent of sanitary sewer service areas and facility siting and design.

Glacial deposits left behind by retreating glaciers created the majority of the soils found in Pierce County. County soils can be grouped into four basic categories: soils with cemented hardpan or bedrock substrata; soils with permeable subsoils and substrata; organic soils; and miscellaneous soils. Soils with cemented hardpan can create perched aquifers where traditional on-site sewer systems (septic systems) cannot function properly. Soils with highly permeable subsoils and substrata can result in areas of aquifer recharge. Urban density development where these two soil groupings exist usually necessitate some form of sanitary sewer service.

Geologically hazardous areas that can pose a risk to wastewater conveyance or treatment facilities include landslide and erosion areas and seismic hazard areas. The primary impacts of these geologic hazards are displacement and uncovering of pipelines and structures. Displacement is a dislocation caused by a slipping of rock masses along a plane of facture.

Erosion potential depends on the physical and chemical characteristics of the soil, vegetative cover, slope, and characteristics of storm events. An area's potential for landslide hazards depends upon geologic, topographic and hydrologic factors. Landslide and erosion hazard areas in Pierce County are depicted in the Critical Areas Atlas – Landslide and Erosion Hazard Areas Map in *Title 18E Pierce County Development Regulations – Critical Areas.* Areas of glacial deposits with slopes greater than 15 percent, such as steep valley walls or bluffs along the shoreline, are generally considered to be unstable. Landslide risk increases with subsurface water migrating through a permeable layer overlying an impermeable layer, particularly clay.

The entire Puget Sound region is seismically active and susceptible to damage from seismic hazards. Seismic hazard areas are areas that are subject to severe risk of damage as a result of earthquake-induced ground shaking, slope failure, settlement, or soil liquefaction. Liquefaction occurs when soil or sand behaves like a dense fluid rather than a solid medium during an earthquake. Shaking reduces the strength and stiffness of a soil and its ability to support structures. Ground shaking and associated ground failure due to settling are the principal cause of damage to facilities from earthquakes. The potential for liquefaction greatly increases the potential for damage from earthquakes and is most likely to occur in poorly drained organic and alluvial soils with a relatively low density and high organic content. Saturated soils, sands and fills are especially susceptible to liquefaction. Seismic hazard areas in Pierce County are depicted in the Critical Areas Atlas - Seismic Hazard Areas Map in *Title 18E Pierce County Development Regulations – Critical Areas.* All of these factors must be considered when siting sewerage facilities.

3.1.5 Soils

Soil type affects the cost of trench excavation for conveyance facilities. Excavation costs in glacial till and clay are generally higher than in loose sands and gravels. Areas with shallow bedrock tend to favor alternative collection methods. Soils that are poorly consolidated require special attention and measures during trench excavation to prevent differential settlement of overlying or nearby structures, such as roadways. Poorly consolidated soils include organic and alluvial soils. Glacial till has the lowest potential for differential settlement. Glacial outwash deposits are considered moderately stable.

Soil properties affect a building site's suitability for septic systems. Soils with high permeability may not sufficiently filter wastewater or allow enough time for the biochemical reactions between wastewater and soil to occur to adequately protect ground water quality. Soils that are poorly drained or that are underlain with a low permeability till layer, can lead to high water table during high rainfall, have a high potential for septic failure. The suitability of soils for on-site systems is site-specific.

3.1.6 Surface Water

Creeks. Crossing creeks and rivers adds to conveyance construction costs. Dewatering during construction next to a creek or river may be required. It is generally not possible to use open trenching methods in creeks and rivers to install conveyance lines due to the damage to fish habitat and water quality. Methods for crossing a creek include suspending the pipe from an existing bridge or using trenchless technologies, such as jacking and boring, microtunneling or directional drilling.

Lakes. Both construction and maintenance costs are higher for conveyance facilities adjacent to lakes. Dewatering of soils is typically required during trench construction adjacent to lakes if the ground water table is above the elevation of the pipe trench. Alternative collection systems such as grinder pumps, STEP systems, or vacuum systems facilities are often required adjacent to lakes. A high ground water table, which is typically encountered adjacent to lakes, may prohibit the installation of on-site septic systems.

Wetlands. Wetlands affect wastewater conveyance and treatment in several ways. Wetlands have poorly-drained soils and a high water table, both of which are prohibitive for on-site septic systems. In addition, dewatering is usually required during construction in wetlands because of high ground water levels, increasing construction costs for conveyance lines. Pierce County Critical Areas Development Regulations are designed to avoid or, in appropriate circumstances, to minimize, rectify, reduce, or compensate for impacts arising from land development and other activities affecting wetlands.

Flood Plains. Ground water levels are often shallow in flood plains. Interceptors constructed in floodplains tend to have a higher amount of infiltration compared with sewers built at higher elevations. They are generally constructed with watertight manholes to avert inflow of storm water during flood events.

3.1.7 Ground Water

Ground water plays a major role in wastewater conveyance and treatment. Construction, operation and maintenance costs increase in areas of high ground water. On-site sewer systems provide limited groundwater recharge. The impacts of on-site sewer systems can degrade ground water quality while, high ground water tables impact on-site sewer systems potential for recharge.

A high ground water table can add costs to the construction of gravity sewers for several reasons. It is necessary to dewater an area to below the elevation of the pipeline during open trench construction. (Because force mains can be installed at shallower depths, they are less susceptible to impacts from ground water). Dewatering can, in turn, lead to excessive ground settling during construction. With conveyance facilities installed below the ground water table, the bedding material in which the pipe lies can act as a drain, conveying ground water through the granular bedding material as the waster follows a path of least resistance. Trenches (coffer dams) are required to stop the movement of ground water. In addition, infiltration can occur at pipe joints, pipe defects, and structures such as manhole penetrations. Infiltration increases the amount of wastewater that must be treated.

3.1.8 Water Supply & Well-Head Protection

There are approximately 814 Class A wells within Pierce County. Criteria for Sewerage Design, WDOE, requires that "*sewer lines shall be placed no closer than 100 feet to any public water supply well*". Collection system construction occurring in the vicinity of a water supply well is coordinated with the local health department and water supply company(ies). Materials for sewer pipelines with the least potential for breaking and leaking at joints are used to ensure that contamination of wells does not occur. Design engineers and construction managers have indicated that in instances where it has been necessary to locate sewers within the wellhead protection zone, standards established by the Washington State Department of Health in the publication *Special Sewage Works Design Considerations for Protection of Waters Used for Shellfish Harvest, Water Supplies or Other areas of Special Health Concerns* are followed.

Sewer lines are typically installed within road rights-of-way and generally avoid wellhead protection zones. In rare instances a well head protection zone cannot be avoided. Results of a GIS analysis of Pierce County Wastewater Utility sewerage facilities within 100 feet of Class A public wells are presented in Chapter 4. See Tables 4.2-20 and 4.7-5.

3.1.9 Climate

The climate of the study area is largely a function of being between the ocean and two sets of mountains. This location moderates temperatures, reduces the intensity of oceanic storms, inhibits the movement of cold arctic air into the region and generally increases rainfall. Prevailing winds are from the southwest and northeast.

Precipitation. Record mean rainfall for Pierce County is 37 inches per year. Seventy-five percent (75%) of precipitation falls from October through March. July is the driest month of the year. December is typically the wettest. Snowpack in the nearby Cascade Mountains is extensive, frequently adding to surface water runoff during storm events in April and May.

Temperature. Mild temperatures predominate. Mean temperature is slightly more than 50 degrees Fahrenheit. Typical summer highs reach the low 90s, while daytime winter temperatures average in the 40s. There is generally no significant frost penetration.

Infiltration and Inflow. Rainfall frequently finds its ways into sewer pipelines by way of stormwater inflow and groundwater infiltration. The volume of water that a pipe is expected to convey or a wastewater treatment plant process must accommodate increases as precipitation increases. Inflow occurs when stormwater runoff enters sanitary sewer pipelines through manhole lids or illegal connections of storm water facilities to sanitary sewers such as, down spouts. Rainfall also leads to groundwater infiltration into pipelines when coupled with impervious soil layers, perched water tables, already saturated soils, and the normal cracks at joints and seals that emerge in sewer pipelines as they age. Generally speaking, for every gallon of wastewater produced at a business or a residence an additional 1.5 gallons of storm water or groundwater enters the collection system. This has far-reaching implications for the sizing of collection system and treatment facilities.

3.2 CULTURAL CONSIDERATIONS

3.2.1 Economic Conditions

The Pierce County economy is a part of the Puget Sound regional economy. Patterns of economic change in Washington State involve evolution in long-standing industries of importance. Commercial timber remains a strong contributor to the local economy despite the changes brought about by urban development and reduced yields.

One long-standing pattern is the continued and expanding importance of international trade in the Puget Sound region, which results in the State becoming more integrated with worldwide economic networks. Another is the continued growth of aircraft manufacturing and its expansion into Pierce County.

More recently, the region has been the forefront of the computer industry whose growth has included Pierce County. This has resulted in more jobs and a greatly increased demand for housing.

Pierce County Economic Trends (1990-1996). The general trends of the Pierce County economy from 1990-1996 are published in the Pierce County Quality of Life Benchmarks Annual Report (February, 1998). Based on estimated income figures for 1996, the Healthy Economy composite showed an overall improvement of nine percent (9%) from 1990 to 1996. This trend is expected to continue.

Integrating Economic Development with the Unified Sewer Plan. Flow projections for the Unified Sewer Plan were developed in consideration of the Pierce County adopted economic development plan. Staging of sewerage facilities will take into account where the development is occurring in the planned urban centers.

The Pierce County Strategic Economic Development Plan recommends that the desired levels of job growth and commercial and industrial expansion and supporting strategies be integrated with the utilities and other elements of the Comprehensive Plan. The economic development plan recommends planned Employment Centers be given priority for sewer service. Table 3.2-1 lists the Employment Centers, shows estimates of the amount of developable land in each Employment Center, and which sanitary sewer utility provides service. With the exception of Cascadia and a portion of the CUGA on the Bonney Lake plateau, all Employment Centers in Pierce County were already in areas of planned sewer service.

Table 3.2-1. Estimates of Developable Land in Designated Employment Centers

Employment Center	Acres	Sewer Service Provider
Frederickson	2,346	Pierce County Wastewater Utility
Thun Field	812	
Sunrise	215	
Port of Tacoma	7	City of Tacoma Public Works
North McChord (part)	167	Pierce County Wastewater Utility
Cascade Corridor – Puyallup Valley	1,411	City of Fife, City of Puyallup
Cascade Corridor North	750	City of Sumner
Proposed Cascadia Development	600	(City of Orting - sewer plan amendment in process)
Gig Harbor North	100	City of Gig Harbor
TOTAL	**6,408**	

Source: Pierce County, 1997

3.2.2 Demographics

In 1997, Pierce County adopted Resolution R97-59 establishing population projections for comprehensive planning purposes. These projections have been used for the land use elements of comprehensive plans which formed the basis of flow projections.

Home to an estimated 700,000 people in 1999, Pierce County is the second most populated county in Washington State. An estimated 383,434 people (55 percent of the County's population) live in incorporated areas. Most residents live in the central third of the County, along the Interstate 5 corridor. The eastern part of Pierce County is sparsely populated, with most of the area federally owned (National Forest and National Park) or in private timber company ownership.

The population of Pierce County is expected to increase by 214,240 people from 1999 to 2017. Most of the population (79 percent) is expected to be located within the urban areas. Projected 2017 populations are listed in Table 3.2-2. Urban population is distributed to the Chambers Creek - Clover Creek Drainage Basin and the Puyallup River Drainage Basin. Population is not allocated on the basis of sewer service areas or drainage basins, nor is it allocated to census blocks or census block groups. As a result, wastewater flow projections cannot be reliably modeled and calculated on the basis of population distribution.

Table 3.2-2. Existing and Forecast Population in Pierce County

Area	1999 Population(1)	2017 Population Forecasts(2)	
Total	700,000	914,240(3)	
Unincorporated	316,566	Urban: 210,200 Rural: 194,200	
Incorporated	383,434	509,840	
	1997 Population In City Limits	**2017 Population In City Limits**	**2017 Population Allocated to Urban Growth Areas(3)**
Chambers Creek - Clover Creek Drainage Basin			
DuPont	1,755	9,500	N/A(4)
Edgewood	10,700	Not Determined	N/A
Fircrest	5,935	7,600	N/A
Lakewood	63,820	93,200	N/A
Ruston	745	790	N/A
Steilacoom	6,240	6,950	2,950
Tacoma	187,200	246,000	68,800
University Place	29,550	33,500	N/A
Puyallup River Drainage Basin			
Auburn	N/A	N/A	12,000
Bonney Lake	10,060	12,100	8,350
Buckley	3,980	7,250	N/A
Carbonado	649	570	10
Fife	5,155	7,600	1,550
Milton (Pierce County part)	4,785	5,900	330
Fife/Milton Overlap	N/A	N/A	320
Orting	3,825	8,000	N/A
Pacific (Pierce County part)	195	790	20
Puyallup	30,740	46,100	11,200
South Prairie	485	800	20
Sumner	8,495	12,400	1,200
Wilkeson	430	840	N/A
Nisqually River Drainage Basin			
Eatonville	1,915	1,950	7,100
Roy	370	600	N/A
Kitsap Drainage Basin			
Gig Harbor	6,405	7,400	9,250
Unincorporated .County	N/A	N/A	87,100
TOTAL	**383,434**	**509,840**	**210,200**

Table 3.2-2. Existing and Forecast Population in Pierce County

Area	1999 Population(1)	2017 Population Forecasts(2)

(1) Source: *April 1 Population of Cities, Towns, and Counties Used for the Allocation of Designated State Revenues*, State of Washington, Office of Financial Management, June 1999.

(2) Source: Resolution No. R97-59 *A Resolution of the Pierce County Council Allocating Population Projections for the Year 2017 to the Cities, Towns, and Unincorporated Areas of Pierce County*, May 1997.

(3) Does not include the City of Edgewood

(4) N/A = Not Applicable

3.2.3 Coordination with other Sewer Utilities

An objective of the planning process for the Unified Sewer Plan has been to minimize conflicts between the provider of sewer services and bring predictability to sewer utilities, their rate payers and the development industry. One method of accomplishing this objective was the incorporation of the plans for sewerage of the cities, towns and other sewer utility providers (36.94.040 RCW). The general sewer plans that describe the sanitary sewer services of the sewer utilities operating in Pierce County are as follows:

City of Bonney Lake. *Sewer Comprehensive Plan, City of Bonney Lake, Washington.*1996

City of Buckley. *Inflow and Infiltration Analysis Engineering Report*. 1994; *Capital Facilities Element, City of Buckley Comprehensive Plan*. 1995 (Sewer Plan Update pending)

City of DuPont. *City of DuPont Sanitary Sewer Comprehensive Plan.*1997

City of Fife. *City of Fife Sewer Comprehensive Plan*. 1998

City of Fircrest. *Sewer and Water Rate Study.*1995 (Sewer Plan Update pending)

City of Gig Harbor. *Gig Harbor WWTP Facility Plan.* 1994

City of Milton. *Capital Facilities Element, City of Milton Comprehensive Plan,* 1995. (sewerage planning conducted by Pierce County)

City of Orting. *Amendment to the General Sewer Plan/Engineering Report for Sewage Treatment Plan Expansion.* 1996.

City of Pacific. *City of Pacific Sanitary Sewer Plan*. 1991

City of Puyallup. *City of Puyallup Sanitary Sewer System Comprehensive Plan Update.* 1997

City of Sumner. *Sumner WWTP Comprehensive Facility Plan*.1999

City of Tacoma. *Tacoma Central WWTP Facilities Planning Report*. 1985

Elbe. *Elbe Facility Plan and Comprehensive Plan.*1982

Fort Lewis. *Fort Lewis WWTP Operations and Maintenance Manual Update.*1999; *US Army Biosolids Management Manual for Army Facilities*. 1996; *Annual Inflow and Infiltration Report,* 1999.

Lakehaven Utility District. *Lakehaven Utility District Comprehensive Wastewater System Plan.*1999

Town of Carbonado. *Comprehensive Sewer System Plan*. 1978.

Town of Eatonville. *Eatonville Wastewater Facilities Plan*.1999

Town of Steilacoom. *Sewer Collection System Comprehensive Plan.* 1989

Town of South Prairie. *Town of South Prairie Wastewater Facility Plan Update.* 1987

Town of Wilkeson. *WWTP Facility Plan Amendment.* 1998

Sewer service areas are the geographic areas identified by each sanitary sewer utility for either existing or planned wastewater collection service, treatment service or both. Although service areas may be the same as sewerage basins, they can be areas receiving on-site sewer system maintenance services or areas whose wastewater flows into contracted capacity in a portion Pierce County collection system. In some cases, collection service is provided by one sewer utility with treatment services provided by wastewater treatment plant owned by a different sewer utility. Please see Chapter 4 for further information regarding existing sewer providers.

3.2.4 Service Area, Treatment and Conveyance Capacity Agreements

Service areas of the Pierce County wastewater utility within cities and towns have been established primarily by interlocal agreements between the County Wastewater Utility and the individual cities and towns. These agreements establish where the County will provide service to incorporated cities and coordinate the joint usage of existing sewer facilities, thereby achieving maximum benefit for both the County and city when new facilities do not need to be constructed.

In the Hylebos service basin, a series of agreements with the City of Tacoma have resulted in capacity in City of Tacoma sewer pipelines and in the Tacoma Central WWTP. Agreements with individual cities establish ownership of collection facilities and collection system capacities for Milton, Fife, and Edgewood. Agreements with the Lakehaven Utility District set conveyance capacity for Lakehaven's East Hylebos service area. In the Lake Tapps service basin, agreements with the Environmental Protection Agency (EPA) and the Cities of Bonney Lake and Sumner defined the sewer service area where sewer service is currently provided. For the Chambers Creek Regional WWTP Sewerage Basin (Chambers Creek Basin), agreements provide for services provided for the cities and towns in the basin. Please refer to USP Appendix D for a list of the interlocal agreements that establish current service area and treatment and conveyance capacity.

3.2.5 On-Site Sewer Systems

New on-site sewer systems are permitted in both rural and urban, incorporated and unincorporated parts of Pierce County. On-site sewer systems handling less than 3,500 gallons per day (approximately 9 dwelling units) are authorized by the Tacoma-Pierce County Health Department. For systems handling between 3,500 and 14,500 gallons per day, the State Department of Health issues permits. The State Department of Ecology issues permits for large on-site sewer systems over 14,500 gallons per day.

On-site sewer systems are allowed where a lot or parcel is located completely outside a horizontal plane of three hundred (300) feet of any permanent wastewater facilities. In unincorporated Pierce County or most Pierce County Wastewater service areas, existing structures are not required to connect to sanitary sewers unless the property owner voluntarily elects to connect and pays all fees and capital charges to the Utility. However, if septic tank systems serving existing structures fail or if a property owner expands the use of the structure, then the owners of the existing structures are required to connect to the public sewer system. WAC 246-272 07001(1) requires connection of a residence or facility with a failed on-site sewer system if sanitary sewers lie within 250 feet. The Pierce County County-Wide Planning Policies call for the elimination of the "*development of new residential or commercial uses on on-site and community sewage systems within in the urban areas in the unincorporated County or within municipal boundaries….*"

3.3 PLANNING METHODS

Information regarding the planning process for the development of alternatives can be found in Chapter 5. The planning methods discussed in this chapter were used in the evaluation of recommended alternative which is explained in detail in Chapter 6.

3.3.1 Flow Projections

Flow projections are an estimate of the amount of wastewater that sewerage facilities must be designed to convey and treat. Several measures of wastewater volumes are used in this plan: Average Dry Weather Flow, Maximum Monthly Flow, and Peak Wet WeatherFlow

Average dry weather flow (ADWF) is the base wastewater without groundwater infiltration or stormwater inflow into sewer pipelines.

Maximum month flow (MMF) represents the sustained condition under which sanitary wastewater flows are combined with wet season influences of groundwater infiltration (I/I). Maximum month flows are the measure of permitted capacity cited in NPDES permits for wastewater treatment plants issued since 1995. It does not apply to collection facilities.

Peak wet weather flow (PWWF) represents the extreme condition under which wastewater flows are combined with storm influenced infiltration and inflow (I/I). Peak flows in the existing Pierce County collection system were used to estimate the appropriate size of force mains, interceptors and pumping stations for the Recommended Alternative. The peak wet weather flow was assumed to be 2.5 times the maximum month flow. The Department of Ecology's *Criteria for Sewage Works Design* requires sewers be designed to carry at least the peak hourly flow when operating at capacity.

3.3.1.1 Land Use Based Flow Projection Methodology

Charged with demonstrating consistency with the GMA, Pierce County chose a land use based approach to wastewater projections as an effective way of linking the sewerage plan to adopted land use to overcome the disadvantages of population based projections. Traditional flow projection methodologies based on population projections limit the ability of the Wastewater Utility to demonstrate consistency with the Washington State Growth Management Act (GMA) and the comprehensive plans adopted under the GMA. In addition, census information and Puget Sound Regional Council (PSRC) forecast analysis zones in Pierce County correspond poorly to the sewerage sub-basins. An attempt to use PSRC population data would have required splitting forecast analysis zones, sometimes several times with many judgment calls on how a population should be divided. Such compound interpolations would have been subject to challenge. Additionally the degree to which the PSRC population data in the forecast analysis zones reflected the Comprehensive Plan was uncertain at the time (1996-1997) the wastewater flow projection methods were being decided.

The flow projections methodology for this plan is based on the adopted land use map and land use designations from the 1996 Pierce County Comprehensive Plan for unincorporated Pierce County, the comprehensive plans of cities and towns in the alternatives, and the Pierce County adopted level of service standard for sanitary sewers of 220 gallons per equivalent residential unit. The method takes into account the connections to the County sewer system existing in 1997 and the densities projected in the capacity analysis for the CUGA prepared by Pierce County Planning and Land Services Department for each land use category of each sewerage sub-basin.

3.3.1.2 Base Sanitary Flow as Residential Equivalents

Historically, the Wastewater Utility has used a flow factor of 220 gallons per day per residential equivalent (RE) to represent Average Dry Weather Flow. The 220 gallons per day flow factor was adopted as the level of service standard for sanitary sewers in the *Pierce County Comprehensive Plan, Capital Facilities Element*. The factor originated from a 1981 study of water consumption records for the Parkland Light and Water Company for the month of February and the Lakewood Water District for the months of

February and March[1]. The study assumed 2.8 people per residence to yield an average of approximately 78 gallons per day (gpd) per person. Residential flow factors were evaluated as part of the calibration effort of the model of the existing collection system. Flow projection calibration conducted for the Unified Sewer Plan confirmed that 220 gallons of wastewater per household reflects the actual volume of wastewater being generated per household.

For each sewerage subbasin, the total number of Residential Equivalent units currently connected to the sewer system was obtained from a GIS query of the sewer billing database. Flow projections conservatively assumed a multi-family residence to be equal to a full 1.0 residential equivalent.

3.3.1.3 Commercial Flows

Existing commercial flows were established to reflect a GIS query of commercial water usage from the sewer billing database. A return-to-sewer factor was developed to convert the water usage data to sewer flow and an I/I factor was applied.

For future commercial development it was assumed that for each acre zoned commercial or industrial would contribute 1,000 gallons per day.

3.3.2 Infiltration and Inflow

Flow projections assume 600 gallons per acre per day for wet weather infiltration, which equates to maximum month flow conditions. An additional 400 gallons per acre per day were added for inflow, which occurs during peak wet weather flow conditions. Therefore, a total of 1,000 gallons per acre per day was applied to drainage areas tributary to the collection lines. This is the standard that is employed when issuing connection permits and was verified through the use of the flow model.

As sewer systems age, inflow and infiltration (I/I) control becomes a problem. I/I is typically made up of stormwater and groundwater. In older service areas where I/I can be most prevalent it can lead to overflow of untreated wastewater during storm events. Uncontrolled I/I will increase the cost of conveyance and treatment and reduces the capacity in pipelines, pump stations and at treatment facilities. The addition of I/I sanitary sewer flows will also change the wasteload characteristics of the flows coming into the wastewater treatment plant. Dilution of the wastewater flows makes it difficult for a biological system to operate efficiently due to a lack of organic waste, which feeds the system.

Federal and state laws require the control of I/I and are enforced under the National Permit Discharge Elimination System (NPDES) permit. NPDES permitting requirements are established for each treatment plant and its collection system. The Pierce County NPDES Permit for Chambers Creek Regional WWTP requires the enforcement of *Title 13, Pierce County Sanitary Sewer Administrative Code* and the prohibition of inflow. To address the issue of I/I, Pierce County maintains an Infiltration and Inflow Reduction Program which seeks to eliminate I/I from the Pierce County system.

3.3.3 Sensitivity Analysis

Sensitivity analysis is a test of how well a sewer system provides flexibility for possible additions to the service area or changes in development intensity beyond what has been planned. Under current growth management regulations, if a sewer collection system constructed to serve the existing Comprehensive Urban Growth Area (CUGA) is too small to support additional wastewater flows from future urban areas, many sewer lines and pump stations may have to be prematurely replaced or additional urban growth cannot occur. This could result in huge costs of upgrading facilities later. Wastewater facilities, particularly pipelines and pump stations, have a life expectancy of 50 years or greater. Facilities

[1] *Chambers Creek- – Clover Creek ULID 73-1 Report on Project Financing Status and Final Assessment Roll,* January 1981

sized for maximum flow over their useful life are less likely to be prematurely replaced. Disturbance to environmentally sensitive areas, streets, neighborhoods, and commercial areas can be minimized.

The sensitivity analysis reviewed possible sources and quantities of flows beyond the CUGA and at stable neighborhoods where build-out at densities or land use intensities per the Comprehensive Plan were not likely to occur. The potential impacts of these wastewater flows on the size and location of the treatment and conveyance facilities identified were expressed as a range of wastewater flows. The lower end of the range represents the minimum necessary to serve only the CUGA assuming moderate density. The upper end of the range reflects the volumes expected over the facilities life.

Sensitivity analysis areas were identified by the following:

Rural Reserve areas. Areas designated Rural Reserve were included because they are areas identified as the next areas added to the CUGA. Data source: Pierce County Geographic Information System (GIS) land use designation coverage

Areas already subdivided to urban densities. Areas subdivided to one-half acre or less were included because the minimum lot size for urban single family zones is two dwelling units per acre in the Pierce County Development Regulations. Data source(s): County parcel layer, GIS

Other urbanizing areas as requested by particular cities and towns or sewer utilities. These areas were identified by cities and towns and other sewerage agencies. Data source: Technical Advisory Committee

Areas that can gravity flow to facilities in alternatives. Data source(s): Engineering judgment on the basis of topographic maps and environmental engineering principles

Exclusion of designated agricultural lands. Lands designated Agriculture were identified by the Pierce County Comprehensive Plan as those intended for long-term commercial agriculture. Data source(s): Critical and Resource Areas Ordinance maps, GIS

3.4 TREATMENT FACILITIES DESIGN CRITERIA

3.4.1 Diurnal Variations/Curve

Wastewater volumes vary throughout the day. If the amount of flow coming into a treatment plant is plotted on a graph, the view of a day's flow would resemble of a Bactrian camel, with a morning peak and an evening peak. Peak flows through the Chambers Creek Regional WWTP tend to occur between 12:00 noon and 12:00 midnight. The flows then trend down to the lowest point about 6:00 a.m. These fluctuations in flows reflect the lag time between peak usage and the time wastewater arrives at the treatment plant. Peak water use tend to occur first thing in the morning when people begin to wake up and then again in the early evening as people return from work. This pattern of peak flow is a constant in daily operation of the plant.

Changes in peak flow and duration gradually increase as collection systems become larger and spread farther away from the plant. With large storm events, such as those which occurred in February 1996, I/I contributes to even greater flows through the plant and creates a new flow curve which, represents the composite time between when the storm event began and ended in various parts of the service area.

3.4.2 Wasteload – BOD and TSS Average and Peak Month

Biological Oxygen Demand (BOD) is a measure of the amount of oxygen consumed in the biological and chemical process which breaks down organic matter in water or wastewater. Total Suspended Solids (TSS) is the total amount of particulate matter found in wastewater. An NPDES permit due to their high probability of impacting a receiving water regulates both BOD and TSS.

The Unified Sewer Plan assumes that expansion of the Chambers Creek Regional WWTP will be based on Biological Oxygen Demand and Total Suspended Solids. The existing Pierce County Pretreatment Ordinance requires that all wastewater discharged to the sanitary sewer system be treated to residential standards or be subject to a surcharge to cover the additional cost of treatment of the excess waste strength. The NPDES permit for Chambers Creek Regional WWTP requires that influent into the plant not exceed 242 milligrams per liter BOD and 303 milligrams per liter suspended solids.

3.4.3 Water Quality

State and federal guidelines require that any discharge with a potential to exceed water quality standards have an effluent limitation included within their NPDES permit for the particular toxicant.

Nutrient Study for South Puget Sound. Currently, the Washington State Department of Ecology is in the second year of a multi-year study of nutrient (nitrogen and phosphorus) sources and impacts in southern Puget Sound. Results of the Ecology study, when completed could influence further effluent limitations of the Chambers Creek Regional WWTP. The Unified Sewer Plan does not speculate on the outcome of the nutrient study, but does acknowledge that changes in treatment requirements are likely during the life of the plan.

Total Maximum Daily Load (TMDL) of the Puyallup River System. Total Maximum Daily Load is an established daily limit for a specific constituent over which water quality will be degraded. Under the Unified Sewer Plan, Pierce County assumes continued discharge of flows from the Lake Tapps service area through the Sumner WWTP. It is anticipated that the Sumner WWTP would be expected to exceed limits for ammonia, chlorine, copper, mercury and zinc. In order to continue discharging to the Puyallup River, it is expected that the Sumner WWTP will be required to provide advanced treatment. Due to 303(d) listings of the Puyallup River watershed, cumulative discharge issues will also dictate allowable flows and wasteloads. One Total Maximum Daily load study for BOD and ammonia has been completed with additional studies waiting to be completed.

3.4.4 Industrial Pretreatment

Industrial Pretreatment is a requirement of the federal Clean Water Act for public wastewater treatment plants treating over 5 MGD of wastewater. It is intended to protect sewerage facilities and workers' health, to prevent inhibition of the treatment processes and violations of surface water quality standards, and to maintain biosolids quality within the USEPA's "Clean Sludge" criteria for trace metals. This is accomplished by limiting what can be discharged into the County's sewer system. Sewage treatment plants are designed to biologically degrade organic material, remove suspended soils and disinfect domestic wastewater. Pollutants from some commercial processes may be toxic to the biological treatment process, may pass through the plant untreated or accumulate in the biosolids, may physically interfered with the biological or chemical treatment process, or may present a health hazard to wastewater treatment staff. Rather than designing public wastewater collection and treatment facilities receiving mostly residential quality wastewater to handle the exceptional cases, enterprises generating wastewater from manufacturing, cleaning or rinsing processes are required to take care of the troublesome byproducts of their operations before discharging into the sewer system.

The Pierce County Wastewater Utility applies the Pretreatment and Accidental Spill Prevention Programs to not only significant industrial users, but also to commercial dischargers. The County has only three major (categorical) industries discharging to the treatment plant. (Please see USP Appendix F for information on the significant industrial users of the Pierce County

Wastewater Utility sewer system). However it has over 1,600 commercial facilities such as photo shops, medical facilities, auto body shops, dry cleaners, lawn services, and restaurants, which when combined, can have significant impacts on the sewer system and treatment plant operations. Fats, oils and grease from petroleum or mineral sources can harm the biological treatment process. Fats, oils and grease from animals and vegetable sources can block sewer lines. Oil/water separators are used to pre-treat oily wastewater. Wastewater with corrosive substances in it can damage sewer lines and disrupt treatment operations. It can also react with other substances in sewage to create noxious fumes dangerous to collection system maintenance personnel and treatment plant operators. Sewer lines have been known to explode, causing severe damage and injury as a result of explosive or flammable materials entering the sewer. Accordingly gasoline, kerosene, naphtha, benzene, toluene, ethers, alcohols, sulfides, chlorates and similar hazardous substances are prohibited from being put in the County sewer system. Solids capable of settling can restrict or block flow in sewer lines so the discharge of ashes, sand, grass and gravel that can clog sewage flow is prohibited.

3.4.5 Pump Stations

Wastewater pump stations operated and maintained by Pierce County range in size from small stations designed to serve a group of homes (localized area), to pump stations providing service for large areas as part of the interceptor system. Pump stations serve as one key component of the wastewater collection system. Reliability of the stations is crucial to ensure continuous conveyance of wastewater from areas that can only be served by pumping wastewater out of low-lying areas, to raise the elevation of wastewater so it can flow by gravity without pipelines being deeply buried, overcome obstacles such as hills, or to increase the conveyance capacity of certain pipelines. At least two pumps are provided for redundant purposes. Stations are designed so that one pump can handle flow with the other pump offline and critical pump stations are equipped with a backup power source.

Flow monitoring also can be obtained from pump station run times. Each pump station has a telemetry system that monitors and transmits information such as: pump failure, high water, power failure, intrusion; panic; low air; low water pressure; pump run time; and, pump on/off. In some cases the telemetry system will transmit water levels, percent speed of the pump station and flow rate.

Types of Pump Stations

The configuration of pump stations in the sanitary sewer system are of four types:

Dry Well/Wet Well. This pumping station configuration consists of a dry well and wet well separated by a water retaining wall. Wastewater flows into the wet well with pumps and other equipment located in the dry well. The control panel for the pumping station is located either in the Dry Well or above ground.

Submersible. In this type of pumping station, the wet well is the primary structural feature. Submersible raw sewage pumps are installed in the bottom of the wet well. The pumps are attached to a guide rail system and supplied with a lifting chain or cable. Mechanical seals are designed to prohibit entry of wastewater into submersible pump motors. The control panel for the pumping station is located above ground.

Self-Priming. In the self-priming arrangement, pumps are located on-grade above the wet well. A fiberglass or metal enclosure houses the pumps and control panels. On-grade installations use horizontal self-priming centrifugal type pumps. When a motor starts, the pumps operate at an accelerated speed for a short period of time to draw liquid into the pump from the wet well and then commence wastewater pumping. Maximum suction lift is dependent on pump speed.

Residential Grinder Pumps. Residential grinder pumps serve residents who have homes located below street level and need to pump wastewater to a County gravity sewer situated at a higher elevation, such as along lake fronts and streams.