Chapter 6
Bureau of Environmental Services

Overview

Portland’s sewer and stormwater systems serve nearly all of the city’s 588,000 residents, numerous commercial and industrial properties, as well as some customers from neighboring jurisdictions. The network of pipes, pump stations, stormwater facilities, and two wastewater treatment plants, with an estimated replacement value of $13.2 billion, is designed to protect public health, water quality, and the environment. In 2011, the city completed the largest public works investment in its history, the 20-year program to control combined sewer overflows (CSOs) to the Willamette River and Columbia Slough, adding significant new infrastructure (including the “Big Pipes”) to the sewer system. Previously, as little as one-tenth inch of rain caused a CSO event. Now, the system can handle more than an inch without overflowing to the river. As a result, instead of sewage discharging in the Willamette 50 times a year, now it is unlikely to happen more than a few times in the winter and every few summers. Repayment of the “mortgage” on this $1.4 billion investment will continue to impact sewer utility rates for years to come. Rates will also be affected by the need for maintenance and improvement of systems, especially aging collection system infrastructure.

Managing Portland’s 37 inches of average annual rainfall, much of it falling on pavement, rooftops, or other impervious surfaces, is an ongoing challenge that involves built and natural infrastructure to be managed in partnership with businesses, residents, and community organizations. Portland has become an international leader in innovative stormwater management and other sustainable practices. These sustainable practices support a high quality of life for residents and strengthen the local economy by attracting visitors and businesses.

Mission and Values

BES’s mission is to serve the Portland community by protecting public health, water quality and the environment. The Bureau provides sewage and stormwater collection and treatment services to accommodate Portland’s current and future needs. The Bureau protects the quality of surface and ground waters and conducts activities that promote healthy ecosystems in our watersheds.
The Bureau’s motto is “Working for Clean Rivers” and the organizational vision is to be recognized as a trusted service provider and innovative environmental leader through a demonstrated commitment to clean rivers, healthy watersheds and our community.

In the 2011 Strategic Plan, the Bureau identified five priorities for the next five years:

- Responsibly manage ratepayer funds to provide services that address community needs now and in the future.
- Invest in natural and built systems to protect public health and improve watershed health.
- Protect, rehabilitate, and maintain our existing infrastructure for long-term reliability.
- Build and expand partnerships to better meet our Mission and Vision.
- Cultivate leadership and excellence in our workforce.

**Purpose of this Chapter**

This chapter describes the public facilities and services provided by the Portland Bureau of Environmental Services that are necessary to carry out its mission. It identifies desired levels of service, inventory and condition information for existing public facilities, and future facilities that will be necessary to support the land uses designated in the Comprehensive Plan, as required by Oregon Planning Goal 11: Public Facilities and Oregon Revised Statute 197. Carrying out the Bureau’s mission and other City and community goals may also require programs, investments and practices that are not related to public facilities. This chapter may acknowledge--but does not comprehensively address--these measures.

**System Services**

BES provides sewage and stormwater management services in its service area through a complex set of infrastructure systems that are closely intertwined with the natural systems of Portland’s watersheds and the historical development of the city. BES is the responsible bureau for compliance with several state and federal regulatory requirements for groundwater and surface water resources (streams and rivers), as well as the Endangered Species Act. (More information about these requirements is provided later in this chapter.) BES is the lead bureau for planning, implementing, monitoring, and reporting on watershed health improvement projects and programs. BES also administers the City’s brownfield remediation program which provides financial and technical assistance to facilitate brownfield clean-up as a redevelopment tool for human and environmental health, environmental justice, water quality, job creation, and neighborhood revitalization.

The Bureau provides wastewater collection and treatment services within the city limits and to areas outside the city limits within the City’s established urban services boundary (USB). BES provides sewer service to specific areas outside the USB via contract agreements with neighboring jurisdictions where sanitary sewers from outside the USB flow to a BES sewer or treatment facility (Clean Water Services and Lake Oswego in the southwest, Water Environment Services of Clackamas County in the southeast, and city of Gresham in the east). Similarly, some neighboring jurisdictions treat sewage from the BES system.
The Bureau operates and maintains the stormwater collection system and has an oversight and regulatory role for stormwater management within the City’s USB. The City’s National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) Discharge Permit covers stormwater from approximately 15,500 acres within Portland’s USB that drain to the City’s MS4 system, which discharges to local streams, the Willamette River, and the Columbia Slough. The City also manages stormwater with sumps or drywells primarily on the east side of the city, under the Water Pollution Control Facilities (WPCF) for Class V Stormwater Underground Injection Controls (UICs) permit.

Due to the close connection between built infrastructure that manages stormwater (pipes, ditches, pump stations, etc.) and the natural system of streams, wetlands, floodplains and forests that convey, filter, infiltrate and reduce stormwater runoff, the city has adopted a watershed approach to managing stormwater and addressing related regulations, guided by the 2005 Portland Watershed Management Plan. The Bureau is the city’s lead agency for watershed protection and restoration for Portland’s five watersheds (Johnson Creek, Fanno Creek, Tryon Creek, Columbia Slough, and the Willamette River) within the USB. All of the watersheds extend beyond the city limits, requiring extensive collaboration with other local, regional, state, and federal agencies, and non-governmental organizations. Improving watershed health is critical to providing stormwater service, meeting regulations, and supporting the resiliency of Portland’s built and natural systems.

**Service Agreements**

The City of Portland has service agreements with other jurisdictions that allow for treatment of each other’s wastewater flows:

- Lake Oswego, for cost sharing of the Tryon Creek Wastewater Treatment Plant.
- Gresham, Milwaukie, Clackamas County Service District #1, and Clean Water Services, for treatment of sewer flows.
- Dunthorpe-Riverdale Service District, for which Portland provides operations and maintenance, engineering, permitting, and treatment services.
- The City also maintains agreements with the Port of Portland and other private entities for maintenance of private pump stations.

The City is negotiating and expects to have in place for Fiscal Year 2013-14 an agreement with Multnomah County Drainage District #1 covering District provision of stormwater management services.

**Inventory Summary**

The Bureau of Environmental Services is responsible for facilities associated with sanitary sewage and stormwater service. The sanitary and combined sewage systems include both collection and treatment facilities. Two municipal wastewater treatment plants serve the city: the Columbia Boulevard Wastewater Treatment Plant (CBWTP) and the Tryon Creek Wastewater Treatment Plant (TCWTP). Separated stormwater system assets include collection, conveyance, and management facilities. While the bureau...
owns and maintains an extensive stormwater system, BES also relies on stormwater management infrastructure (particularly green infrastructure\(^1\)) that it does not own or control as formal assets.

In 2013, the city’s wastewater and stormwater systems combined had an estimated replacement value of $13.2 billion. In addition, the Bureau invests in and relies upon the city’s green infrastructure and natural systems (such as natural areas, tree canopy, wetlands, and streams) for managing rainfall and stormwater runoff. The value of these natural systems is not included in the $13.2 billion.

### Table 6.1 Estimated Replacement Value

<table>
<thead>
<tr>
<th>System</th>
<th>Inventory</th>
<th>Estimated Replacement Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combined Sewers</td>
<td>885 miles of pipe &amp; access structures</td>
<td>$5.0 billion</td>
</tr>
<tr>
<td>Sanitary Sewers</td>
<td>1,000 miles of pipe &amp; access structures</td>
<td>$4.1 billion</td>
</tr>
<tr>
<td>Stormwater system(^*)</td>
<td>1,900 water quality facilities &amp; 454 miles of pipe</td>
<td>$1.9 billion</td>
</tr>
<tr>
<td>Wastewater Treatment</td>
<td>2 plants &amp; 97 pump stations</td>
<td>$2.2 billion</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>$13.2 billion</td>
</tr>
</tbody>
</table>

\(^*\) Estimated replacement value does not include the value of the nearly 9,000 Underground Injection Controls (UICs).

The city’s combined sewer system provides sanitary and stormwater service to approximately one-third of the city’s area, and the majority of its population, through over 885 miles of pipes. Separate sanitary and storm sewer and drainage systems serve the remaining two-thirds (by area) of the city, primarily in the western and outer eastern areas. The separated sanitary sewer system includes a network of 1,000 miles of sanitary lines and associated access structures.

In addition to gravity sewer pipes and service connections, the wastewater system includes more than ninety pump stations and 57 miles of force main which move wastewater uphill as needed to two wastewater treatment plants, where a series of processes clean wastewater through removal of solids and organic materials and disinfects the effluent before discharging to the Columbia or the Willamette River.

The separated stormwater sewer and drainage system collects and conveys stormwater for discharge to local receiving waters (streams and rivers) and includes pipes, culverts, ponds, sumps, detention facilities, ditches, and drainageways, some of which are neither owned nor maintained by the city.

### Condition and Capacity Summary

The Bureau has recent condition inspections for all but a small percentage of the sanitary sewer collection system. Comprehensive condition data is not available for the stormwater system.

Based on recent inspections or condition assessment, over 80% of the combined and sanitary only pipes are in good or very good condition. Although the completion of the CSO program allows capital resources to shift to rehabilitation and system improvements, projected investments are not keeping pace with the rapidly aging collection system. While age is a good predictor of pipe failure, materials must also be

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\(^1\) Green infrastructure: Public or private assets—either natural resources or engineered green facilities—that protect, support, or mimic natural systems to provide stormwater management, water quality, public health and safety, open space, and other complementary ecosystem services. Examples include trees, natural areas, ecoroofs, green street facilities, wetlands, and natural waterways.
considered. Unfortunately, a significant percentage of the pipe system is concrete pipe that was installed in the early 1940s. Because much of the concrete in that era was poor quality, these pipes are failing more rapidly than might be expected from age alone.

Based on recent inspection data, most (69%) combined sewer system pipes are in good to very good condition, but approximately 10% of pipes are at high risk of failure and in need of repair or upgrading. The sanitary sewer pipes are generally much newer than the combined system pipes and over 90% are in good to very good condition. An estimated $225 million is needed to address the highest risk pipe segments. Projects to address this backlog are included in the proposed Investment Strategy, see Appendix A.

BES has established levels of service consistent with our regulatory permits for both the combined and separated sanitary sewer systems. In the combined system, one benchmark is to convey the 25-year storm at full land use build-out (i.e., consistent with the zoning and the Comprehensive Plan) without risk of system overload, as evidenced by basement sewer backups or surcharging of trunk sewers. In the separated sanitary system, the benchmark is to convey the 5-year storm.

Some areas in the combined system are affected by localized hydraulic capacity limitations that increase the risk of basement sewer backups and/or street flooding. These areas are concentrated close in on the east side with scattered areas in other parts of the system. A number of projects to address this hydraulic deficiency are included in the proposed Investment Strategy.

In the separated sanitary system, hydraulic capacity is impacted by stormwater and groundwater entering the sanitary system. Because the source of stormwater inflow and infiltration can be difficult to identify, engineering solutions are challenging to design. Funds are included in the Investment Strategy to address this issue in the basins most impacted. These basins are concentrated in southwest Portland.

The pumping and treatment systems require regular and more frequent capital investment. While pipes have an estimated 100-year useful life, mechanical and electrical components have a useful life that ranges from 20 to 50 years. In general, all of the pump stations and Columbia Boulevard Wastewater Treatment Plant have sufficient capacity. However, Tryon Creek Wastewater Treatment Plant requires capacity upgrades to serve future growth projections and meet expected regulatory requirements. Projects to address both condition and capacity are included in the proposed Investment Strategy, see Appendix A.

Capacity issues for stormwater outside the combined sewer system vary by watershed. Unique challenges exist in the west hills, in the outer east buttes, and along the Columbia Slough. All of these locations have underserved areas, due to deficiencies in the built stormwater system (e.g., undeveloped right-of-way), or natural conditions that limit infiltration and on-site stormwater management, or make building new piped systems very costly or technically infeasible. All of Portland’s major waterways, which are part of the stormwater conveyance network, are water quality limited due to temperature and/or contaminants and the habitat, hydrology and native fish and wildlife species are impacted by stormwater runoff. A number of projects to address stormwater conveyance and/or water quality are included in the proposed Investment Strategy.
Key Issues and Concerns

Serving Existing Residents: Wastewater

Both Portland’s combined sewer system and its sanitary sewer system have hydraulic and condition deficiencies that impact the ability of these systems to serve existing properties at designated service levels. These deficiencies can result in higher risks for sewer backups, surcharging, and/or overflows. The greatest concentration of combined sewer pipe segments with capacity problems is located in the older central neighborhoods. The majority of the sanitary sewer system pipes have adequate capacity, however there are deficiencies, concentrated in the southwest (Fanno and Burlingame basins) where the system is impacted by stormwater entering the sanitary sewers.

Pipe segments that are in poor structural condition are widely distributed throughout the service area with the exception of outer east Portland where the collection system is relatively new.

Small geographic areas within the urban services boundary continue to treat sanitary sewage using some type of onsite system such as a cesspool or septic tank and drainfield. Development of new onsite systems is discouraged by the state and the county (the permitting authority) because of the high risk of bacterial contamination to surface and ground water. A program to extend sewers to some of the unserved areas is included in the proposed Investment Strategy. However, it is important to note that it may not be technically or financially feasible to provide sewer service to all properties within the USB.

Serving Existing Residents: Stormwater

In areas not served by the combined sewer system, most stormwater is conveyed through pipes, ditches, or drainageways to streams and rivers. In parts of both the combined and separated sewer basins stormwater from the right-of-way or city property is filtered into the ground through sumps (UICs). See Figure 6.1. In some cases, stormwater is managed in detention facilities, other vegetated facilities, or allowed to infiltrate in natural areas. Safe conveyance of stormwater is an issue in some areas, particularly in the hilly areas of west Portland and some parts of outer southeast which lack comprehensive conveyance systems and where infiltration is limited by geology or high groundwater. In some cases, solutions may not be technically or financially feasible.

Flooding continues to be an issue, particularly in the Johnson Creek area. The City is working with partners to restore more natural stream and floodplain conditions to manage 10-year storm events along Johnson Creek.

Maintenance of Existing Infrastructure

For 2013, sanitary and stormwater systems have an estimated annual capital maintenance funding gap of $12.4 million, including $2.4 million in combined sewers and $10 million for stormwater. The long-term financial forecast anticipates significant increases in the capital maintenance budget as the system continues to age. BES is applying new technologies and collecting improved data on its assets allowing for enhanced analysis, planning, and targeted implementation of corrective action.
The bureau’s operating resources for operational maintenance needs are strained across all asset types. As of July 2012, the city’s stormwater system included more than 1,900 water quality facilities including green streets, vegetated swales, constructed wetlands, and ponds. In addition, the City owns nearly 9,000 UICs and thousands of storm inlets, trash racks and sedimentation manholes. Although green infrastructure such as green streets and swales can have lower overall life cycle costs (capital and operating combined) than a piped solution, these facilities require more regular maintenance to be effective. As the Bureau’s portfolio of stormwater infrastructure assets increases, additional operating resources are needed for maintenance. Increases to the operating budget have not been supported in recent years.

Meeting Regulatory Requirements

Bureau projects and programs address a wide range of regulations that focus on protecting human and environmental health. Major mandates stem from five federal acts: the Federal Clean Water Act, Safe Drinking Water Act, Water Resources Development Act, the Endangered Species Act, and Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). Whenever possible, the Bureau’s approach to addressing regulatory requirements is to take a comprehensive “watershed approach” to achieve broader environmental health and other city goals. Projects to address known regulatory requirements are included in the proposed Investment Strategy. Looking ahead, potential changes in regulatory mandates or permit conditions could present additional financial challenges for the Bureau. More information on regulatory requirements and the watershed approach can be found later in this chapter.

In December 2000, Portland Harbor was listed as a Superfund site by the federal government because there is contaminated sediment in the river. The City is one of more than 100 parties that have begun a voluntary settlement process for allocating costs of investigating and cleaning up Portland Harbor. The Portland City Council designated the Bureau of Environmental Services as the lead agency for the City regarding City concerns in the Portland Harbor cleanup. If it is determined that the City’s activities contributed contamination to the sediments, the city may need to participate in and pay for some of the cleanup work in the harbor. Because cleanup actions have not yet been determined, cleanup costs are not known at this stage. Therefore, no projects are included in the proposed Investment Strategy.

Accommodating Growth

The Bureau of Environmental Services plans for its facilities based on build-out densities allowed within the comprehensive plan land use densities. The Bureau expects to be able to maintain and improve the sewer systems to accommodate growth as long as sewer and stormwater rates are sufficient to meet capital investment needs.

The geographic distribution of new growth is potentially a concern for all BES services – sanitary sewer, stormwater management, and protection and improvement of watershed health. In parts of the city, it is difficult to provide traditional constructed sanitary and/or stormwater systems, both from a cost and engineering perspective. Coordinating growth and density in centers and corridors in areas with good infiltration or where constructed stormwater management is technically and economically feasible will help
address these concerns. Development of some currently underdeveloped areas may be limited by options for sanitary sewer service and/or stormwater management.

**Climate Change**

Climate change is expected to influence local hydrology, habitat, and water quality. Preliminary analysis regarding anticipated local impacts suggests that changing weather patterns and temperatures may affect local stormwater management, wastewater treatment, and watershed health. It is not possible to accurately predict the degree of change in climate variables; therefore an adaptive management approach is necessary. The climate variable with the most potential to cause problems for the stormwater system is changes to winter rainfall patterns.

Most of the stormwater pipes and sumps (UICs) in Portland have been in place for decades and were sized with assumptions about climate and land use that were appropriate at the time they were built. Some of these systems are already experiencing problems with the increased runoff caused by increased impervious area. Changing rainfall patterns during the winter months could exacerbate this problem. It could also cause increased erosion and sediment in stormwater runoff. Sediment can clog pipes, make greenstreet facilities less effective, and deteriorate water quality of receiving streams.

The combined sewers could also be impacted by changing rainfall patterns with the added concern of the potential for more frequent combined sewer overflows (CSOs). During very heavy rain storms, runoff from buildings, streets, and other impervious surfaces impacts combined sewer capacity potentially causing overflows.

Climate change predictions include higher summer air temperatures and resultant increases in water temperatures. When wastewater temperatures increase, the dissolved oxygen content decreases and the biological activity of wastewater treatment processes tend to increase. Higher temperatures could result in increased odor production in the collection system and increased oxygen requirements for some biological treatment processes.

Increased temperatures and shifts in the timing and amounts of precipitation could also affect the region's natural systems. These changes are likely to stress and change vegetation, including vegetated facilities (such as green streets, ecoroofs, and rain gardens), and natural areas, particularly wetlands and streams, that we depend on to manage stormwater naturally. Risk of wildfires, floods, and invasive plants and animals are expected to increase. These changes may make it more difficult to meet water quality standards, lead to increasing or more restrictive regulations especially as more fish and wildlife species are listed as threatened or endangered due to changes in habitat, and may lead to higher operations and maintenance costs for infrastructure.

**Sanitary Sewer and Stormwater Rates**

Construction of the recently completed $1.4 billion combined sewer overflow control (CSO) facilities has increased sewer and stormwater rates significantly over the past two decade. The CSO program and other capital projects are financed through bond sales. Bond repayment terms vary from 20 to 30 years. Approximately one-third of the bureau’s annual budget is allocated to debt payments. Portland’s rates are
high by regional and national standards; however, this is expected to change as other cities begin to undertake combined sewer overflow control capital projects. Planned operations and maintenance of, and capital improvements to, the sewer and stormwater systems will depend on continued predictable increases in sewer and stormwater rates. Continued public acceptance of rate increases is essential to meeting level of service standards and will require open and clear dialog with the public and decision makers.

Investment Strategy Summary

The work of the Bureau is focused on strategic and comprehensive project and program delivery to protect public health and restore the environment. The Bureau anticipates an annual average capital improvement program of $100 million or approximately $2 billion in capital investment over the next twenty years. Using a risk-based asset management approach, the Bureau budgets to maintain infrastructure and protect or enhance natural systems to meet regulatory requirements and enhance the health of watersheds. Asset management is a tool that addresses life-cycle costs, trade-offs between capital and operating expenditures, and prioritization of projects based on consequence and likelihood of failure, to achieve long-term system sustainability and acceptable levels of service. This approach is reflected in the Bureau’s operating budget as well.
Regulatory Compliance

Environmental Services’ projects and programs are largely guided by, or in response to, several federal regulatory mandates related to wastewater, stormwater, and natural resources. These regulations are focused on protecting human health and the environment, in line with the bureau’s mission. Integrated planning efforts, including a comprehensive view of watershed health, guide the Bureau’s response to many of these regulatory mandates. The watershed approach outlined in the 2005 Portland Watershed Management Plan provides a framework to coordinate and integrate regulatory response to achieve efficiencies and address the larger goals of clean and healthy rivers, while addressing issues and regulatory drivers such as flooding, contaminated sediments, or water quality in streams. Key regulatory mandates are described below. Except where otherwise indicated, projects and programs to address known mandates are included in the proposed Investment Strategy. While not recognized in the Investment Strategy in this document, the bureau also invests in programs such as outreach and education which have been determined to be cost-effective elements for effective service delivery.

Clean Water Act

The Clean Water Act (CWA), first adopted in 1978, establishes the basic structure for regulating discharges of pollutants into the waters of the United States and regulating the water quality of surface waters. Several aspects of the CWA apply to the work of the bureau.

National Pollutant Discharge Elimination System Permits

The National Pollutant Discharge Elimination System (NPDES) permitting program was developed to control the discharge of point and certain non-point sources of pollution to the nation’s waters. The NPDES program is administered in Oregon by the Department of Environmental Quality (DEQ). Several different types of NPDES permits apply to BES:

- **Wastewater Program**
  
  Portland has NPDES Waste Discharge permits for treated municipal wastewater discharges from the Columbia Boulevard Wastewater Treatment Plant (CBWTP) and the Tryon Creek Wastewater Treatment Plant (TCWTP). The permits include water quality-based effluent limits and requirements for programs for pre-treatment, ‘Fats, Oils, and Grease,’ and illicit discharge response. In addition to the treatment plants, both sanitary sewer overflows (SSOs) and combined sewer overflows (CSOs) are regulated under this permit.

- **Stormwater Program**
  
  Portland has a Phase I NPDES permit for stormwater discharges from the municipal separate storm sewer system (MS4). The regulations do not prescribe specific pollutant discharge limits, rather they allow for the implementation of Best Management Practices to improve water quality to the “maximum extent practicable” based on location conditions, resources, and priorities. The City’s compliance approach is outlined in the Stormwater Management Plan (2011) which includes the following elements: development standards; industrial and commercial controls; illicit discharge detection and elimination; structural controls; operations and maintenance; preservation and restoration of natural areas; and public involvement.
- **Industrial Stormwater Program**
  Portland is the agent for DEQ for administration of 1200-Z and 1200-COLS industrial stormwater permits within its jurisdiction. Some types of construction stormwater permits, such as 1200-C permits for large construction sites, are administered directly by DEQ.

**Capacity, Management, Operations, and Maintenance (CMOM) Regulations**

CMOM is a requirement of the CBWTP permit. It requires the bureau to improve the performance and reliability of the sanitary and combined sewer systems. Consistent with the 2011 NPDES Permit for CBWTP, BES submitted a Draft CMOM Program Report to DEQ in June 2013. The CMOM program is intended to reduce the likelihood of sewer releases by improving the overall reliability of the sanitary and combined sewer collection system. The strategies and activities defined align with the asset management approach to managing, operating, and maintaining the wastewater collection system. The approach uses risk-based strategies for the development, reinvestment, operations, and maintenance of the system.

**Water Quality Standards and Total Maximum Daily Load Programs**

Section 303 of the Clean Water Act established programs to develop and implement water quality standards and limits for pollutants received by water bodies. DEQ is responsible for developing water quality standards and total maximum daily loads (TMDLs) in Oregon. TMDLs specify the maximum amounts of certain pollutants (including heat) that a particular body of water is allowed to receive without exceeding water quality standards. The goal is to protect beneficial uses such as recreation, cold water fisheries (such as salmon), and municipal and industrial water supplies.

The City is responsible for addressing Environmental Protection Agency (EPA)-approved TMDLs in the Lower Willamette mainstem and its tributaries, as well as in Tryon, Fanno, and Johnson Creeks; and the Columbia Slough.

**Amended Stipulated Final Order (CSO Program)**

In 1991, BES entered into a legal agreement with DEQ concerning the city of Portland’s CSO-abatement program, because overflows from the combined sewer system violated water quality standards for the Willamette River and the Columbia Slough. Completion of the CSO controls program in 2011 was a major milestone. Of relevance to this CSP, the agreement requires Portland to continue to further reduce CSO discharges using cost-effective methods that achieve other mission-based objectives such as watershed health, stormwater management, and wastewater operations and treatment. The Post-2011 CSO Facilities Plan was submitted on September 2010 and approved by DEQ in February 2011.

**Safe Drinking Water Act**

The Safe Drinking Water Act mandates a variety of programs to protect drinking water supplies. While the Portland Water Bureau is the primary entity regulated by this Act, Environmental Services does have to comply with a sub-set of the regulations through its UIC Program.
Underground Injection Control (UIC) Program

The National UIC Program was enacted in 1974 under the Safe Drinking Water Act. In Oregon, the program is administered by DEQ. In 2005, DEQ issued the City a Water Pollution Control Facility (WPCF) permit for stormwater discharges to approximately 9,000 city-owned UICs. The ten-year WPCF permit regulates the construction, operation, and maintenance of all City-owned UICs. The permit required the development and implementation of a UIC Management Plan, describing the measures the City will implement to control pollutants prior to discharge to a UIC to protect groundwater as a drinking water resource. The UIC Management Plan (2008, revised 2012) includes the following elements:

- Systemwide inventory, assessment and evaluation to determine compliance, prioritization and response actions.
- System management to prevent, minimize and control stormwater prior to discharge, including operations and maintenance, spill prevention and pollution control.
- Stormwater Discharge Monitoring Plan (2006, revised 2012) for data collection and evaluation to demonstrate public UICs are operated in a manner that protects groundwater as a drinking water resource.
- Corrective Action Plan (2006) to evaluate, select, and implement actions to address UICs that do not meet permit conditions.

The City has completed a significant amount of work to ensure compliance with the permit.

Endangered Species Act (ESA)

The Endangered Species Act (ESA) regulates the conservation of threatened and endangered plants and animals and the habitats in which they are found. All eight species of salmon and five species of steelhead that spawn, rear and migrate through waterways in the Portland area are listed as threatened or endangered under the ESA. In addition, ESA-protected Pacific Eulachon (smelt), Bull Trout and Green Sturgeon are present in the Columbia and Willamette Rivers and some local tributaries. Streaked Horned Lark (a bird found primarily in the Columbia Slough) was formally listed as a threatened species in 2013. Pacific lamprey is an ESA candidate species as well.

The basic requirements of the ESA are to avoid harming or harassing the listed species or adversely modifying their critical habitat, and to work to recover these species through the development and implementation of recovery plans. Critical habitat is federally identified and mapped. Portland’s waterways are designated as protected critical habitat, which triggers specific requirements for any projects including City infrastructure projects, that involves federal actions such as funding or permitting.

The National Oceanic and Atmospheric Administration Fisheries, the federal agency with jurisdiction over salmon and steelhead, adopted a federal recovery plan for salmon and steelhead in the Lower Columbia River, including Portland, in 2013. BES recently signed a conservation agreement with the USFWS and 15 other state and federal partners regarding lamprey.

The City has a multi-pronged approach to comply with the ESA and advance the recovery plan. BES leads the City’s ESA program and a streamlining team for city projects requiring ESA permits. Plans and
projects that help achieve other City objectives, such as culvert replacement, stream bank restoration and riparian protections, erosion control and revegetation, watershed monitoring, zoning, and climate change planning are part of the City’s ESA response and critical to species recovery. Several city bureaus have programs and projects related to species recovery; BES implements those projects that are related to its sewer and stormwater mission.

**Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA – Superfund) and Portland Harbor Cleanup**

The Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA, also known as Superfund) was enacted in the wake of the discovery of toxic waste dumps in the US, such as Love Canal and Times Beach in the 1970s. It allows the U.S. Environmental Protection Agency (EPA) to clean up such sites and to compel responsible parties to perform cleanups or reimburse the government for EPA-led cleanups.

In December 2000, the EPA listed a portion of the Lower Willamette River, known as Portland Harbor, as a Superfund site under the federal National Priorities Listing process. The Portland Harbor Superfund investigation is currently focused on a stretch of the Willamette River from River Mile 2 to River Mile 11.8, roughly the area from the Broadway Bridge to just short of the confluence with the Columbia River. The City operates stormwater and combined sewer overflow outfalls within the Portland Harbor area. The outfalls drain City-owned rights-of-way, industrial, commercial, residential, and vacant lands.

Under an intergovernmental agreement, the City and Oregon DEQ are working to identify sources that discharge significant contamination to the municipal conveyance system and to control these sources to reduce contaminant loads. The City is working closely with DEQ and EPA to develop a comprehensive plan to address future stormwater discharges under state and municipal programs to prevent recontamination of the harbor after clean up. If it is determined that the City’s activities contributed contamination to the sediments in Portland Harbor, the city may need to participate in and pay for some of the cleanup work in the harbor. Because cleanup actions have not yet been determined, cleanup costs are not known at this stage. Therefore, no projects are included in the proposed Investment Strategy.

**Goals & Policies**

Draft Goals and Policies related to Sanitary and Stormwater Facilities and services can be found in Chapter 5. Key Infrastructure Policies.
Wastewater and Stormwater Systems

Systems Overview

Environmental Services provides sanitary sewage and stormwater collection through a complex set of infrastructure systems that are closely intertwined with the natural systems of Portland’s watersheds and the historical development of the city. Wastewater and stormwater are conveyed through either combined pipes (wastewater and stormwater in a single pipe) or separated pipes (sanitary only or stormwater only). The combined and sanitary sewage pipes convey flow to one of the city’s two wastewater treatment plants. In the separated area, stormwater is conveyed via pipes, ditches, swales, and natural drainageways, or simply flows overland to surface water (streams or rivers) or underground sumps (UICs). In portions of the combined sewer area, stormwater is also collected from the right–of-way or city property and discharged to UICs. See Figure 6.1, System Overview.

BES uses both “gray” (primarily pipes and pumps) and “green” infrastructure. Green infrastructure is a part of stormwater management in both the combined and separated stormwater areas. Green infrastructure solutions (such as trees, ecoroofs, natural areas, and green streets) capture and filter precipitation and urban runoff that may otherwise drain into the sewer system or directly into rivers and streams without benefit of pollution or velocity reduction. Green infrastructure can sometimes be the most cost-effective solution to protecting the piped infrastructure system. It can also contribute to other goals, such as climate change adaptation and mitigation. While the bureau owns and maintains an extensive stormwater management system, BES also relies on stormwater management infrastructure (particularly green infrastructure) that it does not own or control as formal assets. Portland’s stormwater system depends on management and expansion of the city’s tree canopy and natural areas that intercept rainfall, keeping it out of pipes and filtering it naturally. Natural streams and drainageways, although not owned by the bureau, are a critical part of the water conveyance network. Green infrastructure components of the stormwater system may be owned or managed by private property owners, other bureaus (most often, Portland Parks & Recreation), and other institutions and agencies (such as schools, the Oregon Department of Transportation (ODOT), and others).

BES conducts system planning to identify, characterize, and analyze (model) its systems. System plans recommend projects and programs to address condition, capacity, meet regulatory requirements, and growth goals. System planning is driven by an asset management approach (described below) and increasingly integrated with watershed planning. BES has current system plans for the combined and sanitary sewer system, the two wastewater treatment plants, but not for its pump stations or pressurized force mains. Stormwater system planning is underway.
Figure 6.1 Systems Overview
Portland’s Watersheds

BES’s sewer and stormwater systems are managed to protect or enhance human and environmental health and Portland’s watersheds, see Figure 6.2. Each watershed has distinct characteristics and conditions, described below, which are relevant to existing and future infrastructure system planning and investments. All of Portland’s watersheds include waterways that are TMDL-listed for water quality and have critical habitat for ESA-listed salmonids.

In 2006, Portland City Council adopted the Portland Watershed Management Plan (PWMP) in order to focus the City’s efforts to protect and restore Portland’s natural systems. The PWMP lays out an integrated set of strategies to improve watershed health, and provides a framework to coordinate and integrate responses to some of the City’s regulatory requirements. A healthy urban watershed has the hydrologic, habitat, and water quality conditions suitable to protect human health and viable ecological functions and processes, including self-sustaining populations of native fish and wildlife species whose natural ranges include the Portland area.” The City’s and BES’s goals under the PWMP are to achieve improvements in hydrology, water and sediment quality, habitat, and biological communities. Both the Portland Plan and the updated PWMP Implementation Plan (2012) reinforce the importance of improving watershed health through repair and maintenance of existing infrastructure, investment in built and natural stormwater infrastructure, environmentally-friendly development and the protection, enhancement and restoration of natural resources. While BES is the lead bureau for watershed health, implementation of the PWMP depends on the efforts of several city bureaus and coordination with other agencies and non-governmental entities. Watershed projects related to BES’s mission are included in the Investment Strategy.

To inform future investments, the Bureau conducts comprehensive watershed monitoring to track changes in watershed health over time—including water quality trends. Now in the fourth year of monitoring, the Portland Area Watershed Monitoring and Assessment Program (PAWMAP) is establishing consistent citywide data through an efficient sampling approach modeled after EPA protocols. Every year BES samples a subset of the 298 inventoried miles of streams in Portland. Of the stream reaches sampled and analyzed so far, none meet the city’s water quality benchmarks, in large part because of mercury and total suspended solids. Targets for in-water large wood, an indicator of in-stream habitat function and complexity, have been achieved in only 13% of the sampled reaches, and only 2.5% of sampled stream reaches meet the standard for a healthy macro-invertebrate population. (Macro-invertebrates include all species with exterior skeletons, including insects, which are a critical part of the food chain and an indicator of overall environmental health.) In sum, Portland's streams generally are not considered functional for water quality, habitat, and biological communities. Impervious area (roads, parking lots, and rooftops) covers between 22% and 40% of Portland’s watersheds, generating large
quantities of stormwater runoff and disrupting the natural water cycle. Due to implementation of public and private stormwater management approaches, including surface water quality facilities like green streets and rain gardens, some of this impervious area is managed. However, effective impervious area—the runoff that remains unmanaged—ranges from 12% in the Johnson Creek watershed to 28% for the mainstem Willamette watershed.

Portland’s six primary watersheds are described in more detail below. Specific stormwater system descriptions and challenges for each watershed are in the Stormwater System section.

**Portland Willamette River Watershed**

The Willamette River Watershed in Portland is only 0.5 percent of the Willamette River’s total drainage basin, which covers more than 11,000 square miles in western Oregon. Within the City of Portland, the watershed encompasses 69 square miles of land. Other city watersheds—Johnson Creek, Fanno Creek and Tryon Creek—drain to the Willamette River. The river flows north through the downtown core to the Columbia River and serves industrial, residential, commercial, and recreational uses. The highly altered stretch of the river through Portland is the gateway to the entire Willamette Basin for salmon, steelhead, lamprey, and other native fish and wildlife. Despite heavy urbanization, valuable habitat for feeding refuge, rearing, and mating still exists in this portion of the watershed. The river is also a significant place for people to encounter nature through active or passive recreation, and the working harbor is a major economic driver for the region.

The watershed includes the central city and much of inner southeast and northeast Portland, which is highly developed and covered by impervious surface, although relatively flat and with generally good infiltration. The watershed also contains Forest Park and several other large parks and open space areas, and includes smaller tributary streams on the west side of the river that are not part of the Fanno or Tryon Creek basins.

The Willamette River has water quality limitations, including established TMDLs for temperature, bacteria, and mercury. Completion of the Combined Sewer Overflow (CSO) Program in 2011 significantly reduced CSO discharge events to the Willamette River, which improved one aspect of river health, but more work remains to address water quality and habitat in the main stem river. Nine miles of the main stem Willamette River in Portland are designated as a federal Superfund site. In the west side tributaries, water quality challenges and stormwater-related high flows in natural channels lead to degradation of the physical and biological characteristics of these tributary systems. Protection and restoration of remaining natural areas on the Willamette escarpment and in the west hills are important to connecting existing high-quality habitat, preserving the natural hydrologic function of steeply sloped areas, and preventing further water quality impacts in the main stem river.
Figure 6.2 Portland Watersheds
Columbia Slough and Columbia River Watersheds

The Columbia Slough Watershed extends along the Columbia River shoreline and through north and northeast Portland to Alameda Ridge. The watershed drains approximately 51 square miles of land and is defined by the 19-mile long main channel (the slough) as well as approximately 30 miles of secondary waterways. The Upper Columbia Slough is a highly managed system, with piped stormwater, dikes and levees, and a system of pumps that provide area drainage and flood control. The lower nine miles of the slough—from NE 18th Avenue to Kelley Point Park—are tidal and directly connected to the Willamette River. The lower slough provides valuable habitat for migrating juvenile Columbia River and Willamette Basin salmon. The slough provides recreation and access to nature for the metro region, particularly underserved neighborhoods in north and northeast Portland. The Columbia South Shore Well Field, part of Portland’s drinking water supply, is located in this watershed.

The watershed is an important economic and transportation hub, the location of thousands of jobs as well as 170,000 residents. Much of the northern section of the watershed has industrial land uses on large parcels. More information on the slough’s unique stormwater management considerations is in the stormwater system section. Completion of the CSO program greatly reduced sewage overflows to the Columbia Slough, which has improved water quality.

However, the slough remains water quality limited, with established TMDLs for temperature, bacteria, nutrients, and toxics. Low levels of contamination in the sediment are also widespread. In 1994, the City of Portland established a Consent Order with DEQ related to sediment. The City entered the Voluntary Clean Up Program in 2006. The City and DEQ have adopted an approach that includes reducing pollutant sources, cleaning up specific sites, and long-term monitoring to track how the slough is responding to watershed management actions. BES has completed a predesign that identifies priority city-owned stormwater outfalls that need pollutant reduction facilities.

Protection of valuable natural resources like Smith and Bybee Wetlands and Big Four Corners Natural Area, ongoing work to revegetate the banks of the slough, construction of green street facilities, and stormwater pollution controls by businesses along the slough are improving conditions in the Columbia Slough watershed, but significant challenges remain.

The Columbia River watershed in Portland is a fraction of the river’s overall drainage basin in North America and covers just over one square mile of the City of Portland along the river’s south shoreline and Hayden Island. The City provides stormwater and sewer services to the residents and businesses in this area, and the Columbia Boulevard Wastewater Treatment Plant discharges Portland’s wastewater effluent to the Columbia River. While development on Hayden Island is concentrated on the eastern side, the western portion is outside the City’s service area and remains undeveloped. The island provides rare shallow water habitat and riverine woodlands. The Columbia River south shoreline is leveed for approximately 11 miles and the drainage districts are responsible for flood control in this area.

Johnson Creek Watershed

The Johnson Creek Watershed encompasses approximately 54 square miles of land, over half of which lies outside the City of Portland. Johnson Creek originates in Clackamas County east of Boring, Oregon,
and flows west approximately 25 miles to its confluence with the Willamette River. The watershed has a mix of land uses: agricultural, commercial, light industrial, and residential. Salmon, steelhead, and other native fish are found in significant portions of the watershed. Johnson Creek provides some of the city’s best opportunities for native species recovery.

Fifteen miles of the creek channel is lined with concrete and rock from Works Progress Administration (WPA) attempts to control flooding in the 1930s, which has exacerbated storm-related flooding, particularly in the Lents neighborhood. In addition, development in the East Buttes area has disturbed natural drainageways, seeps, and springs that are an important part of the hydrologic cycle, and the entire creek has low flows during the summer.

Agricultural runoff, particularly in the headwaters (outside City limits), and legacy pollutants such as DDT are a significant challenge to stream health. Remediation efforts require collaboration among multiple jurisdictions. The creek has established TMDLs for bacteria, temperature, and toxics.

Through the implementation of the Johnson Creek Restoration Plan (JCRP), the City and partners have purchased more than 260 acres of frequently flooded property and are removing WPA alterations and restoring the natural stream channel. The goal of the JCRP is to curb impacts from nuisance flooding while improving water quality and habitat, reversing the damage from earlier attempts to control flooding that altered the natural channel of the creek. Several floodplain restoration projects completed in the past ten years are making cumulative improvements in the natural resource functions of the watershed, and additional priority projects are planned.

**Fanno Creek and Tryon Creek Watersheds**

The Fanno Creek Watershed covers approximately seven square miles of land in southwest Portland. The balance of the watershed’s 32 square miles is mainly in Washington County. Several of the tributaries to Fanno Creek provide cool water and habitat for native fish, and Fanno Creek itself is a tributary to the Tualatin River.

Stormwater flows into stream channels and into Fanno Creek or is managed by the storm sewer system and surface water facilities. Impervious area from development, combined with local geology and steep slopes, results in highly variable flows that impact streams. Fanno Creek has water quality challenges, including established TMDLs for temperature, bacteria, and nutrients.

The Tryon Creek Watershed covers approximately six square miles of southwest Portland. About 21 percent of the watershed is outside the City of Portland’s boundary in the jurisdictions of Multnomah County, Clackamas County, and the City of Lake Oswego. Most of the development is concentrated in the upper part of the watershed where impervious surfaces cover significant area. Tryon Creek State Natural Area and other parks and natural areas provide valuable, but fragmented, habitat. Native resident fish are found in the creek, but salmon and other migratory fish are largely excluded by the culvert under Highway 43 near the mouth of the creek.

Stormwater in this watershed flows quickly across soils that are slow to infiltrate and down steep slopes into stream channels that flow into Tryon Creek. Runoff from major transportation corridors including I-5
and Barbur Boulevard discharges to Tryon Creek or its tributaries. The creek has water quality challenges, including established TMDLs for temperature and bacteria. Stream bank erosion, channel incision and simplification, and fine sediment deposition are issues in both the Tryon and Fanno Creek watersheds. The Fanno/Tryon Watershed Management Plan calls for a dual approach in Tryon Creek of managing stormwater runoff, to reduce impacts to streams, especially in the upper watershed, while restoring and protecting existing natural areas to preserve the natural functions of the water cycle. In Fanno Creek Watershed, the primary focus is on managing stormwater runoff from commercial corridors and high-traffic streets.

**Asset Management Approach**

Although BES began incorporating asset management into its business practices more than 20 years ago, in 2010 the Bureau launched an Asset Management Improvement Program to better define asset management principles and practices as they should be applied to BES assets, identify opportunities for improvement, and establish a framework for implementing improvements. This helps the bureau prioritize investments within and across the different systems (sewage conveyance, treatment, and stormwater management). Asset management is a dynamic process, and the bureau’s implementation of asset management varies by system and asset types.

The focus of the asset management approach is assessment and mitigation of business risk. Business risk is calculated as the product of consequences of failure to meet levels of service and likelihood of failure. In determining the consequences of failure to meet levels of service, the following triple bottom line risk factors were used:

- economic, including impacts on operations, maintenance, and/or replacement and emergency costs,
- environmental, including impacts on physical habitat, biological communities, and/or compliance with regulations, and
- social, including impacts on public inconvenience and perception and/or public health and safety.

Starting with these triple-bottom-line asset management factors, staff identified specific risks and associated dollar values for individual consequences of capacity and structural failures. The potential consequences of pipe failure include sewage backing up into private property, sewage overflows to the surface, and/or sinkholes opening to the surface.

Likelihood of failure is the probability an asset will fail. For structural deficiency risk, likelihood of failure was determined from condition assessment data and literature curves that relate pipe condition grades to remaining useful life for different pipe materials. For capacity deficiency risk, likelihood of failure was estimated by computer model simulation of flows for storms with different frequencies and under existing and future development conditions.

Sewer pipe segments were evaluated using a geographical information system (GIS) database tool to prioritize and map potential spot repairs and whole pipe rehabilitation/replacement. The database includes information from pipe inspection regarding condition, grade, and defects of the pipe as well as data concerning consequence of failure, likelihood of failure, estimated cost, and prioritization. This pipe
rehabilitation tool was utilized to identify rehabilitation/ replacement needs for the sanitary and combined sewer collection systems.

Pipe assets were evaluated to determine the current and potential future capacity risk. Alternatives were developed to address capacity and structural risks and were evaluated for cost-effectiveness in addressing level of service goals including reducing sewage backups into basements in the combined system. In the sanitary system, rainfall derived infiltration and inflow (RDII) is the biggest cause of capacity deficiencies. The effects of RDII were evaluated for the pipelines and pump stations using flow monitoring data and/or modeling assumptions based on pipes of similar age and location.
Wastewater Collection System

Wastewater is collected and conveyed via either combined sewers or separated sanitary sewers. Sewage is collected and transported through a combination of gravity pipes, pump stations, and pressurized force mains to major interceptors that convey the sewage to one of two wastewater treatment plants.

Wastewater Collection System Inventory

The collection system consists of a network of approximately 1,900 miles of collection system piping (1,000 miles of sanitary sewer, 885 miles of combined sewer, and 13 miles of sewers Portland maintains by agreements with other agencies), ranging from six inches to 22 feet in diameter. The system includes 39,760 access structures, 57 miles of force mains, and 25 outfalls. The City is responsible for operation and maintenance of 97 pump stations (80 that are owned by the City; six owned by other public agencies and 11 privately-owned septic tank effluent pumping (STEP) systems). The total wastewater service area is approximately 92,500 acres.

The combined sewer system collects and transports sewage and stormwater flow in a single pipe network to the CBWTP for treatment. It is divided into 41 basins, which are grouped into four major CSO service areas: West Side Willamette, East Side Willamette, North Willamette, and the Columbia Slough, see Figure 6.3. This area is approximately 31,700 acres in size and is bounded on the north by the Columbia Slough, on the south by Johnson Creek, on the west by the Portland West Hills, and on the east by 82nd Avenue (approximately). It includes most of downtown Portland and many older residential areas.

In the combined system, raw sewage is collected from local properties and stormwater runoff is collected from the public right-of-way, rooftops, parking areas, and other impervious surfaces. The system includes publicly-owned stormwater control facilities (such as green streets and sumps) that divert stormwater from the pipe system and 14 pumps stations. The city also relies on privately-owned vegetated stormwater facilities such as rain gardens, to reduce stormwater volume entering the combined system. Combined sewage is conveyed through a series of collector sewers and trunk sewers to diversion structures located at the downstream ends of the basins. The diversion structures route the combined sewage from the basins into the interceptor system that conveys the flow to the CBWTP. When capacity is not available in the interceptors, the diversion structures overflow to the CSO control facilities (storage tunnels and pumping systems) to deliver captured CSOs to the CBWTP for treatment. During large, infrequent storms when the tunnels fill, the excess combined sewage spills over the control dams in the tunnel shafts and discharges to the Willamette River or the Columbia Slough.

The sanitary sewer system includes the network of pipelines and pump stations that collect and convey wastewater only. The area served by sanitary sewers is divided into 29 basins, totaling 60,800 acres, and covering most of outer east and southwest Portland, see Figure 6.3. The basins are defined by the network of sanitary sewers that collect wastewater and convey it to either a major sanitary trunk sewer or a combined interceptor sewer. Seventy-four of the City’s pump stations pump separated sanitary flow of

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2 BES has defined multiple basins for the combined sewer, sanitary sewer, and stormwater systems. Basin boundaries are based on the routing of flows to downstream discharge locations. The basins are delineated separately for each type of sewer – combined, sanitary, and stormwater. Within one watershed, there may be combined sewer basins, sanitary sewer basins, stormwater basins, or a combination of each.
which 55 are located in the Columbia Slough Service Area. The sanitary flow from the Tryon Creek Service Area (Tryon Creek and Dunthorpe-Riverdale basins) is treated at the Tryon Creek Wastewater Treatment Plant.

Flow from the Durham Service Area (Skyline and Clean Water Service South basins) flows to the Durham Advanced Wastewater Treatment Facility, owned and operated by Clean Water Services of Washington County. Aside from the few customers served by Gresham, the remaining flow is treated at CBWTP.

**Wastewater Collection System Levels of Service**

Levels of service for the wastewater sewer system establish a framework for characterizing system deficiencies, developing and evaluating alternative solutions, and selecting recommended improvements. The following levels of service are specific to the collection system:

- Provide sewage service to support development consistent with the Comprehensive Plan where feasible.
- Customers properly connect and maintain sewer connections per City standards.
- In the combined sewer area, convey combined sewage to prevent releases to buildings or streets up to a 25-year storm frequency (a storm with a 4% chance of happening in any year).
- Prevent combined sewer overflows to frequencies established by the NPDES permit.
- Public sanitary/combined conveyance facilities are maintained in accordance with standards.
- In the separated sewer area, sewage releases to surface waters (SSOs) are prevented for storm events up to a 5-year frequency (a storm with a 20% chance of happening in any year).

The Bureau has evaluated the sanitary and combined sewer pipe systems for structural integrity and the capacity to convey design flows. Pump station capacities have been evaluated to determine whether they could adequately pump the collection system design flows. Characterization of these systems is presented in terms of the risk of not meeting the technical levels of service. The estimated total sewer system capacity and structural deficiency risk is shown in Figure 6.4. In this figure, risk is expressed in dollars per acre and summarized in 25-acre grid cells color coded to signify a risk range. This figure illustrates the areas of the system where total sewer risk is currently highest. The Bureau has included a number of projects in its Investment Strategy to reduce this risk.
Figure 6.3 Sanitary and Combined Sewer Basins and Service Areas
Figure 6.4 Sanitary and Combined Sewer System Risk
Wastewater Collection System Current and Projected Condition

Sewer pipes are inspected to determine both structural and operational condition. Over the past 40 years, most of the collection system has been inspected. Approximately three-quarters of the pipe segments have been inspected over the last ten years. Of the remainder, approximately 65% were constructed within the past 20 years and are therefore assumed to be in excellent condition.

Table 6.2 Pipe Condition

<table>
<thead>
<tr>
<th>Combined Sewer System</th>
<th>Miles</th>
<th>Very Good</th>
<th>Good</th>
<th>Fair</th>
<th>Poor</th>
<th>Very Poor</th>
<th>TBD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipes Total</td>
<td>878</td>
<td>51%</td>
<td>18%</td>
<td>11%</td>
<td>12%</td>
<td>6%</td>
<td>0.57%</td>
</tr>
<tr>
<td>Pipes 8” or less</td>
<td>321</td>
<td>45%</td>
<td>22%</td>
<td>8%</td>
<td>16%</td>
<td>8%</td>
<td>0.93%</td>
</tr>
<tr>
<td>&gt; 8 and &lt; 24”</td>
<td>401</td>
<td>54%</td>
<td>18%</td>
<td>14%</td>
<td>10%</td>
<td>4%</td>
<td>0.25%</td>
</tr>
<tr>
<td>&gt;= 24 and &lt; 36”</td>
<td>68</td>
<td>66%</td>
<td>13%</td>
<td>7%</td>
<td>9%</td>
<td>4%</td>
<td>0.03%</td>
</tr>
<tr>
<td>36” and larger</td>
<td>88</td>
<td>65%</td>
<td>8%</td>
<td>8%</td>
<td>15%</td>
<td>3%</td>
<td>1.14%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sanitary Sewer System</th>
<th>Miles</th>
<th>Very Good</th>
<th>Good</th>
<th>Fair</th>
<th>Poor</th>
<th>Very Poor</th>
<th>TBD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipes Total</td>
<td>1,012</td>
<td>71%</td>
<td>20%</td>
<td>5%</td>
<td>2%</td>
<td>0%</td>
<td>0.40%</td>
</tr>
<tr>
<td>Pipes 8” or less</td>
<td>770</td>
<td>78%</td>
<td>18%</td>
<td>2%</td>
<td>2%</td>
<td>1%</td>
<td>0.13%</td>
</tr>
<tr>
<td>&gt; 8 and &lt; 24”</td>
<td>142</td>
<td>54%</td>
<td>31%</td>
<td>12%</td>
<td>2%</td>
<td>0%</td>
<td>1.41%</td>
</tr>
<tr>
<td>&gt;= 24 and &lt; 36”</td>
<td>50</td>
<td>46%</td>
<td>32%</td>
<td>16%</td>
<td>4%</td>
<td>0%</td>
<td>2.00%</td>
</tr>
<tr>
<td>36” and larger</td>
<td>50</td>
<td>52%</td>
<td>16%</td>
<td>26%</td>
<td>6%</td>
<td>0%</td>
<td>0.00%</td>
</tr>
</tbody>
</table>

As inspections are conducted, structural defects are noted and scored. The condition scoring method for sewer mains uses five grade ranges as shown below:

Table 6.3 Structural Condition Rating System

<table>
<thead>
<tr>
<th>Grade</th>
<th>Condition</th>
<th>Description</th>
<th>Structural Score Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Excellent</td>
<td>No defects or few minor defects</td>
<td>0 - 9</td>
</tr>
<tr>
<td>2</td>
<td>Good</td>
<td>Minor defects or few moderate defects</td>
<td>10 - 99</td>
</tr>
<tr>
<td>3</td>
<td>Fair</td>
<td>Moderate defects that will continue to deteriorate</td>
<td>100 - 999</td>
</tr>
<tr>
<td>4</td>
<td>Poor</td>
<td>Moderately severe defects that will become Grade 5 defects in the foreseeable future</td>
<td>1,000 - 9,999</td>
</tr>
<tr>
<td>5</td>
<td>Very poor/ immediate attention required</td>
<td>Defects requiring immediate attention. (Failed or failure imminent.)</td>
<td>10,000+</td>
</tr>
</tbody>
</table>
All pipes are at risk of structural failure at some point in time. Pipes in poor condition are at risk to fail sooner than pipes in good condition. In accordance with the asset management approach, the business risk of a structural failure for any given pipe is estimated by calculating the potential cost of consequence of failure, estimating the likelihood of failure, and developing a risk distribution as a function of time. To assess structural deficiency risk for the entire sewer system, this process was applied to every pipe in the city’s inventory for the service area. Figure 6.5 shows the 100-year present worth value of structural deficiency risk for all condition Grade 4 and 5 pipes summed by 25-acre grid cells. Only Grade 4 and 5 pipes are shown in this figure because they represent pipe rehabilitation needs within the 20-year planning horizon. The Bureau is in the fourth year of a multi-year $123 million rehabilitation program to address the highest risk pipes. Assuming adequate funding, the Bureau anticipates reducing its highest risk. Unfortunately, the collection system is degrading more rapidly than investment projections.

A significant percentage of the pipe system is concrete pipe installed in the early 1940s. Much of that era’s concrete was of poor quality, so pipes are failing more rapidly than expected from age alone.

Pump stations, components and force mains require more frequent renewal than the gravity pipe system. The Pump Station Improvement Program was established to keep pump stations in good working order to maintain reliability and efficiency within the conveyance system. The program addresses capacity, mortality, reliability, and code compliance. Funding for this program is proposed to increase in future years to allow for timely capital renewal at each of the 97 pump stations. In general, pump stations are assumed to have a 50-year useful life; however, major components require renewal after about 25 years.

Vegetated stormwater facilities (green streets, etc.) in the combined sewer system are not included in this condition assessment, as most of them are relatively new. However, it is important to recognize the fact that these facilities, which reduce stormwater pollutants in the separated system and reduce the capacity demand in the combined sewer system, require regular maintenance to be effective. Budget requests for increased funding to maintain these facilities have not been supported. Lack of maintenance could lead to system failure.

Wastewater Collection System Current and Projected Capacity

To support the capacity and performance analyses of the sewer system, BES developed a highly detailed simulation technique called explicit modeling. The technique is explicit in that it models public and private facilities (manholes, pipes, green streets, onsite vegetated facilities, etc.) and impervious surfaces at the property level. Explicit modeling enables BES to more clearly define the sources of basement sewer backup risk and capacity problems throughout the basins, to efficiently calibrate flow monitoring data with more certainly than traditional models, and to evaluate the cumulative benefits of green infrastructure stormwater controls for streets, parking areas, and roofs.

The models are specific to each sewer basin and three of the interceptors. The basin model calibrations were performed by comparing basin model results against flows measured by temporary flow monitors installed within the basins. For the interceptors, flow data is available from more permanent monitors. The good correlation between the model predictions and the physical measurements at the monitors gives BES confidence in the model’s ability to predict hydrologic and hydraulic response from rainfall events.
Figure 6.5 Structural Deficiency Risk (Sanitary and Combined Sewer Pipes)
The hydraulic capacity characteristics of the combined sewer system are evaluated for five different design storm scenarios: three storms (2-year, 5-year, and 25-year) for existing conditions, one storm (25-year) for future conditions (build out of the Comprehensive Plan), and the 3-year summer storm (Regulatory criteria). Each of the existing-condition design storms represents a different level of risk. The combined sewer system performance measures focus on providing sufficient capacity to eliminate or significantly reduce street flooding risk and basement sewer backup risk for the 25-year design storm under future (2050) conditions. An additional regulatory requirement is to eliminate untreated CSO discharges to the Willamette River from May 1 to October 31 of each year except during storms greater than or equal to a summer storm with a 3-year return frequency under future conditions. Typically, this requirement impacts only the stormwater control facilities and the CSO tunnels and not the balance of the collection system capacity.

The greatest concentration of pipe segments with capacity problems is located in the older central neighborhoods. These capacity problems lead to the risk of the combined sewer backing up into basements during intense storm events. The highest risk of basement sewer backups on the east side of the Willamette River are in an area roughly bounded by NE Prescott Street to the north, SE Holgate Blvd to the south and SE 45th Avenue to the east. On the west side of the river, the highest predicted risk of basement sewer backups is in NW Portland in an area roughly bounded by NW Yeon Avenue to the north, West Burnside Street to the south and NW 23rd Avenue to the west.

The performance measure for identifying locations of potential capacity deficiency is basement sewer backup. Individual tax lots are determined to be at risk for basement sewer backups when the maximum water surface elevation in the sewer pipe is within eight feet of the estimated main floor elevation of the property. The estimated main floor elevation is three feet above the estimated ground elevation. The accuracy of the basement sewer backup risk is limited by the estimated main floor and ground level elevations which were determined with a digital terrain model. In the absence of reliable and systematic data, it was assumed that each tax lot has a basement. In addition to basement sewer backup risk, there is the risk of SSOs, CSOs, and the risk of surcharging of trunk sewers to degradation of pipe material.

The capacity-related sanitary sewer system technical levels of service are for storm events up to a 5-year frequency to convey sewage to prevent releases to buildings or streets and to prevent releases to surface waters. The performance measures for these are the same as for the combined system for basement backups, street flooding, surcharging in pipe constructed of brick, and pipe surcharge for a duration greater than 30 minutes. There is an additional performance measure related to pump stations: Separated sanitary pump stations should have adequate firm capacity to pump the peak hourly and peak instantaneous flows associated with the 5-year, 24-hour storm intensity of its tributary area, without overflows. Firm capacity is defined as the capacity of the pump station with the largest pump out of service.

Most of the sanitary sewer basins meet the service levels for conveyance. Exceptions are the Fanno Creek and Burlingame basins where street flooding and basement sewer backups may occur during storms smaller than the service level design storms. During rain events, stormwater enters the sanitary pipes either through inappropriate connections or through cracks in the pipe material. This Rainfall...
Derived Inflow and Infiltration (RDII) is impacting the capacity of the sanitary pipe system. During intense storms, the Fanno Basin Pump Station is unable to keep up with the additional flow. A capital improvement project is underway to address this issue. The capacity of the Tryon Creek Wastewater Treatment Plant is also impacted by RDII. Capacity upgrades to the plant are discussed below. Note that in this same geographic area, there are other stormwater management issues such as incomplete conveyance systems. These are discussed below as part of the stormwater system.

Figure 6.6 illustrates the present worth of pipe capacity deficiency risk associated with the piped system.

The capacity assessments of city pump stations were performed using basin-wide hydrologic and hydraulic models that estimate the base and peak design storm flows coming to the pump stations from the sanitary and combined sewer systems. The models are based on EPA-SWMM, which simulates the upstream hydrologic inputs including direct storm runoff and hydraulic routing of both the sanitary and wet weather flow components. For the separated sewer areas, the modeling system relies on a site-specific set of regression equations to create generate the RDII flows. The regression equations were developed using the city’s HYDRA rain gauge system data and actual flow monitoring data to define the hydrologic response of the collection system to the rainfall inputs. A calibration assessment was performed to evaluate the quality of the monitoring flow data and the “goodness of fit” for models.

Using this integrated method of EPA-SWMM and regression equations, the full wet weather flow rates from the collection system to each pump station were developed for the appropriate design storm. The estimated flows were then routed in the model through each pump station to determine whether or not the installed station capacity was able to fully convey the design storm. This capacity assessment was performed for both the existing collection system conditions as well as the future (2040-2050) system conditions.

- **No Capacity Deficiencies:** Pump station “Firm Capacity” is able to safely convey the peak design storm flows, which means the station is able to keep one pump in reserve for emergency conditions.

- **Insufficient Firm Capacity:** Pump station must use “Full Capacity” (all available pumps) in order to safely convey the peak design storm flows.

- **Insufficient Full Capacity:** Pump station is not able to fully convey the peak design storms even using all available pumps.

The 14 pump stations in the combined area have sufficient capacity to convey flows. Three pump stations in the separate area have insufficient firm capacity and two have insufficient full capacity. Projects to address these capacity issues are included in the proposed Investment Strategy.
Figure 6.6 Capacity Deficiency Risk (Sanitary and Combined Sewer Pipes)
Providing Sanitary Sewer Service to Unserved Areas

The City’s level of service for wastewater collection is to provide sewage service to support development consistent with the Comprehensive Plan where feasible. In order to identify system needs and serve unconnected areas, properties that are currently not connected to the sanitary sewer system were reviewed to determine whether tax lots met the conditions required for sewer service connection:

- No gravity sewer exists close enough to allow for a lateral to connect to the sewer.
- It must be feasible to provide service to the lot. Pump stations are not considered feasible for fewer than five properties.

There are significant areas currently unserved by sanitary sewers within the USB, primarily in the Johnson Creek and Skyline basins. It is estimated that 1,500 developed properties have some type of on-site sewage system and are not connected to the piped sewer system. Some of these properties are zoned for development; others are already developed with on-site systems such as cesspools and/or drainfields. In some cases, with current technology, it may not be technically or financially feasible to connect these properties to the sewer system. Estimates to serve individual properties range as high as over $1 million. Lack of sanitary sewer service may cause existing developed properties to become uninhabitable and may deem some vacant lots to be undevelopable.

Recommended Wastewater Collection System Improvements

BES developed and evaluated alternatives to address the structural and capacity pipe deficiencies identified during the characterization of the system and to meet the levels of service summarized above.

For pipes with structural deficiencies, the alternatives include whole pipe replacement (which may include lining) or a spot repair. Ongoing monitoring is recommended when the defects do not warrant rehabilitation at this time. The preferred alternative is illustrated in Figure 6.7. Given the age of the collection system, pipe rehabilitation is expected to be an ongoing need.

There are two primary alternatives for providing capacity in the combined system – conveyance or stormwater control. The conveyance alternative is a traditional pipe upsizing approach (replacing existing pipes with larger pipes). The stormwater control alternative uses green infrastructure to detain and/or infiltrate stormwater through vegetated facilities. In the sanitary system, the capacity alternatives include pipe upsizing, pump station expansion, RDII (rainfall derived infiltration and inflow) removal (usually pipe repair or replacement, and wastewater treatment plant expansion. In areas currently unserved by any sanitary sewer system, alternatives have been developed and evaluated to provide new sanitary sewer service where technically and financially feasible. The preferred alternative is illustrated in Figure 6.8.
The recommended plan for the combined sewer system includes projects that reduce basement sewer backup risk, replace structurally deficient pipes, reduce surcharging in major trunk lines, and contribute to CSO reduction through the incorporation of stormwater control facilities. The primary focus of these projects is to provide adequate capacity in the combined sewer system to convey the design flow and resolve basement sewer backup risk. For the most part, this is completed by either increasing pipe capacity through upsizing of pipe diameter or by routing stormwater runoff to stormwater control facilities to reduce the runoff that enters the system. In a few basins the resolution of basement sewer backup risk is achieved through stormwater separation, redirection of flow, or underground pipe storage facilities.

Based on asset management principles, only cost-beneficial projects – projects for which the cost of doing them now is less than the amount of risk from failure as expressed in dollars - (either as stand-alone projects or when combined with hydraulically dependent projects) are recommended as they will cost-beneficially reduce the risk within the combined sewer system. Of the estimated $930 million in capacity-related risk in the combined sewer system, only $200 million in projects were recommended to move forward in the March 2012 plan. One key assumption in the recommendation is development of some private stormwater management facilities to address some of the capacity issues.

In the long-term, capacity improvement projects will be drawn from the list of projects that are currently not considered cost-beneficial. It is expected that some will become cost-beneficial in the future due to one or more of the following factors:

- The sewer system is aging so pipe segments proposed for upsizing will have a higher risk of having a structural failure. Because the risk is greater, the project will resolve more risk.
- The dollar value of basement sewer backup risk might increase to be more than the current estimate of $5,000 per basement sewer backup.
- Other risk reduction (such as operations and maintenance efficiencies) may be quantified and included in the risk calculation.
- More stormwater control facilities might be implemented on private property through a stormwater retrofit program and reduce the maintenance costs assumed in the system plan because maintaining the facilities will be the responsibility of the property owners.
- Changes to the zoning might alter the future base assumptions changing the number of properties predicted to be at risk of basement sewer backups.

In the sanitary sewer system, the most critical capacity issues are the deficiencies in the Fanno Creek and Burlingame Basins. Significant wet weather flow and capacity problems in this area require a system-based solution that combines capacity upgrades with RDII reduction. Major elements of the recommended plan include increasing the capacity of Fanno Basin Pump Station, constructing a surge tank facility to protect recently completed force mains, near-term RDII reduction and pipe upsizing to resolve local capacity issues, long-term RDII reduction to reduce the risk of flows exceeding the capacity of the Fanno Creek Interceptor and the Fanno Basin Pump Station, and increasing the capacity of a short section of the Southwest Parallel Interceptor.

The recommended plan for the sanitary sewer system includes projects to extend sewer service to unserved areas that are both technically and financially feasible.
Figure 6.7 Recommended Sanitary and Combined Pipe Rehabilitation Projects
Figure 6.8 Recommended Sanitary and Combined Sewer Capacity Projects
Collection System Investment Strategy

The Investment Strategy (Appendix A) includes the following projects and programs for the collection system:

- **Pump Station Improvement Program**: Program to refurbish or upgrade pump stations not in compliance with current codes, not operating reliably, need improvements because of growth in the receiving sewage basin, and/or are over 20 years old with out-of-date equipment. The Pump Station Improvement Plan guides the selection of projects. This program was developed to ensure the 97 pump stations are maintained in accordance with a scheduled plan to increase pump station reliability.

- **Sewage Pipe Rehabilitation Program**: Based on regular inspection, this program rehabilitates the highest risk pipes.

- **Capacity Upgrades**: Based on the Systems Plan, these programs add capacity by upsizing pipes and/or adding surface infiltration facilities. Projects are prioritized based on risk and benefit/cost. Work also includes cost-effective pipe rehabilitation, if located within the project area. Capacity upgrade projects are anticipated in the following basins: Holladay/Stark/ Sullivan, Beech/Essex, Oak, Taggart/Insley, Wheeler, Alder, NE 13th Ave, Northwest Neighborhoods, and North Portland.

- **Sanitary Sewer Collection System Capacity**: A series of projects is proposed to address infiltration and inflow (RDII) in the sanitary sewer system in SW Portland. Projects typically involve rehabilitation of main lines and laterals and disconnecting storm inlets from the sanitary sewer.

- **Sewer Extension Program**: Where technically and financially feasible, sewer extensions are proposed to relieve septic systems at risk of failure, to correct party sewer situations, and to provide service where development will be occurring soon and service is currently not available.
Wastewater Treatment System

Wastewater Treatment System Inventory

The City of Portland owns and operates two municipal wastewater treatments plants, where wastewater is processed through removal of solids and organic materials and the addition of disinfection. The Columbia Boulevard Wastewater Treatment Plant (CBWTP), located in north Portland, serves as the city’s main sewage treatment facility, cleaning and discharging most of Portland’s wastewater. The plant provides service to nearly all of Portland’s 583,000 residents. The service area for the wastewater collection and treatment system totals 94,000 acres, including 9,000 acres outside the city limits. The Tryon Creek Wastewater Treatment Plant (TCWTP), located south of Portland in the city of Lake Oswego, serves Lake Oswego and a small portion of southwest Portland, see Figure 6.9.

The CBWTP campus is generally bound by N. Columbia Boulevard on the south, N. Portland Road on the west, the Columbia Slough on the north, and Union Pacific rail lines on the east and southeast. Two other parcels are part of the 147-acre campus: a 36-acre site known as Triangle Lake is located just north of the slough and a 24-acre future expansion site is located west of N. Portland Road on the south bank of the slough. Site zoning is Heavy Industrial (IH) and General Industrial (IG). A narrow strip along the Columbia Slough has environmental overlays for conservation (c) and protection (p). The northern tip of the site has an aircraft landing overlay (h). The entire campus is designated as a conditional use.

As currently configured, the CBWTP includes nearly 350,000 square feet of buildings and over 700,000 square feet of tanks, pumps, and other structures. In October 2011, an updated Master Plan was approved for the campus, see Figure 6.10. The Master Plan allows for development of an additional 122,000 square feet within the campus boundaries without conditional use review, as long as Master Plan standards are met. As part of the land use approval, mitigation activities are proposed to protect the community in the areas of transportation, facilities design, landscaping and screening, open space, neighborhood livability, safety, physical services such as waste disposal and water supply, protection of designated resources, and enhancement of environmental and recreational resources. Odor monitoring and control systems include retrofits to existing facilities and installation of odor controls in all new facilities. The odor monitoring and control systems were developed in collaboration with the CBWTP Citizen Advisory Committee and treatment plant neighbors and are intended to assure compliance with City Council Resolution 35453.
Columbia Boulevard Wastewater Treatment Plant

In addition to process facilities, maintenance facilities, storage, and office areas, the campus also provides space for Multnomah County Vector and Nuisance Control (four buildings totaling 10,500 square feet) and is one of five fueling stations for publicly-owned vehicles. The site is also designated as one of the City’s incident command centers to handle emergencies such as floods or earthquakes.

The TCWTP is a 13.5-acre plant located in the City of Lake Oswego with a rated treatment capacity of 8.3 million gallons per day. It is bounded by the Willamette River to the east, Tryon Creek to the north, and privately owned Industrial zoned properties to the west and south. Development on the plant site includes 80,000 square feet of tanks and 13,000 square feet of building structures. The plant’s service area includes part of southwest Portland, unincorporated Multnomah County, and the City of Lake Oswego.

**Wastewater Treatment System Levels of Service**

The following bureau levels of service are specific to the wastewater treatment plants:

- Treatment plants are in compliance with NPDES effluent limits.
- 100% of biosolids are beneficially re-used.
- 90% of methane is beneficially re-used.
Wastewater Treatment System Current and Projected Condition and Capacity

Columbia Boulevard Wastewater Treatment Plant

The Columbia Boulevard Wastewater Treatment Plant is an activated-sludge, secondary treatment plant with a designed capacity (average dry weather flow (ADWF)) of 100 million gallons per day (mgd) for secondary treatment. The headworks and the primary treatment process have a design capacity of 450 mgd. The plant receives an ADWF of approximately 63 mgd. The major processes at the plant are liquids handling (pretreatment, primary treatment, secondary treatment, disinfection, and discharge), solids handling, methane utilization, and water re-use.

Liquid processes include:

- Influent pumping;
- Preliminary treatment: bar screens with screen presses, grit basins with grit washer-separators and grit disposal facilities, septage receiving and testing station, and an emergency bypass to the primary clarifiers;
- Flow monitoring and controls;
- Dry weather primary treatment: standard physical clarification for 120 MGD minimum;
- Wet weather primary treatment: fine screening, chemically enhanced primary treatment (CEPT), standard clarifiers and bypass to route excess flows to disinfection and outfalls;
- Secondary treatment: aeration basins, secondary clarifiers, and sludge collectors;
- Chlorine disinfection with dechlorination;
- Effluent pumping: to a 72-inch line that carries flows to the dechlorination facility at Hayden Island, then to an alternative dry weather outfall/diffuser in the Columbia River, and to a 102-inch diameter pipeline that carries treated effluent to the dechlorination facility, then to an alternative wet weather discharge outfall and diffuser in the Columbia River.

Solids handling includes:

- Degritting;
- Transport, storage, handling, processing grit and sewer cleanings;
- Gravity thickening of primary sludge;
- Gravity belt thickening of the waste activated sludge;
- Two-stage anaerobic digestion of primary and secondary sludge;
- Gas collection, storage, and energy generation;
- Seasonal lagoon storage for secondary sludge; and
- Belt press dewatering of anaerobically digested biosolids.

The plant generates approximately 13,000 dry tons of biosolids annually. The solids, in the form of dewatered cake, are transported in trucks to farms in central and eastern Oregon for direct land application, providing for beneficial reuse.
Figure 6.9 Columbia Boulevard and Trvon Creek Wastewater Treatment Plants Service Areas
As the anaerobic digesters at CBWTP stabilize wastewater solids, they produce a gas that contains methane. Methane is a primary constituent of natural gas. The CBWTP currently collects and uses a portion of its digester gas to fuel boilers, for heating the digesters, and for space heating. The plant also produces electricity by using digester gas to fuel two 850 KW generators. The on-site generated electricity offsets demand for 40 – 50% of previously purchased power. Some gas is sold to a nearby industrial customer. Excess gas is burned in flares on site. A study is looking at alternative uses for the excess gas including expanded electrical generation or conversion to vehicle fuel.

The current hydraulic capacity of the Columbia Boulevard Wastewater Treatment Plant is sufficient to accommodate future twenty-year growth. However, many of the existing process facilities are aging and in need of rehabilitation to ensure maximum efficiency. Projects to address capital maintenance are proposed in the 20-year planning horizon. In addition, changing regulatory requirements impact operations. A number of projects are proposed to maintain the plant and to continue to address regulatory requirements. This is likely to require new process facilities to be located on the west side of Portland Road.
Tryon Creek Wastewater Treatment Plant

The Tryon Creek Wastewater Treatment Plant is located in north Lake Oswego and receives sanitary flow from sanitary basins in southwest Portland and the city of Lake Oswego. It has an ADWF design capacity of 8.3 mgd and a peak wet weather flow capacity of 37.5 mgd. The plant currently has an ADWF of 4-6 mgd, with Lake Oswego contributing 65% of the flow volume. Treated wastewater is discharged to the Willamette River via an outfall system. Solids are trucked to CBWTP for processing.

The draft update to the Tryon Creek Wastewater Treatment Plant Facilities Plan recommends significant improvements to address projected increases in peak flows to 50 mgd, anticipated new permit requirements, and functional obsolescence of existing facilities. The Plan recommends acquisition of additional property to increase peak flow hydraulic capacity and allow for gravity flow through the treatment process. Solids will continue to be trucked to CBWTP. Figure 6.11 illustrates the recommended 30-year site plan for the Tryon Creek Wastewater Treatment Plant.

Required improvements can be divided by process needs. Improvements to the liquid treatment processes include:

- improvements to the influent collection systems – both the Lake Oswego Foothills Interceptor and the BES Tryon Creek Interceptor, and the Tryon Creek Pump Station;
- demolition of the existing headworks and construction of a new headworks and dry weather clarifiers to be located on property to be acquired which is currently occupied by a self-storage facility;
- construction of an influent pump station to flow from Portland’s Tryon Creek Interceptor;
- enhancements to the existing aeration basins and secondary clarifiers;
- enhancements to the disinfection processes including conversion of former primary clarifiers to chlorine contact basins; and
- construction of an additional outfall for effluent disposal when plant flow and Willamette River levels are both high.

Improvements to the solids treatment processes include:

- Construction of a new solids thickening facility and
- Conversion of the existing digesters to blended storage facilities.
- Thickened, blended raw solids will be hauled to CBWTP for processing. A new enclosed loading facility will be constructed for odor control.

Other site improvements will address the non-potable water system; odor control; site design, security, and circulation; architecture, landscape architecture, and site aesthetics; support buildings; and electrical and instrumentation and controls.
Recommended Wastewater Treatment System Improvements and Investment Strategy

Significant improvements have been made at CBWTP to accommodate the increased wet weather flows resulting from the completion of the CSO controls. A limited number of future improvements to accommodate growth and anticipated regulatory requirements are recommended in the March 2010 Facilities Plan Update:

- Completion of the phased reconstruction of the lagoon
- Secondary Process Improvements (anticipated to meet changing permit requirements) – requires expansion to the west side of Portland Road
- On-site disinfection
- Solids dewatering
- 2 additional digesters
- Thermophilic equipment, blend and batch tanks (for Class A biosolids)
- 2 potential waste re-use projects: expansion of co-generation or alternative uses for methane gas such as conversion to vehicle fuel and improvements to the solids handling processes to create Class A biosolids which have a higher commercial value for fertilizer and could also result in savings in transportation costs.

In addition to the above projects from the Facilities Plan, a series of capital maintenance projects are planned in the 20-year planning horizon. The Investment Strategy includes three investment categories related to wastewater treatment:

- **Columbia Boulevard Wastewater Treatment Plant (CBWTP) Improvements**: This program includes a number of mid-size improvements at the Columbia Boulevard Wastewater Treatment Plant including Seismic Improvements, Outfall Diffuser Extension, Access / Egress Improvements, Bio-Solids Dryer, Dewatered Sludge Hopper, TWAS Piping Upgrade, Centrifuge. Also included is an expansion to Secondary Treatment, if required, to be located on the west side of Portland Road. All are consistent with the Facilities Plan and the Conditional Use Master Plan.

- **Tryon Creek Wastewater Treatment Plant (TCWTP) Improvements**: This program includes improvements identified in TCWTP draft Facilities Plan. Projects include construction of new headworks and dry weather clarifiers, a new influent pump station, odor control facilities, electrical upgrades, and site enhancements. The acquisition of an adjacent parcel will facilitate gravity flow (resulting in potential operational savings from reduced pumping) through the updated processing facilities.

- **Rehabilitation, Repair, and Modification Program**: This program provides for annual reinvestment in the treatment facilities to protect capital investment and enhance system reliability. It provides best management practice to prevent probable violations of the NPDES permit. The aging Columbia Boulevard and Tryon Creek plants require regular investment. Projects include equipment replacement, minor capacity upgrades, restoration of a facility to its original condition and renewal of useful life for more than 10 years, and regulatory mandates.
Figure 6.11. Tryon Creek Wastewater Treatment Plant Recommended Site Plan
**Stormwater System**

Sanitary sewage and stormwater are managed very differently. In the sanitary system, sewage is collected and conveyed to wastewater treatment plants and finally discharged to the Columbia or Willamette River. Conversely, the City’s goal for stormwater is first on-site management for pollution reduction and flow control, as regulated by the Stormwater Management Manual (discussed in more detail). Any flow not managed on site is then routed to the nearest conveyance system, which includes pipes and natural drainages. BES distinguishes two primary stormwater management systems in the USB: the combined sewer system and the “separated” stormwater area.

In the combined sewer area, stormwater is managed to reduce peak flows to avoid combined sewer overflows to the Willamette River and Columbia Slough and/or releases to streets or private properties (including basement sewer backups). Surface stormwater facilities – including green street facilities, rain gardens, ecoroofs, trees and other vegetation – detain stormwater, reducing peak flow to the combined sewer and allowing the system time to accommodate the increased flow from rain events. UICs are also used in parts of the combined sewer areas to collect stormwater from the right-of-way and city-owned property and allow that water to infiltrate into the ground. Once stormwater enters the combined sewer, it becomes part of the wastewater flow and is treated at the treatment plant. The pipes and other facilities managing this stormwater are discussed above in Wastewater Collection System.

Within the separated sewer areas of the city, stormwater is not conveyed to the wastewater treatment plants. Instead, stormwater management and conveyance depends on a combination of built and natural infrastructure systems. Approximately two-thirds of the city’s land area drains to the city’s MS4 system and UICs, both of which are managed under regulatory permits. Flow enters the system from overland runoff and impervious surfaces, including roadways, parking lots, and rooftops. Stormwater in these areas is conveyed through swales, drainage ditches, pipes, and stormwater inlets/catchbasins and discharged to receiving waters (streams and rivers) or to UICs for subsurface infiltration. In some areas, the stormwater system includes facilities that detain peak stormwater runoff and control flow release, and treatment facilities that remove or reduce pollutants.

As development occurs, impervious surfaces reduce the ability of stormwater to soak into the ground and increase the amount of stormwater runoff, disrupting the natural water cycle. Without appropriate stormwater management, these conditions erode stream channels, increase the risk of landslides, contribute to street and stream flooding, and prevent groundwater recharge. Parking lots, roadways, rooftops, and other impervious surfaces increase the pollution levels and temperature in streams, rivers, and groundwater resources.

The city’s stormwater management requirements for all areas are defined in the Stormwater Management Manual (SWMM). The SWMM applies to all development and redevelopment projects within the City of Portland on both private and public property.

The City of Portland’s approach to stormwater management emphasizes the use of vegetated surface facilities to manage and infiltrate stormwater on the property where the stormwater runoff is created. Infiltrating stormwater onsite with vegetated surface facilities provides a number of benefits, including but not limited to pollution reduction, volume and peak flow reduction, and groundwater recharge. These
benefits play a critical role in protecting stormwater infrastructure and protecting Portland’s water bodies, including about 300 miles of streams and rivers that ultimately receive and convey stormwater. This in turn benefits human health, fish and wildlife habitat, recreational resources, and drinking water. The SWMM complements and supports the Portland Watershed Management Plan and other City standards and practices. Protecting and restoring existing natural resources, open spaces and tree canopy is also a component of the City’s stormwater management strategy. BES relies on, and collaborates with, other bureaus (particularly Portland Parks & Recreation and the Bureau of Planning and Sustainability) in the protection, management and restoration of resources that reduce impacts on the built stormwater system and help address clean water regulations.

Not all stormwater is managed by the City’s systems. Some of it simply flows over land via private property and/or public right-of-way directly to a receiving water body. Some stormwater management in Portland is the responsibility of other agencies and jurisdictions, including the drainage districts and entities like Oregon Department of Transportation. Stormwater management is further complicated by ownership. In the sanitary system, once sewage enters the system, it is the responsibility of BES. The stormwater system is not a closed system. Stormwater from public property may flow across private property and the reverse, which blurs lines of responsibility. Management and conveyance relies on public-private partnership and innovative solutions that recognize site-specific conditions.

In parts of Portland that lack constructed storm sewers or public drainage facilities, surface water flows over land through private properties. Often this water collects in some kind of open conveyance, or drainageway, which carries it across private property. These drainageways may be naturally formed (such as streams or creeks) or constructed (such as ditches or man-made channels). Drainageways often receive stormwater runoff from multiple sources, accumulating impacts from upstream development on downstream properties. Preserving the natural functions of drainageways protects properties by reducing the impacts of ponding, flooding, erosion, and other effects of excess flows. Especially in areas not specifically protected by zoning, drainageway protections help limit site and off-site impacts of stormwater discharges and flows, mitigate runoff, prevent erosion, and protect the privately owned elements of the watershed drainage network. The City administers drainageway protections, or drainage reserves, during review of private property development proposals. The Stormwater Management Manual allows stormwater to be conveyed from private property to stormwater systems, including drainageways, if onsite stormwater disposal is not feasible.

**Stormwater System Inventory**

The City’s separated storm sewer and drainage system consists of a 458 miles of stormwater pipe and approximately 144 miles of drainage channels that discharge to streams and rivers. In addition, approximately 9,000 stormwater infiltration sumps (UICs) discharge stormwater underground. The storm sewer and drainage system service area is shown in Figure 6.11. Citywide (in both the combined and separated sewer basins), the Bureau owns and/or maintains approximately 1,900 surface water quality facilities, including detention ponds, swales, constructed wetlands and green street facilities, and approximately 8,000 sedimentation manholes (located upstream of a UIC) that provide some level of detention and pollution reduction.
The City’s MS4 area includes stormwater conveyance infrastructure such as pipes, ditches, roads, catch basins, curbs, gutters, and manmade channels that discharge to waters of the State. Portland’s MS4 area is approximately 15,500 acres. The City’s MS4 permit does not cover:

- Stormwater that flows to UICs (WPCF permit applies)
- Stormwater that flows to the combined sewer system
- Natural drainageways and stream systems
- Direct stormwater discharges from private property to natural stream systems (without entering the MS4)
- Areas with no public stormwater infrastructure
- Areas with individual, general, or industrial stormwater permits

The NPDES stormwater regulations do not prescribe specific pollutant discharge limits. Instead, they allow for the implementation of Best Management Practices (BMPs) to improve water quality to the “maximum extent practicable” based on local conditions, resources, and priorities. The City developed, updates and implements a Stormwater Management Plan (SWMP) that describes measures the City will implement throughout the five-year (2011-2016) permit term to reduce pollutant discharges in the MS4 storm sewer system. Best Management Practices include both programs and capital projects in the following categories: development standards; industrial and commercial controls; illicit discharge detection and elimination; structural controls; operations and maintenance; preservation and restoration of natural areas; and public involvement. These BMPs are reflected in the bureau’s Investment Strategy.

The City’s stormwater system includes approximately 9,000 UICs that collect stormwater from the public right-of-way and City-owned properties and discharge it to the subsurface. Approximately 90 percent of the UICs include a sedimentation manhole prior to the sump. UICs are most prevalent east of the Willamette River where soils better support infiltration. The City’s WPCF permit regulates the construction, operation, and maintenance of all City-owned and operated UICs. Unlike the MS4 permit, the WPCF permit includes numerical standards, based on national drinking water standards, for stormwater discharges to a UIC. The permit also establishes the requirements the City must implement throughout the ten-year (2005-2015) permit term to control pollutants prior to discharge to a UIC to protect groundwater as a drinking water resource. These requirements are included in the bureau’s Investment Strategy.

As discussed earlier in this plan, the city’s stormwater management approach also relies on assets not owned or controlled as part of the BES system. This includes nearly 300 miles of surface streams and rivers, numerous acres of natural area and open space that convey, absorb, and filter rainfall and stormwater, and the tree canopy that intercepts rain and reduces stormwater volumes citywide. To help protect water quality and reduce stormwater runoff, BES and other bureaus invest in protecting and restoring natural areas and expanding the urban tree canopy on public and private property. For more information about Portland’s natural and green infrastructure see the City’s Natural Resource Inventory, urban canopy studies, and the Portland Parks & Recreation chapter in this document.
Figure 6.11 Existing Stormwater System
Stormwater System Levels of Service

Recently, the Bureau has intensified its stormwater planning activities, especially outside of the combined sewer system. Efforts are underway to update the Stormwater Management Manual (SWMM) and develop a comprehensive system plan for stormwater. The proposed stormwater system plan will focus first on identifying risk associated with failing to meet defined levels of service and then performing a targeted alternatives analysis with the goal of identifying and addressing the greatest sources of stormwater-related risk. The Bureau established service categories and related performance indicators to help frame the characterization of system deficiencies, development and evaluation of alternatives, and selection of recommended improvements. These categories include:

- Protect public health and safety and property:
  - Sanitary sewage releases: In the separated area, sewage releases to surface water are prevented for storm events up to a 5-year frequency. In the combined sewer area, prevent releases to buildings or streets up to a 25-year storm frequency.
  - Erosion and landslide hazards: Limit risk claims due to City stormwater.
  - Localized/nuisance flooding: Design and manage infrastructure to limit nuisance flood events.
  - Groundwater contamination: In the UIC area, facilities are managed to effectively reduce pollution to the groundwater.

- Protect biological communities and improve ecological function:
  - Loss of habitat: Address water quality and quantity consistent with requirements of the Endangered Species Act.
  - Mitigate contamination of surface water and sediments through use of pollution reduction facilities.
  - Minimize disruption to the hydrologic cycle by managing impervious area and through flow attenuation.

- Support community needs:
  - Address deficiencies that impede community improvements. Increased impervious surface area – whether public or private – requires an approvable discharge point for stormwater conveyance.

Since 1999, the Stormwater Management Manual (SWMM) has provided policy and design requirements for stormwater management throughout the City of Portland. The requirements apply to all development, redevelopment, and improvement projects within the City of Portland on private and public property and in the public right-of-way. Portland’s approach to stormwater management emphasizes the use of vegetated surface facilities to treat and infiltrate stormwater on the property where the stormwater runoff is created. Infiltrating stormwater onsite with vegetated surface facilities is a multi-objective strategy that provides a number of benefits, including but not limited to pollution reduction, volume and peak flow reduction, and groundwater recharge. These benefits play a critical role in protecting stormwater infrastructure and improving watershed health. Revisions to the SWMM will incorporate a systems-based approach, which will focus on the needs of the system to which stormwater is being conveyed. For example, the risks and
requirements for protection of groundwater when stormwater is infiltrating into the ground are different than the risks and requirements for protecting the capacity and treatment needs of the combined sewer system. The SWMM will continue to emphasize a management hierarchy, requiring onsite stormwater management prior to conveyance offsite. As stormwater system and facility planning evolves, the SWMM will focus regulatory and design approaches by local stormwater systems, including storm-only sewers, drainageways and waterbodies, and combined sewer systems.

**Stormwater System Current and Projected Condition and Capacity**

Comprehensive condition data is not available for the stormwater system in the separated stormwater areas. Of particular concern for stormwater management are the many miles of public right-of-way that are undeveloped or otherwise lack adequate stormwater infrastructure, see Figure 6.12

While comprehensive stormwater system planning is underway, existing plans and modeling information reveal some of the condition and capacity issues related to the stormwater system in each watershed. These are summarized below.

**Portland Willamette River Watershed**

The Willamette Watershed’s developed areas are largely served by the combined sewer system, but portions of the area are also served by UICs and the City, Port of Portland, and ODOT MS4 systems and private systems. The areas within the watershed that have been analyzed with modeling are shown in Figure 6.11.

Studies such as the Westside Streams Water Quality and Trend Analysis Status Report (2010) and the Tanner Creek Water Quality Characterization (2011) identify sources of water quality deficiencies in the watershed and guide the development of pollution reduction projects.

Primary deficiencies in the Willamette watershed are water quality and high flows in the natural channels of the west hills that lead to degradation of the streams. Similar to the Fanno Creek and Tryon Creek watersheds, steep slopes and low infiltration capacity of soils presents challenges for on-site stormwater management in some areas, and makes innovative solutions and protection of the existing natural resources that manage water important.

The Stephens Creek subwatershed of the Willamette has had the most complete and recent stormwater evaluation (2013). It was the first watershed analysis that evaluated not only conveyance system capacity and water quality, but also the hydrologic indicators of stream health. In this area, approximately 22% of taxlots do not have an approvable stormwater discharge point and approximately 25% of the city-managed rights-of-way in the subwatershed do not have an approved stormwater conveyance system.
Figure 6.12 Roads Underserved by Stormwater System
Columbia Slough and Columbia River Watersheds

The existing stormwater systems in the Columbia Slough watershed and on Hayden Island are shown in Figure 6.11. The Columbia Slough watershed is flat, primarily sandy alluvium with good infiltration, but a high water table, which limits the use of sumps and surface infiltration facilities in some areas.

Several entities are responsible for conveying and treating stormwater runoff in the Columbia Slough watershed, which creates unique management challenges. The City of Portland is only responsible for systems that convey stormwater from public right-of-way to the slough. The City manages stormwater in the southeast portions of the watershed using approximately 3,500 UICs. In the Columbia South Shore Well Field, wellhead protection area regulations limit infiltration of stormwater. Private and public UICs in this area are required to protect the groundwater through measures to control and treat spills that could pollute runoff.

Three public drainage districts, operating separately from the City of Portland, are responsible for flood control within their respective district boundaries. Flood control responsibilities include preventing Columbia River water and local stormwater from flooding property by operating pump stations to convey flow into the Columbia Slough and Columbia River. There are over 600 privately-owned stormwater conveyance systems that discharge runoff from private properties into the slough. The Portland International Airport and the Oregon Department of Transportation (ODOT) own and operate stormwater systems that discharge to the slough at 15 different outfall locations. The Port of Portland operates several more private stormwater systems that discharge stormwater from their properties into the slough.

The City is currently using hydrologic and hydraulic modeling to assess stormwater system capacity deficiencies for much of the service area through a cooperative project with Multnomah County Drainage District #1 (MCDD) to recertify the district's levee system with the Corps of Engineers. In addition, stormwater system deficiencies related to sediment quality in the slough are being evaluated as part of a DEQ Consent Order. BES has identified 52 priority city-owned stormwater outfalls that need pollution control. The investment strategy includes an estimate for these projects.

Johnson Creek Watershed

The existing stormwater systems in the Johnson Creek watershed are shown in Figure 6.11. Stormwater sumps, or UICs, are the primary stormwater management system within the watershed. Currently, the watershed has about 2,400 active sumps.

Flooding along Johnson Creek is a significant stormwater-related issue. Under the Johnson Creek Restoration Plan (2001), the City is working to reduce “nuisance floods” (floods that have about a 10% chance of occurrence in any given year, or an average of once every 10 years), while also improving water quality and habitat. Until recently, Johnson Creek flooded Foster Road in the Lents area about every other year. With the completion of the Foster Floodplain Natural Area restoration project in 2012, flooding is expected to be reduced to a six to eight year recurrence, and further implementation of projects from the restoration plan will continue to improve conditions. In addition, a multi-bureau team is studying the feasibility of managing larger floods (those that have about a 1% change of occurrence in any given year, or occur on average once every 100 years).
Resources have recently shifted to study and understand the stormwater flows from East Buttes, Johnson Creek tributaries and other upland areas into Johnson Creek. Stormwater system planning is expected to comprehensively identify system deficiencies. Based on hydraulic modeling and field observations, stormwater system capacity deficiencies are expected to be identified in the steep, natural channels south of Johnson Creek and east of Interstate 205. Soils in this area have limited capacity to infiltrate stormwater. Natural drainage and local seeps and springs make on-site stormwater management difficult. Disruption of these resources has caused problems for development. Steep slopes present potential landslide risks and many streets lack stormwater management infrastructure. The relatively recent development in some neighborhoods east of I-205 and south of Powell Boulevard has increased the amount of impervious area and decreased vegetation, contributing to the flashiness (rapid rise and fall) of Johnson Creek and its tributaries and exacerbating stormwater problems downstream.

Fanno and Tryon Creeks Watersheds

The existing stormwater systems that contribute flow to Fanno Creek, other Tualatin River tributaries, and Tryon Creek are shown in Figure 6.11. This figure also shows the portions of the stormwater system that have been assessed using hydrologic and hydraulic models.

Water quality is a primary challenge related to stormwater in these watersheds. As a part of the Fanno and Tryon Creeks Watershed Management Plan (2005), pollutant loading from different land uses was modeled. These results were used to estimate the source of water quality deficiencies in these watersheds and serve as a guide for the development of pollution reduction projects. High traffic commercial corridors are a significant source of pollutants. Some existing stormwater detention ponds contribute to temperature problem.

The 2005 Fanno/Tryon Watershed Management Plan also identified numerous stormwater capacity deficiencies at culvert crossings and within piped systems. In addition, most of Portland’s properties and streets that lack adequate stormwater systems are located in the Fanno and Tryon watersheds. These areas tend to have soils with low infiltration capacity that do not allow for on-site stormwater discharge; steep slopes that have potential landslide hazards; and streets that lacking drainage infrastructure for off-site stormwater discharge.

Recommended Stormwater System Improvements

Recommended improvements can be divided into two categories: retrofits to address stormwater issues that impact existing development and proactive options that can reduce the need to expand the stormwater management system. These vary somewhat by watershed and by stormwater basin.

In the combined sewer basins, priority will continue to be on managing stormwater as close to the source as the possible (i.e., keep water out of the sewer), as called for in the City’s NPDES permit. This strategy will be implemented through projects such as private property retrofits (eco-roofs, rain gardens, parking lot retrofits) and public stormwater infiltration facilities in the rights-of-way. The investment strategy includes these multi-objective green infrastructure projects, which also address basement sewer backups. Within in the combined sewer basins, there also may be opportunities to separate stormwater from the sanitary sewer system. This approach is currently under review in the Lloyd District area.
In the separated stormwater areas, the Bureau has identified a variety of projects and programs to address stormwater system needs. In addition to the types of projects identified for the combined area, there are also projects to address flood management, pollution reduction, and overall watershed health. However, it is important to note that the Bureau anticipates that there will be areas where it is neither technically nor financially feasible to provide stormwater management services. It may be desirable to encourage increased density in areas that are already highly impervious. Allowing for higher density may make neighborhood stormwater management system improvements more cost effective by increasing the number of properties served in proportion to the public investment.

Citywide, the bureau continues to invest in programmatic approaches that protect the existing stormwater system and natural resources, and help avoid the need for future costly capital projects to treat stormwater. These programmatic approaches include capital programs included in the investment strategy, such as land acquisition for protecting high-quality natural resources that are part of the water cycle, and green street projects. Non-capital programs, such as community education and outreach, tree planting, revegetation and control of invasive species are also critical parts of the bureau’s strategy to protect water quality and address other regulatory drivers.

While citywide stormwater system planning is not yet complete for all areas, existing watershed and stormwater plans recommend the following investments. Additional stormwater system improvements to address system risk will be recommended in the coming years.

In the Columbia Slough Watershed, projects will focus on water quality with a primary goal of improving the quality of the sediments in the Slough. Specific water quality projects are being identified as part of the Columbia Slough Sediment Order. Flood control is also an issue in the slough, both keeping Columbia River water from flooding property within the drainage districts’ boundaries and keeping stormwater generated from within the drainage districts from flooding properties. A study will determine whether or not a new stormwater pump station is required. The bureau continues to invest in protection, restoration, and enhancement of natural resources as well as built infrastructure improvements.

In the Johnson Creek Watershed, projects will continue to focus on floodplain restoration and management through restoration in target areas along the main stem of the creek. These projects are multi-objective: providing flood mitigation, improving water quality, and enhancing fish and wildlife habitat. The CIP identifies larger flood mitigation projects in West Lents and in East Lents. Restoration is underway on Crystal Spring Creek, a tributary stream that is a source of clean, cold, and constant flows. Projects are also underway to protect and restore natural resources in the uplands and tributaries. Future work will begin to address upland stormwater system conveyance and capacity.
In the **Fanno/Tryon Watershed**, projects will focus on stormwater system improvements including flow control and treatment to improve water quality, protect streams, and ensure storm system reliability. Stormwater retrofits will focus on managing stormwater from existing impervious area in major transportation corridors such as Beaverton-Hillsdale Highway and SW Barbur Boulevard. Projects to increase culvert capacity and improve fish passage in the streams and their tributaries are underway or planned. Additional projects include stream daylighting, sewer infrastructure protection, stream enhancement, and roadside drainage and shoulder improvements. The bureau and partners continue to focus on protecting, restoring, and enhancing natural resources that support water quality, hydrology, and habitat.

In the **Willamette River Watershed**, the Bureau will continue to implement stormwater projects to address capacity in the combined sewer system to limit sewer overflows and improve watershed health. In the separated sewer system projects will address other stormwater-related impacts to the river, tributaries and their watersheds. Projects will focus primarily on controlling the flow of stormwater and improving water quality through projects to retrofit existing impervious area with stormwater facilities along public right-of-way and on private property. Construction of new neighborhood-scale water-quality facilities could be a cost-effective solution in some areas. As in the Fanno/Tryon Watershed, projects often require partnering with other public agencies (such as ODOT) or private property owners. Restoration and enhancement of remnant habitat areas along the main stem Willamette River to create habitat “stepping stones” through the industrial harbor and downtown core is important for ESA-listed species migrating to upstream habitats.

### Investment Strategy

**Process**

Each year, the Bureau prepares capital and operating budgets for the upcoming fiscal year and for the five-year planning horizon. The work of the Bureau is focused on strategic and comprehensive program delivery protecting public health and restoring the environment within a prescribed, but negotiated, regulatory framework. Using asset management principles including reducing risk and the likelihood of failure, the Bureau develops budgets to maintain infrastructure and natural systems to meet regulatory requirements and enhance the health of watersheds. Asset management addresses life-cycle costs, trade-offs between capital and operating expenditures, and prioritization of projects based on risk and consequence of failure, to achieve long-term system sustainability and acceptable levels of service. The Bureau uses an integrated approach, rather than one that addresses only single subject regulatory requirements, whenever possible. Taking an integrated approach is often more cost-effective and results in better watershed health outcomes – hydrology, water quality, habitat, and biological communities – while also addressing other urban environmental problems.

In order to be best stewards of ratepayer dollars, the bureau delivers its services through a wide array of operating programs that complement the capital investments. Public education has proven to be a particularly cost-effective approach to reducing the volume and pollutant load entering the sewers. Investing in public engagement and community stewardship has yielded a number of stormwater management benefits such as extensive tree planting, clearing of invasive species in parks and other
natural areas, and construction and maintenance of stormwater facilities by private entities (such as eco-
roofs and rain gardens). The bureau works closely with a number of non-governmental organizations
including watershed councils, environmental groups, and neighborhood groups, which often leverages
volunteer contributions and other sources of funding to meet multiple community benefits.

The Bureau has been implementing an asset management approach to guide investment for several
years. To date, extensive work has focused on the Combined and Sanitary Collection System where an
updated Systems Plan has evaluated projects using a risk-based asset management framework. This
approach will be expanded to the Bureau’s other systems and asset types as resources are available to
do the required analysis. Watershed monitoring data, regulatory requirements and watershed planning
(such as the Johnson Creek Restoration Plan) guide prioritization of stormwater and watershed
investments. Applying asset management approaches to the natural systems and green infrastructure is
an emerging effort for the Bureau.

The Capital Improvement Plan (CIP) is developed utilizing a multi-step process to identify, develop,
review, score, and rank projects to determine funding and scheduling priorities and ensure that the core
sanitary sewer and stormwater systems are met to serve the community. A bureau-wide stakeholder
review team investigates, scores, and ranks all CIP projects in accordance with identified CIP criteria. CIP
weighted criteria, scoring, instructions, scheduling guidelines, estimating procedures, and project request
forms are used to ensure each project is developed, reviewed, and scored based on detailed and
consistent information. A CIP development strategy guides project selection and scheduling. Projects are
reviewed by managers in finance, program areas, operations, and engineering to ensure financial
resources are expended effectively and appropriately. The bureau director reviews the final CIP plan and
submits it to City Council during the annual City budget process.

The public is involved in the budget development process through the Bureau’s Budget Advisory
Committee and the Public Utilities Review Board. All CIP projects that affect the public include public
involvement and outreach plans.

Projects and Programs

The major components of the sewer system define the program categories within the capital budgeting
process: Sewage Treatment, Maintenance and Reliability, Surface Water Management (i.e., stormwater
and watershed health), and Systems Development.

The Bureau focuses efforts on comprehensive, multi-purpose solutions in the highest priority areas for
work in all four program areas of the CIP, guided by both regulatory requirements and the Bureau’s
mission and Strategic Plan. The Bureau anticipates nearly $2 billion in capital investment in these
programs over the next twenty years. Capital projects and programs are drawn from the recommended
system improvements discussed in earlier sections. It is important to note that the proposed Investment
Strategy represents a conservative financial approach to addressing system needs. The Bureau’s 20-year
Investment Strategy (included in Appendix A) is summarized in Table 6.4.
Table 6.4 Investment Strategy Summary

<table>
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<tr>
<th>Program</th>
<th>FY 2013-2018</th>
<th>FY 2018-33</th>
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<tbody>
<tr>
<td>Wastewater Treatment and Maintenance &amp; Reliability</td>
<td>$109,671,000</td>
<td>$305,964,000</td>
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<tr>
<td>System Development</td>
<td>$23,462,000</td>
<td>$60,000,000</td>
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<td>Surface Water Management</td>
<td>$73,441,000</td>
<td>$127,515,000</td>
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<td><strong>TOTAL</strong></td>
<td><strong>$535,470,000</strong></td>
<td><strong>$1,196,279,000</strong></td>
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</table>

Specific objectives for the program areas are described below.

**Sewage Pumping and Treatment Systems**

Regulations, primarily through the NPDES Waste Discharge permits, require investment in the ten year planning horizon with a focus on process improvements at Columbia Boulevard Wastewater Treatment Plant (CBWTP), including secondary process improvements and upgrades to the mixing systems in the digesters. Other investments in this program area will focus on ongoing maintenance at the CBWTP and the Tryon Creek Wastewater Treatment Plant through the Repair, Rehabilitation and Modification program and the Pump Station Improvement program. An updated Facilities Plan for CBWTP was completed in March 2010; no new projects were identified for the near term. The draft TCWTP Facilities Plan identifies extensive investments to be made at this site including acquisition of property for a new headworks facility which will allow for gravity flow through the plant and upgrades to nearly all the existing facilities on site.

**Collection System Maintenance and Reliability**

This program area is focused on improving and maintaining the existing sanitary and combined sewer collection system to provide accepted levels of service. The March 2012 Systems Plan (for sanitary and combined sewers) recommends grey and green infrastructure projects that have a favorable benefit/cost ratio and reduce system risk. The plan identified approximately $175 million in pipe rehabilitation for near-term investment. Additional projects are planned to address the highest risk of basement sewer backup. In response to system failure in the Fanno Basin, an extensive improvement program is underway through fiscal year 2016, including a new pump station to augment the existing pump station. A small amount of work remains to meet ongoing requirements for the Combined Sewer Overflow Program to provide increased efficiency of system operations.

**Surface Water Management**

This program area focuses on systematically protecting and restoring surface water assets (such as drainageways, streams and wetlands) and improving overall watershed health to protect public health and safety and comply with state and federal regulations. Projects often involve collaboration with other public agencies, nonprofits and community partners. The Bureau prioritizes projects that protect the most critical existing watershed functions and/or preserve those locations at the greatest risk of damage. This is accomplished by implementing the Watershed Management Plan recommendations for restoring important natural functions and/or using green infrastructure to reduce or avoid stormwater impacts. A stormwater system plan for the Stephens Creek subwatershed was completed in 2012 which identified
investment needs for that area. A citywide stormwater system planning process is now underway to identify projects to improve stormwater conveyance, capacity and water quality. Other near-term priorities for this program area include continuing restoration of Johnson Creek and its floodplains; stormwater retrofit projects in Fanno/Tryon and the Columbia Slough; and restoration and enhancement projects along the main stem Willamette River and its tributaries, and the Columbia Slough.

**Systems Development**

In support of Metro’s 2040 Growth Concept, this program area funds projects that cost effectively and incrementally expand the sewer collection system to serve planned development. Work is underway to identify clusters of properties that are currently served by on-site sewage systems, such as septic or cesspools, and to plan for alternatives prior to failure of on-site systems. This program also funds sewer improvements in association with public works projects by others, primarily transportation projects – both road and transit. In response to City Council action, the Bureau has developed a program to address non-conforming sewer connections. Most of the work to date has been in response to either a service failure or a property sale. Some work has been accomplished in conjunction with planned pipe rehabilitation projects.

**Financial Strategy**

The Bureau annually prepares a five-year financial plan. Periodically, the Bureau forecasts on 10-year and 20-year horizons to gain additional understanding and insight into long-term financing needs and rate implications. The five-year financial plan has three key elements. Initially, operating and capital expenditure requirements for the Bureau are developed through separate operating and capital planning processes and then they are brought together. Overall revenue requirements and a corresponding five-year funding program are developed taking into account the impact of capital construction on future operations and maintenance requirements.

The financial planning process lays the groundwork for setting utility rates, which are formally adopted each year by the City Council. Rates are set on a cost of service basis, meaning that rates are designed to charge customers for their proportional cost of collecting, transporting, and treating discharges. Debt obligations (“mortgage payments”) have a significant impact on the bureau’s financial plan and its rates. In fiscal year 2013-14, approximately one-third of the budget was allocated to debt payments.

**Existing Financial Strategies**

Environmental Services receives revenue for capital investment from sewer fees, charges and permits; line and branch and system development charges; cash transfers from the Sewer System Operating Fund; and Bond proceeds, the latter are the primary funding source of the Bureau’s capital expenditures.

**System Funds**

The Bureau’s financial reporting system is organized into five separate funds:

- The Sewer System Operating Fund provides for the day-to-day operation, maintenance and management of Bureau programs.
• The Sewer System Construction Fund holds equity contributions and net bond proceeds for transfer to the Sewer System Operating Fund to reimburse capital-related expenditures.

• The Sewer System Debt Redemption Fund provides for payment of debt incurred for capital construction.

• The Sewer System Rate Stabilization Fund functions as a reserve that enables the Bureau to level its projected annual revenue requirements to reduce significant changes in sewer and stormwater rates from year to year.

• The Environmental Remediation Fund was created to provide funding to remediate former solid waste disposal sites. The Environmental Remediation fund now also provides funding of the City’s share of the Portland Harbor Superfund program remedial investigation and feasibility study costs and the City’s source investigation program

Debt Service Coverage

The Bureau’s current financial planning standard is to set rates adequate to provide Net Revenues (gross revenues less operating expenses) including transfers from the Rate Stabilization Fund equal to or greater than 1.50 times the annual debt service requirement on first lien debt, and 1.30 times the annual debt service requirement on all (first and second lien) debt. These targets exceed the requirements specified in the existing debt covenants. This approach helps the bureau maintain a high bond rating, which reduces the cost of borrowing money to pay for capital projects.

Ending Fund Balances

The Bureau’s current policy is to maintain combined ending fund balances within the Operating Fund and the Rate Stabilization Funds equal to or greater than 10 percent of each year’s operating expenses.

The Construction Fund ending fund balance is targeted at 35 percent of the next year’s CIP, or $500,000, whichever is greater, for planning purposes. Actual ending fund balance will differ depending on the rate of expenditures and the timing of CIP borrowings.

Projected revenues and expenditures

Table 6.5 depicts forecast resources and requirements for the Operating Fund. While the Bureau annually prepares a five-year financial plan, Table 6.5 includes an FY2019 – FY2033 summary column to provide a 20-year extended outlook.
## Table 6.5 Sewer system operating fund forecast sources and use of funds ($1,000)

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<td>-</td>
<td>-</td>
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<td>186</td>
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<td>5,825</td>
<td>4,750</td>
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<td>Debt Redemption Fund</td>
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<td>$515,200</td>
<td>$544,623</td>
<td>$567,356</td>
<td>$9,566,665</td>
</tr>
</tbody>
</table>

(1) Includes capitalized personal services, materials & services, internal services, land, equipment and capital improvements

Revenues from service charges and fees, and transfers from the Sewer Construction Fund are the largest resources for the Operating Fund. Projections for expected new customers, average water use per account, increases in impervious area, and planned rate increases are used to forecast revenues over the forecast period.

Operating expenses include personal services, materials and services, internal services, transfers for general fund overhead, and transfers to the Rate Stabilization, Construction, Environmental Remediation, and Debt Redemption Funds. The operating expense forecast reflects the Bureau’s existing operating budget, assumed cost escalation factors and service additions associated with CIP and other programs.
Factors Influencing the Forecast

The following are considered risks to the forecast as their potential effects were not explicitly included in the investment strategy or financial forecast. Potential costs are not known in all cases.

- **Portland Harbor**
  The Portland Harbor Superfund Site investigation is currently focused on a stretch of the Willamette River from River Mile 2 to River Mile 12. The City is one of the potentially responsible parties actively engaged in assessment and evaluation of cleanup alternatives in this section of the river. The total cost associated with the cleanup and restoration activities and the City’s ultimate share of those costs are unknown at this time.

- **Willamette Basin TMDLs**
  The DEQ intends to finalize a mercury TMDL within the next few years and an update of the temperature TMDL is also pending. Changes may affect operations at the Tryon Creek Wastewater Treatment Plant and some projects and programs, but specific implications and the ultimate costs are unknown at this time.

- **MS4 Permit**
  The City's MS4 permit includes requirements to evaluate program effectiveness at reducing applicable TMDL parameters. As new TMDLs are developed and approved, technical work and associated budgets will likely increase.

- **Sanitary Sewer Overflows (SSOs)**
  State and federal regulators continue to study the operations and maintenance of municipal sewer systems and potential guidelines regarding SSOs. Should SSO rules similar to those proposed in 2001 eventually become effective, the Bureau's sewer system would be affected. Such rules could have significant financial impacts to both capital (via upsizing of facilities) and operating (increased system oversight) budgets.

- **Sanitary and Stormwater Service to Residents**
  As discussed in earlier sections, there are challenges to providing sanitary sewer service to all properties within the USB. These include properties with onsite disposal, undeveloped properties, and properties serviced by under capacity sewer lines. While some of the solutions are included in the financial forecast, the full extent of the need is not fully known. Similarly, the Bureau recognizes the need to make improvements to the stormwater system, however, the extent of these improvements is not fully known at this time.

- **Sanitary Sewer and Stormwater Rates**
  The bureau’s capital and operating budget forecasts are influenced by annual sewer and stormwater rates approved by the City Council. Planned operations and maintenance of, and capital improvements to, the sewer and stormwater systems will depend on continued predictable increases in rates. Annual rate increases determine the bureau’s ability to address the key issues and concerns listed in the Overview section. Lower rate increases than planned would require either reduced operation and maintenance expenditures or delays in maintenance of existing infrastructure and new capital system improvements, which may increase future costs.
In addition, the financial forecast makes assumptions about factors internal to the Bureau and the City, such as program levels, and external factors, such as inflation and borrowing costs. Changes to these factors may change the financial forecast. This is particularly true of an extended forecast such as the 20-year forecast shown in Table 6.5. The following describes some of the factors and risks involved in unanticipated changes:

- The financial forecast is based on a 1.5% decrease in average use per single-family residential customer (based on winter water consumption), and a 0.75% decrease in average use per multi-family, commercial and industrial customer, roughly consistent with recent history. The forecast also assumes an account growth rate of 0.5% per year. Should consumption or account growth be lower than anticipated, revenues would be adversely affected.

- Changes in interest rates will affect the cost of new debt. Any significant increase in interest rates over the forecast interval will increase revenue requirements for interest on new debt. Conversely, lower-than-anticipated interest rates would reduce borrowing costs and therefore revenue requirements.

- The forecast rate increases are based on best estimates of inflation over the forecast interval. An increase in the actual rate of inflation above the forecast inflation rate will lead to correspondingly higher revenue requirements.

- The current economic recession has resulted in a drastic drop in all construction related fees and permits, most notably System Development Charges, which are a material revenue source. The financial plan assumes construction activities will rebound. If construction activity does not rebound as assumed, revenues would be adversely affected.