CHAPTER 8

Public Health and Safety Characterization

GOAL

Protect property and public health by planning, designing, developing, operating, and maintaining sanitary sewer and stormwater infrastructure.

INTRODUCTION

Public infrastructure—e.g., water systems, sewers, streets, and electricity—provides the underlying built framework that supports public health and safety. BES is responsible for constructing and maintaining sanitary and stormwater collection and treatment facilities for the City of Portland. Because transportation systems also affect water quality and quantity, these issues are included. Street trees are also included because in addition to providing habitat and aesthetic benefits for humans, they capture rainwater and reduce the amount of runoff entering the stormwater system. In this way, they are part of the city's stormwater infrastructure.

WATERSHED GEOLOGY

The geology of the watershed play a large role in determining how sanitary and stormwater infrastructure performs in terms of runoff, infiltration potential, and sanitary sewer separation potential. The area north of Columbia Boulevard is relatively flat, with elevations ranging from 20 to 50 feet above mean sea level (msl). The soils in this area have low infiltration potential. However, significant filling with dredge spoils and other fill has occurred in many locations, such as Portland International Airport and other Port of Portland facilities. Dredge spoils are primarily sandy soils and have very high permeability. The soil underlying the dredge spoils has low infiltration potential. Other areas in the watershed have been filled with soils with varying permeability.

South of Columbia Boulevard (and Airport Way to the east), the elevation slopes up to the south from about 40 to approximately 300 feet above msl in some areas. All soils in this area have a moderately high to high infiltration potential.

SANITARY SEWER FACILITIES

Two types of wastewater collection systems occur in Portland:

- A separated sanitary and stormwater system that conveys sanitary sewage and stormwater in separate pipes
- A combined sewer system that conveys both sanitary sewage and stormwater in the same pipes

Both types of systems are found in the Columbia Slough Watershed, and are summarized below. The City of Portland's 1999 *Public Facilities Plan* (PFP) contains more detailed descriptions and maps of the systems by subbasin. The following description of the storm and sanitary systems

was taken largely from the PFP. It should be noted that the total acres of the watershed in the PFP differs from the area used in this characterization. The PFP includes an area that topographically is not part of the Columbia Slough Watershed, but its stormwater drains to the Slough.

Separated Sanitary System

Separated sanitary sewers collect and transport sanitary wastewater only. In the separated areas, stormwater is collected in its own pipes and discharged either to the Columbia Slough or to the ground. A full explanation of stormwater collection and disposal in the Columbia Slough Watershed in provided later in this chapter.

The vast majority of the watershed has separated sanitary sewers. The current separated sanitary sewer area comprises approximately 30,519 acres, or over 80 percent of the watershed. The Columbia Slough watershed includes five separated sanitary sewer basins, as shown on Figure 8-1. The characteristics of the basins are detailed in Table 8-1 and land use is shown in Table 8-2.

Figure 8-1: Sanitary Sewer Basins and Unsewered Areas

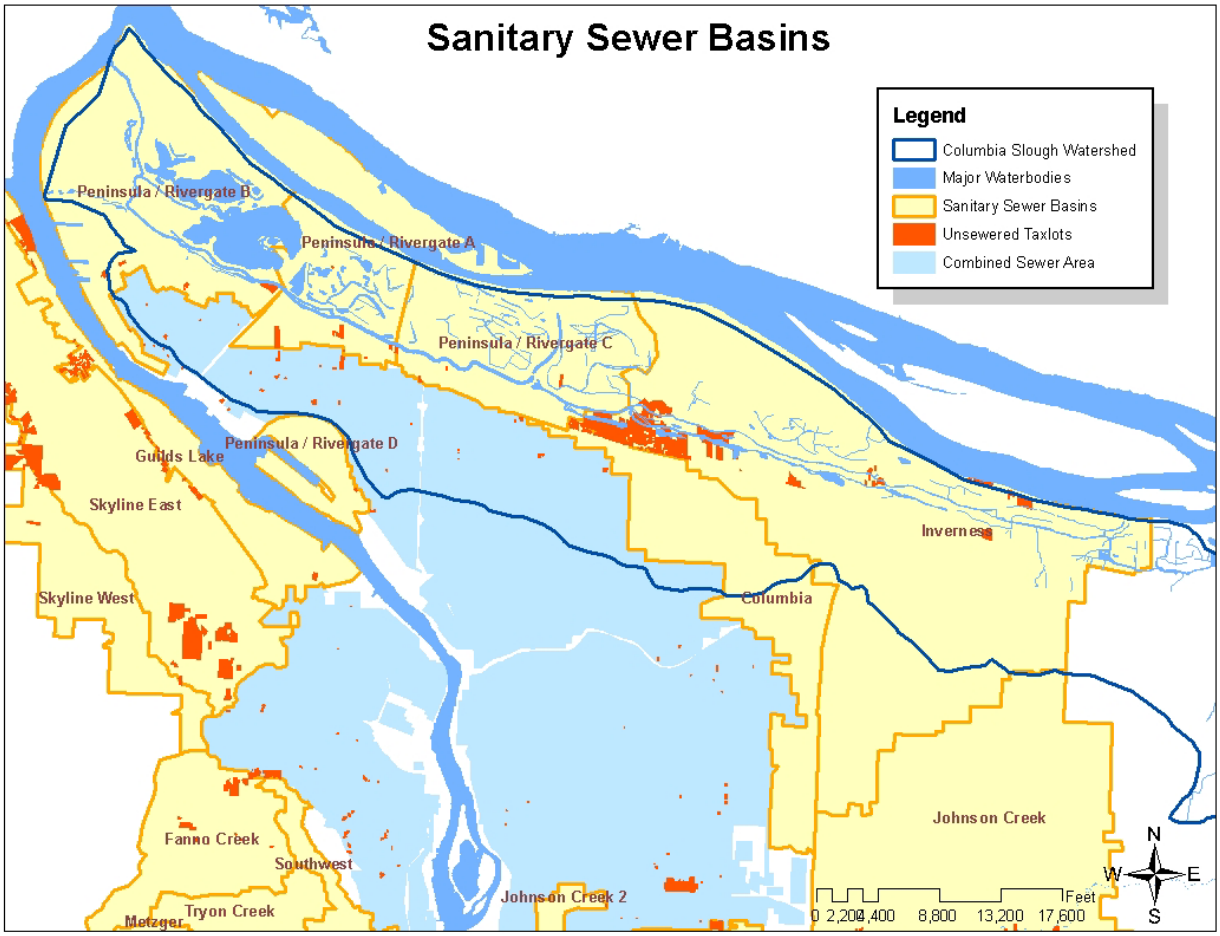

Table 8-1: Characteristics of Sanitary Sewer Basins

Basin	Area (acres)	Population		Number of Pump Stations	Length of Pipes (feet)	Density of System (linear feet of pipe per acre)
		Existing	Future			
Columbia	3,573	30,948	33,403	8	456,767	127.83
Inverness	13,082	48,975	58,593	21	688,558	52.63
Peninsula/ Rivergate A	4,585	6,600	7,442	11	107,671	23.48
Peninsula/ Rivergate B	5,733	4,728	4,914	5	110,084	19.2
Peninsula/ Rivergate C	3,546	2,934	4,242	16	140,346	19.2
TOTAL	**30,519**	**94,185**	**108,594**	**61**	**1,503,426**	

Source: City of Portland Public Facilities Plan (1999)

Table 8-2: Separated Sanitary Sewer Basin Size and Land Use

Basin	Area (acres)	Multifamily Residential	Single-family Residential	Commercial	Industrial	Parks and Open Space	Other
Columbia	3573	464	1679	214	143	322	750
Inverness	13082	1177	3140	654	6018	1177	916
Peninsula/ Rivergate A	4585	275	275	504	1330	825	1376
Peninsula/ Rivergate B	5733	57	115	0	3784	1261	516
Peninsula/ Rivergate C	3546	35	106	177	2234	638	355
Total Acres	**30519**	**2010**	**5315**	**1550**	**13508**	**4224**	**3912**
% of Total		**7%**	**17%**	**5%**	**44%**	**14%**	**13%**

Source: City of Portland Public Facilities Plan (1999)

Because the northern portion of the watershed is relatively flat, there are 61 sanitary pump stations that convey the flows.

The PFP notes several basement-flooding events from sanitary sewer overflows in the eastern portion of the watershed. From 1988 to 1996, there were 40 complaints regarding sanitary sewer overflows to basements.

In theory, sanitary systems convey only sanitary wastewater, not stormwater; flow rates therefore should not be influenced by rainfall events. In practice, however, sewers are not watertight and receive additional flow from groundwater infiltration and rainwater inflow. There may also be direct illicit connections from residences and businesses to sanitary sewers. The level of service for separated sanitary sewer systems is based on current U.S. Environmental Protection Agency (EPA) and Oregon Department of Environmental Quality (DEQ) guidelines for wet-weather performance. The guidance documents state that separated sewer systems should have adequate capacity to collect and transport the base sanitary flow and the infiltration/inflow (I/I) associated

with the 5-year storm event without producing sanitary sewer overflows (SSOs). Overflow points include backups to connected properties and overflows or bypasses at pump stations.

Combined Sewer System

The first sewers in Portland, constructed in the late 1800s, were combined sewers. They consisted of a network of trunk sewers that drained into the Columbia Slough, as well as into the Willamette River. The combined sewer area of the Columbia Slough Watershed is relatively small—approximately 15 percent, or 5,500 acres. The combined sewer area is located west of NE 42nd Avenue.

The majority of the combined sewer pipes within the Columbia Slough Watershed were constructed between 1900 and 1940. Beginning in 1947, interceptors (large pipes) were built to transport base sanitary flows to the Columbia Boulevard Wastewater Treatment Plant (CBWTP), which began operations in 1952. The Columbia Slough Watershed currently includes 11 combined sewer basins, as shown on Figure 8-2. Table 8-3 shows characteristics of the 11 basins. Table 8-4 shows land use in the basins.

Figure 8-2: Combined Sewer Basins

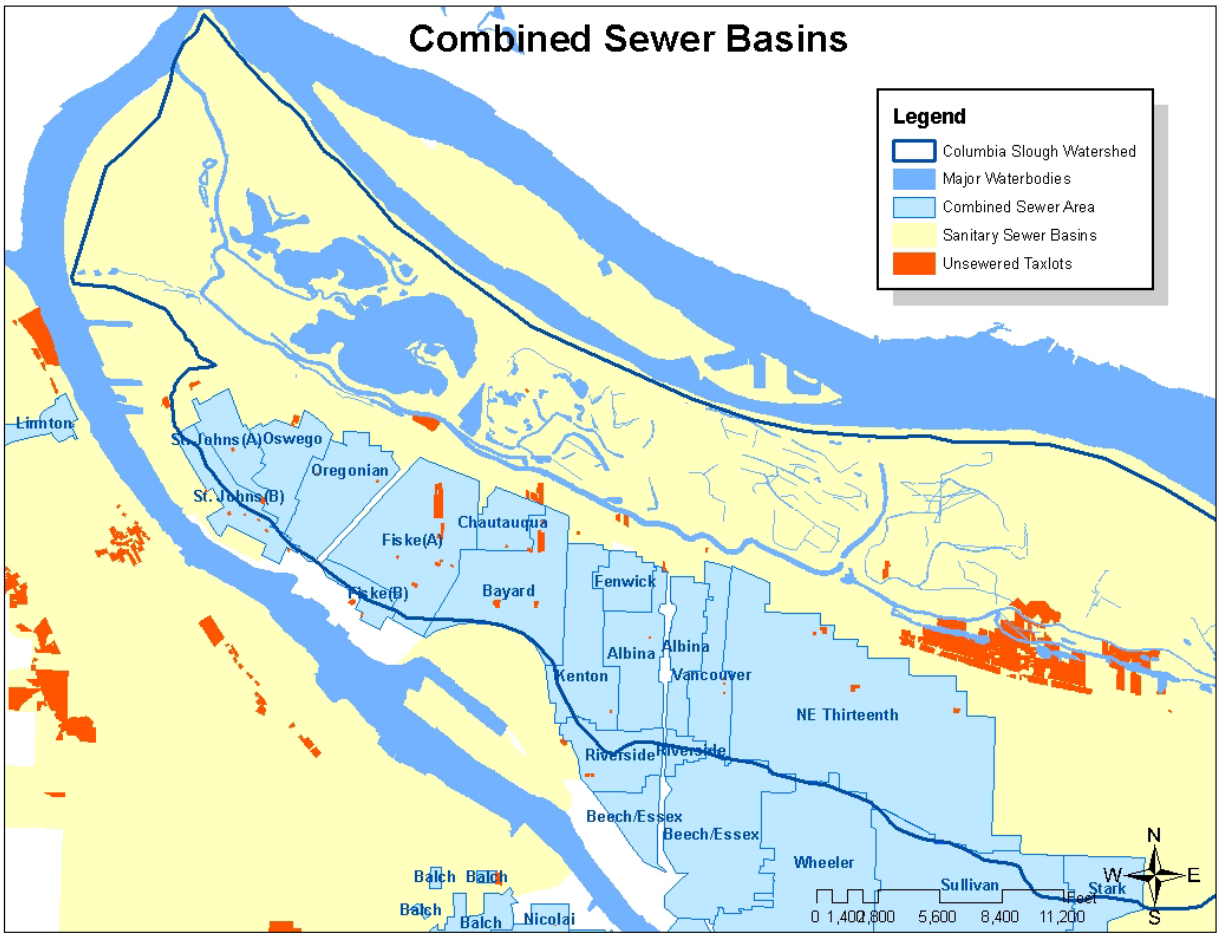

Table 8-3: Characteristics of Combined Sewer Basins

	Area	Population		Percent Impervious		Length of Pipes	Density of System	Percent Disconnection
Basin	Acres	Year 1994	Year 2015	Year 1994	Year 2015	Linear Feet *	Linear feet per acre	Residential Rooftop Area
Albina	512	6,301	7,402	50	65	111,232	217.25	74
Bayard	547	4,878	4,770	37	44	103,841	189.83	52
Chautauqua	145	1,166	1,077	33	42	23,432	161.6	68
Fenwick	151	1,116	1,312	40	50	30,543	202.27	49
Fiske A	698	5,655	5,855	46	51	136,153	195.06	55
Kenton	406	4,397	4,169	40	47	88,821	218.77	48
NE 13th	2,022	24,621	24,545	34	35	432,470	213.88	50
Oregonian	366	2,719	2,837	46	49	66,463	181.39	88
Oswego	242	1,781	1,852	44	49	48,036	498.49	89
St. Johns A	179	943	1,007	44	49	58,266	325.28	87
Vancouver	275	2,824	2,735	41	50	56,972	202.60	44
TOTAL	**5,543**	**56,401**	**57,561**	**40**	**45**	**1,156,229**	**2,606**	**57**

Source: City of Portland Public Facilities Plan (1999)
* 14,246 linear feet of pipe constructed in 2001

Table 8-4: Combined Sewer Basin Size and Land Use

	Area	Multifamily Residential	Single-family Residential	Commercial	Industrial	Parks and Open Space	Other
Basin	**acres**	**acres**	**acres**	**acres**	**acres**	**acres**	**acres**
Albina	512	113	317	46	0	31	0
Bayard	547	22	454	16	0	49	0
Chautauqua	145	30	86	6	1	20	0
Fenwick	151	45	63	23	15	5	0
Fiske A	698	147	482	35	14	21	0
Kenton	406	24	333	24	0	24	0
NE Thirteenth	2022	182	1557	121	81	61	20
Oregonian	366	22	293	29	15	4	0
Oswego	242	17	203	17	0	5	0
St. Johns A	179	16	134	13	4	11	0
Vancouver	275	63	143	17	25	25	3
Total Acres	**5543**	**681**	**4065**	**347**	**155**	**256**	**23**
% of Total		**12**	**73**	**6**	**3**	**5**	**0.4**

Source: City of Portland Public Facilities Plan (1999)
* Percentages do not equal 100 because of rounding.

Large rainfall events have a significant impact on the combined sewer system because the pipes have limited capacity. When that capacity is exceeded, the pipes overflow. This is called a combined sewer overflow (CSO).

In December 2000, the City of Portland completed a number of large projects to control CSO volume by over 99 percent in the Columbia Slough. Those projects included:

- Residential downspout disconnections. Through this program, stormwater from roofs is directed to lawns and vegetated areas. Approximately 57 percent of the stormwater runoff from rooftops located in the combined sewer area has been removed by disconnecting downspouts.

- Separating stormwater from combined sewers. Three combined sewer basins were separated. Stormwater from these three basins now flows to the Ramsey Lake Constructed Wetland for treatment prior to discharging into the Slough.

- Construction of the Columbia Slough Consolidation Conduit (the "Big Pipe"). The conduit intercepts flow from combined sewer outfalls and transports it to the CBWTP for treatment.

All these projects reduced CSO events on average to once every 5 years in winter wet-weather conditions and once every 10 years in summer dry-weather conditions. The CBWTP also continues to expand its facilities and operations to accommodate increased volumes. In 2005, the CBWTP will process 103 million gallons a day (mgd), and by 2040 it will process 143 mgd. Another way BES reduced CSO events was to remove stormwater from the system and manage it as close to the source as possible in facilities such as bioswales.

The estimated design life of sewer pipes is 100 years. In the older parts of the City, significant portions of the system are approaching their life expectancy. As these pipes reach their life expectancy, they can crack and form holes, resulting in either sewage leaking out of or groundwater leaking into the pipes. Too much groundwater leaking in can cause sanitary sewer overflows and basement flooding. Large-diameter pipes can even collapse. The PFP addresses the aging infrastructure.

Unsewered Areas

The area east of NE 42nd Avenue was predominantly unsewered, using individual septic and cesspool systems for sanitary waste disposal. This resulted in increased nitrogen going into the Columbia Slough via groundwater, with potential impacts to human and wildlife health. In the 1990s, the construction of the Mid-County Sewer Project provided sewer service to this area. However, pockets of unsewered areas, totaling approximately 570 parcels and 640 acres, still exist within the watershed.

- Between NE 33rd and NE 57th Avenues along the north of Columbia Boulevard. This area contains many industrial and commercial parcels. Sewer design is currently underway as part of the ongoing South Airport Sewer Project.

- The town of Maywood Park.

As these unsewered areas are connected to the sanitary system, negative impacts to groundwater and public health and safety will be greatly reduced.

STORMWATER FACILITIES

Stormwater flows to open channels (rivers, streams, drainageways, swales, water quality facilities, and constructed wetlands) and closed systems (pipes, culverts, and sumps). The City's separated stormwater system collects, conveys, and disposes of stormwater runoff separately from sanitary flows. The separated stormwater pipes are designed to convey a 10-year flood event and to contain or route floods from the 100-year event, while preventing property damage or human injury.

The Columbia Slough Watershed includes five large separated stormwater basins (Figure 8-3):

- I-205
- Peninsula Drainage District No. 1
- Peninsula Drainage District No. 2
- Rivergate East
- Columbia Slough South Shore

Separated stormwater basins are large stormwater planning areas and are composed of several individual stormwater outfalls.

Stormwater runoff to the Columbia Slough may be discharged through a City of Portland (City), Port of Portland (Port), Oregon Department of Transportation (ODOT), or privately owned storm sewer system. The City and Port storm sewer systems encompass large areas that drain both private property and traffic corridors, with multiple outfalls to the Slough. The City has identified 57 major outfalls in its municipal storm sewer system permit. ODOT outfalls primarily drain state roads and highways in the area. In addition, there are a large number of riparian properties that have privately owned outfalls to the Slough.

Stormwater conveys pollutants from many sources to the Columbia Slough waterway. Chapter 6: Water and Sediment Quality Characterization, provides additional information about pollutants that stormwater may carry.

As of January 2004, there were 153 active NPDES 1200-COLS Industrial Stormwater permits issued to facilities in the watershed. Most of these facilities discharge through the City's storm sewer system or through private outfalls. Others discharge through the Port's storm sewer system. For a detailed look at the stormwater pipes and locations of outfalls and sumps, see the *Columbia Slough Map Atlas.*

Figure 8-3: Separated Stormwater Sewer Basins

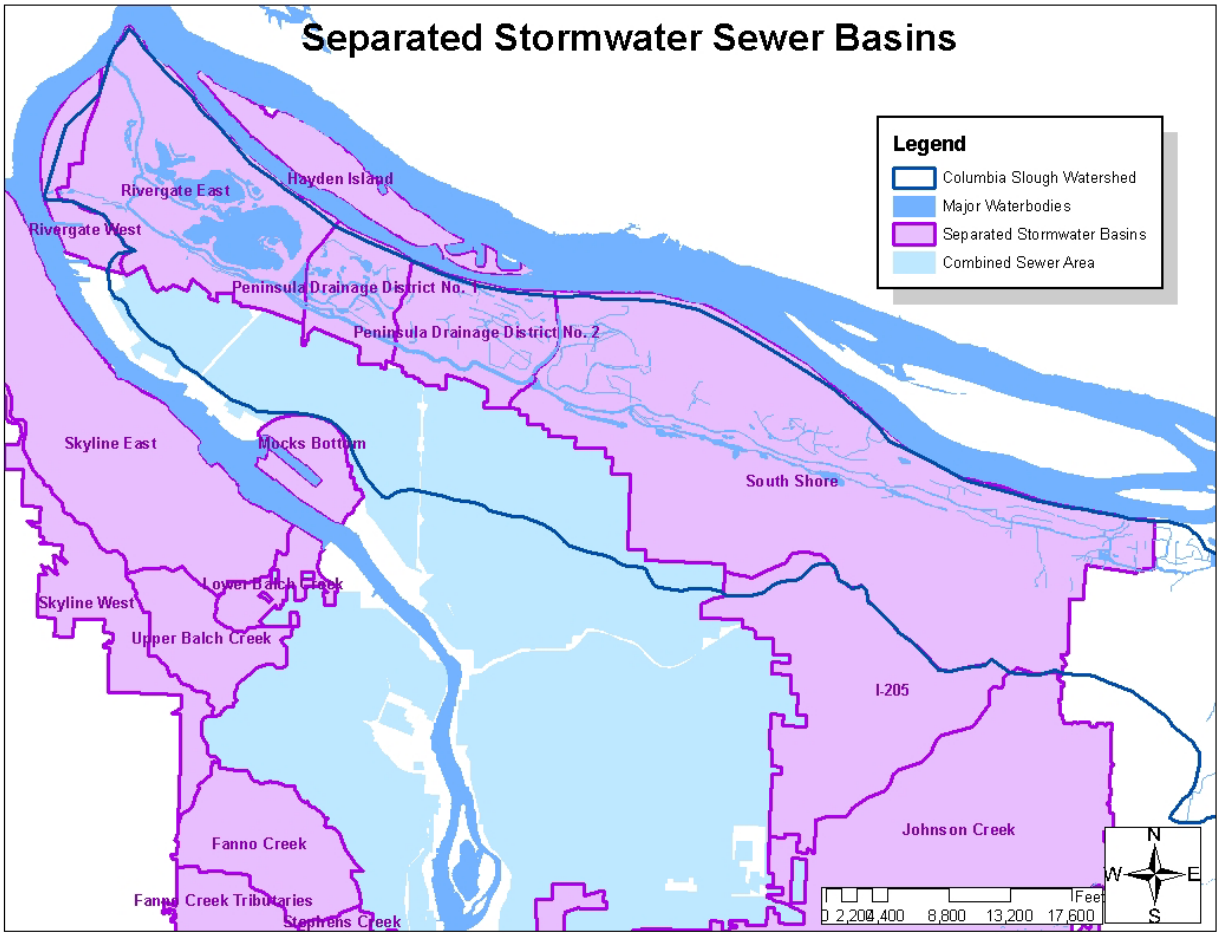

Table 8-5 shows characteristics of the five separated stormwater basins in the Columbia Slough Watershed, and Table 8-6 shows land use in the basins. Hayden Island is also included, even though it is not within the topographical watershed boundary.

Peninsula Drainage Districts No. 1 and No. 2, Rivergate East, and a portion of the South Shore basins are predominantly industrial areas. The stormwater systems in these basins consist primarily of local collection pipes and open drainageways that convey flow into the Columbia Slough. The remaining portion of the South Shore basin is developed as mixed residential (36 percent) uses. The I-205 basin is primarily residential.

Stormwater runoff from I-205 north of Powell Boulevard is conveyed via a pipe to the Columbia River. I-84 runoff west of I-205 is conveyed to the Willamette River. Runoff from I-84 east to roughly NE 122nd is conveyed to the stormwater system beneath NE 122nd and discharges to the Columbia Slough. Runoff from I-5 discharges to the Columbia Slough.

Table 8-5: Characteristics of Separated Stormwater Basins (2003)

Basin	Area (acres)	Percent Impervious		Number of Sumps	Pipe Length (linear feet)
		Existing	Future (2015)		
I-205	4,678	36	43	1,634	20,388
Peninsula Drainage Dist 1	1,254	46	33	1	34,585
Peninsula Drainage Dist 2	1,950	67	58	5	74,805
Rivergate East	4,783	60	68	5	109,775
South Shore	13,118	67	60	1,506	245,815
TOTAL	**27,144**	**276**	**262**	**3,151**	**485,368**

Source: City of Portland Public Facilities Plan (1999)
Note: The percent impervious surface decrease from existing to future is because stormwater management techniques will be used to reduce the effective impervious surface area.

Table 8-6: Separated Sewer Basin Size and Land Use (2003)

Basin	Area (acres)	Multifamily Residential	Single-family Residential	Commercial	Industrial	Parks and Open Space	Other
		Percentage in Watershed in City					
I-205	4,678	61	16	11	4	10	0
Peninsula Drainage District No. 1	1,254	2	0	0	45	53	0
Peninsula Drainage District No. 2	1,950	8	1	5	60	20	6
Rivergate East	4,783	1	1	0	59	28	10
South Shore	13,118	29	7	3	54	7	0
TOTAL	**27,144**	**101**	**25**	**19**	**222**	**118**	**16**

Source: City of Portland Public Facilities Plan (1999)

Sumps

Subsurface infiltration through the use of sumps provides another method of managing stormwater. Sumps are concrete cylinders, often 3 to 4 feet in diameter and range in depth from a minimum of 2 feet to up to 40 feet. The bottom of the sump is typically solid concrete, but approximately 2 feet above the sump floor, the walls are perforated to allow stormwater infiltration to surrounding soils. Most of the newer sumps have a standard construction depth of approximately 30 feet, while older sumps may vary in depth. Many sumps have a sedimentation manhole preceding them, which removes particulates and associated pollutants before the stormwater enters the sump.

In 2004, the Columbia Slough Watershed contained approximately 3,270 active public sumps, which collect and infiltrate stormwater from public rights-of-way. There are also private sumps within the watershed. (See the *Columbia Slough Map Atlas* for the locations of public sumps in the watershed.) Some sumps are located in areas with high groundwater. In these areas, sumps may not be as effective at handling stormwater runoff. Some sumps in the watershed currently do not have pretreatment devices, such as sedimentation manholes, to filter sediments and pollutants. The City of Portland is currently negotiating a citywide permit with DEQ for all City-owned stormwater sumps. The permit conditions include development of a plan to modify sumps that threaten groundwater quality. All sumps, public and private, must be registered with the state.

In July 2003, the City Council adopted a revised Columbia South Shore Wellhead Protection Area and Reference Manual. All sumps in the protection area that posed an increased risk to groundwater due to type of drainage received must be retrofitted to include pretreatment devices, such as a sedimentation manhole, by June 30, 2008. The City of Portland Stormwater Management Manual prohibits the installation of new sumps within the Columbia South Shore Wellhead Protection Area and Cascade Station/ Portland International Center Plan Districts. Also, certain development within the Columbia South Shore Wellhead Protection Area must implement water quality retrofits to protect groundwater quality.

Constructed Wetlands

The City owns and maintains 153 surface water quality facilities that treat stormwater. Three of these facilities contain constructed wetlands:

- Ramsey Lake Constructed Wetland. Located in the Lower Slough, west of Smith and Bybee Lakes, there is a 20-acre constructed wetland that filters stormwater from approximately 600 acres of the St. Johns neighborhood, and a 2-acre constructed wetland that filters stormwater from roughly 240 acres in the Rivergate Industrial Area.

- NE 138th Constructed Wetland. Located at NE 138th Avenue and the Columbia Slough, this wetland filters stormwater from 224 acres of residential and industrial areas.

- Whitaker Ponds Constructed Wetland. Located at NE 47th Avenue near the Slough, this facility filters stormwater from 12 acres of heavy industrial lands.

The constructed wetlands all have a forebay where the stormwater first enters the facility. In the forebay, large sediment particles settle out and oils and grease collect. The forebay may be closed to contain a spill should one occur. From the forebay, the stormwater flows into a construction wetland. The wetlands are planted with native vegetation that further helps filter pollutants from the stormwater.

Urban Tree Canopy and Stormwater

Tree canopy in the Columbia Slough Watershed has largely been removed as a result of development. Trees are important to watershed health and provide multiple benefits to infrastructure function:

- Interception of precipitation to reduce stormwater runoff
- Reduction of sediment transport

- Reduction of suspended solids in the waterway
- Infiltration of stormwater into the soil
- Habitat for wildlife
- Reduction of the urban heat island effect
- Reduction of greenhouse gasses by using carbon dioxide
- Reduction of air temperature
- Noise abatement

A BES report stated that tree canopies can intercept as much as 10 to 40 percent of the precipitation in showers that are over 0.4 inches, and from 40 to 100 percent of precipitation in showers less than 0.1 inches (BES 2000). The report cites studies showing that softwoods (conifers) intercept greater amounts of water than hardwoods because their leaves have a greater number of sharp angles that trap water droplets.

Numerous projects in the Columbia Slough Watershed have increased the number of street trees. Street tree plantings have focused primarily on residential, business, and parking lot areas in the upland portion of the watershed. Depending on planting and maintenance limitations, street tree plantings could be expanded to include commercial and industrial districts. There are areas of the watershed that have great potential for increasing street tree canopy. (See the *Columbia Slough Map Atlas*.)

The BES Watershed Revegetation Program partners with willing public and private property owners to plant native trees and shrubs. To achieve water quality goals, the program focuses on properties along the waterway. To date, the program has revegetated more than 500 acres along nearly 40 miles (210,000 linear feet) of riparian corridor throughout the watershed and has consistently exceeded the ultimate stocking goal of 400 trees per acre. The plantings will greatly increase total canopy coverage in the watershed as they mature.

SEDIMENT QUALITY AND FISH CONSUMPTION

Another aspect of public health concern in the Columbia Slough Watershed is increased cancer risk due to fish consumption.

The Columbia Slough is a slow-moving body of water that receives untreated stormwater runoff from many different land use types. Fine sediment is transported to the Slough in stormwater and deposited in the waterway. Toxic chemicals bind to soil particles, especially to sediments with higher amounts of organic matter (e.g., decomposed vegetation, dead macroinvertebrates, and microorganisms). Despite the hydrophobic (water-fearing) nature of these toxic chemicals, a very minute fraction do sometimes leave the sediment particles and leach into the water, where they seek out other media that have fats or lipids, such as fish and other biota (algae and aquatic plants). A study conducted by the City of Portland and DEQ found that fish caught in the Columbia Slough contain chemicals that pose cancer risks to humans that eat them (BES 1995). (For more information, see Section 6: Water and Sediment Quality Characterization).

CONCLUSIONS

The Columbia Slough Watershed has both combined and separated sanitary and stormwater collection systems. These systems are complex and difficult to model. There are approximately 570 acres of unsewered areas that may be contributing bacteria and nutrients to the Slough. The Slough has a total maximum daily load (TMDL) for bacteria, which means the Slough does not meet certain beneficial uses because of bacteria and may pose human health risks.

Some of the sanitary sewer system is approaching the end of its life expectancy. Increased maintenance may be needed to repair older pipes.

With the construction of several large-scale projects such as the consolidation conduit, sewer separations, and implementation of the Downspout Disconnection Program, CSO volumes have been controlled to 99.6 percent. Combined sewer overflow may still occur in the Lower Slough at a frequency of once every 10 years in summer and once every 5 years in winter.

Stormwater is managed in a number of ways in the Slough: separated pipes with outfalls directly to the Slough, sumps, ground surface infiltration, and constructed wetlands. Managing stormwater with a piped collection and disposal system simplifies the hydrologic cycle. Stormwater pipes collect stormwater and discharge it directly to the Slough, thereby bypassing the natural system, which would have infiltrated stormwater into the ground.

Several large, high-volume roads, such as I-5 and I-84, bisect the watershed. Runoff from these roads is discharged to the Slough. Roads contribute a myriad of pollutants, and it is likely that these high-traffic roads are contributing to pollutant loading in the waterway.

Street trees are effective at collecting rainfall and keeping a percentage of the rainfall out of the system. In doing so, street trees are part of the solution to reduce stormwater runoff into the Slough and can help avoid simplifying the system. Street trees provide additional aesthetic and urban heat island benefits.

Fish and other aquatic biota may contain toxic chemicals in their fats. Therefore, consuming fish caught in the Columbia Slough could pose a health risk.

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