Planning Commission Meeting Date: July 5, 2018 **Agenda Item 6a.**

PLANNING COMMISSION AGENDA ITEM

CITY OF SHORELINE, WASHINGTON

AGENDA TITLE:	**2018 Comprehensive Plan Amendment – 2018 Surface Water Master Plan**
DEPARTMENT:	**Planning & Community Development**
PRESENTED BY:	**Uki Dele, Surface Water & Environmental Services Manager** **Paul Cohen, Planning Manager** **Steven Szafran, AICP, Senior Planner**

- ☐ **Public Hearing** ☒ **Study Session** ☐ **Recommendation Or**
- ☐ **Discussion** ☐ **Update** ☐ **Other**

INTRODUCTION

Over the past few years Staff has been working with consultants, Brown and Caldwell and FCS Group (BC Team), to update the City's 2011 Surface Water Master Plan (2011 Master Plan) which is a supporting component of the City's Comprehensive Plan. The purpose of tonight's presentation is to update the Planning Commission on the elements of the *Draft* 2018 Surface Water Master Plan (2018 Master Plan) as contained in **Attachment A**. In addition to the updated, the Capital Facilities Element will be amended to reference the 2018 Master Plan instead of the 2011 Master Plan (**Attachment C**).

The primary purpose of the 2018 Master Plan is to address drainage and water quality challenges associated with growth, increasing regulations, and aging infrastructure. The 2018 Master Plan will guide the City's Surface Water Utility (Utility) for the next five to 10 years, including recommendations for capital improvements, programs, long-term asset management, and a financial plan that sustainably supports the Utility.

The 2018 Master Plan was developed using Asset Management principles based on level of service and level of service targets to provide a transparent way to inform the City Council (Council) on management strategy decisions and associated rates. On November 20, 2017, Council adopted the 2018 Surface Water Utility Budget with rates to implement the recommended proactive management strategy. The proactive management strategy includes implementing 25 high-priority projects and 24 new/enhanced programs that address high priority long-term needs, as well as anticipated new regulatory requirements.

As part of the 2018 Master Plan, Staff developed performance measures for each of the programs the Utility will be implementing based on the proactive management strategy. These measures will be used to monitor the success of the programs and ensure they are effectively meeting the level of service targets and expectations for the next 5 years and beyond.

Approved By: **Project Manager** U.D **Planning Director** [signature]

BACKGROUND

The 2018 Master Plan is a vision document that establishes the management strategy for the Surface Water Utility to help meet the established level-of-service goals and permit requirements. It also includes the development of both a financial and policy process for the Utility to implement the strategy.

The Surface Water Utility provides stormwater, water quality, and environmental services to the residents of Shoreline. The Utility is funded through the Surface Water Utility Fund, which generates revenue through annual Surface Water management fees. The Utility provides for capital improvements and operational activities that reduce flooding and drainage issues, water quality programs to meet the NPDES Phase II permit requirements, as well as stream and wetland enhancement within the City.

Master Planning

The City's first Surface Water Master Plan was adopted with the 2005 Comprehensive Plan. The 2005 Master Plan identified and prioritized Surface Water projects and programs for development. An updated Surface Water Master Plan was adopted in 2011. The 2011 Master Plan established a prioritized schedule to prepare and implement Basin Plans for each of the City's 11 surface water basins. The 2011 Master Plan was intended to serve as a management plan for approximately five years, or until all the Basin Plans were completed.

Since 2011, the Utility has accomplished several advances in the way surface water is managed in the City. Significant accomplishments include condition assessments associated with each of the Basin Plans and establishing a method to prioritize the capital improvement projects and activities identified in the Basin Plans. In recent years, the Utility has also completed capital improvement projects that were not identified in the 2011 Master Plan. Most notably, the ongoing Stormwater Pipe Repair and Replacement program has addressed critical pipe repair work, consistent with recommendation contained in completed Basin Plans. In addition, Small works and Greenworks projects that apply low impact development (LID) techniques to reduce runoff and improve water quality through infiltration and bioretention have been completed.

In 2016, the City retained Brown and Caldwell to assist the City in updating the 2011 Master Plan. Brown and Caldwell were tasked with updating the 2011 Master Plan so as to guide the Utility for the next five (5) to 10 years, including establishing new levels of service, development of an Asset Management Program framework, project recommendations for inclusion in the Capital Improvement Program (CIP), and a financial plan for long-term utility management.

On October 10, 2016 the Council reviewed the draft level of service and levels of service targets used in developing was is now the 2018 Master Plan.[1] The staff report documenting the levels of service and levels of service targets can be found at the following link:
http://cosweb.ci.shoreline.wa.us/uploads/attachments/cck/council/staffreports/2016/staffreport101016-8a.pdf

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[1] Given the passage of time, the documents title has changed from the 2017 Surface Water Master Plan to the 2018 Surface Water Master Plan to reflect the actual year of completion.

On May 15, 2017 the Council discussed and provided direction on four policy issues that are been incorporated into the 2018 Master Plan. The staff report for the policy discussion can be found at the following link:
http://cosweb.ci.shoreline.wa.us/uploads/attachments/cck/council/staffreports/2017/staffreport051517-8b.pdf

On July 17, 2017, the Council received updates on the plan progress, reviewed and provided feedback on the prioritization process and management strategy being used in the plan development and financial analysis. The staff report for the this discussion can be found at the following link:

http://cosweb.ci.shoreline.wa.us/uploads/attachments/cck/council/staffreports/2017/staffreport071717-9a.pdf

On August 7, 2017, the Council discussed and provided direction on which management strategy to use in developing rates and financial analysis for the 2018 Master Plan and 2018 – 2023 Surface Water Management Fees. The staff report for the discussion can be found at the following link:

http://cosweb.ci.shoreline.wa.us/uploads/attachments/cck/council/staffreports/2017/staffreport080717-9a.pdf

On December 4, 2017, the Council received updates on the elements of the 2018 Master Plan and was introduced to the measurements staff will be using to ensure the effectiveness of the programs in meeting the level of service. The staff report for the update can be found at the following link:

http://cosweb.ci.shoreline.wa.us/uploads/attachments/cck/council/staffreports/2017/staffreport120417-9a.pdf

The 2018 Master Plan includes elements to ensure a comprehensive plan that addresses current and future anticipated needs and provides information for the financial analysis and associated rates to support the Utility. The 2018 Master Plan document is included in **Attachment A** and is scheduled to be finaled and adopted by City Council in November 2018 as part of the 2018 Comprehensive Plan Docket.

DISCUSSION

The elements of 2018 Master Plan will help articulate the current activities of the Utility, including identifying gaps and resources needs to fill the gaps by developing a prioritized list of projects and programs that the Utility will focus on for the next six years. In preparing the 2018 Master Plan, the following objectives were achieved:

- Develop updated levels of service (LOSs) for the Utility that align with customer expectations;
- Review current policies, programs, and operational activities for the Utility and make recommendations for improvements;

- Advance the Asset Management Program to improve stewardship of the surface water system infrastructure, and assure customers that funds are spent responsibly and effectively;
- Prepare an operations and maintenance (O&M) manual to establish clear processes and protocols;
- Assess the current state of the City’s surface water systems;
- Create an updated set of proposed capital improvement projects and prepare updated planning-level cost estimates;
- Prioritize project and program recommendations for implementation;
- Develop management strategies based on selected projects and programs; and
- Conduct a financial analysis to support funding and rate recommendations.

Levels of Service

A key objective of the 2018 Master Plan is to match the levels of service (LOS) provided by the Utility with the expectations of customers. This requires a clear understanding of customers’ needs, expectations and preferences. Levels of service are common-language statements that describe characteristics or attributes of services provided by the Utility to meet the community’s basic needs and expectations. The adopted LOS should align with overall strategic goals of the organization and support its business drivers. It helps the Utility focus efforts and resources, communicate service expectations, and reconcile budgetary limitations.

Staff and the BC Team reviewed the 2011 Master Plan, the adopted 2012 Comprehensive Plan, and the City Council Goals and Work Plan to determine the recommended LOS provided to customers in terms of asset management practices. In engaging in a series of discussions with the public, relevant Staff, and the Council, the final LOS and associated LOS targets were developed as shown in Table 1 below.

Table 1. Levels of Service and Level-of-Service Targets for the Surface Water Utility

Level of Service		Level-of-Service Target
LOS 1: Surface Water Impacts	Manage public health, safety, and environmental risks from impaired water quality, flooding, and failed infrastructure	No verifiable health and safety issues or environmental damage caused by the stormwater services outside of risk tolerance
LOS 2: Equitable Service	Provide consistent, equitable standards of service to the citizens of Shoreline at a reasonable cost, within rates and budget	Meet the levels of service as measured by customer satisfaction and rate and revenue projections
LOS 3: Communication and Outreach	Engage in transparent communication through public education and outreach	Maintain a communication plan to inform the community on Utility goals and progress
LOS 4: Regulatory Compliance	Comply with regulatory requirements for the urban drainage system	Meet or exceed regulatory requirements for NPDES Phase II and federal, State, and local regulations affecting surface water management

The LOS and LOS targets shown in Table 1 were used to develop a matrix of performance targets and performance measures, both of which provide a much higher level of detail and specificity. Performance targets were used to develop prioritization criteria for capital improvement projects and programmatic recommendations. By organizing and linking prioritization criteria back to levels of service, the Utility was better able to determine which projects and programs are likely to provide the greatest benefit toward achieving levels of service. The results of the prioritization, in combination with estimated costs, were used to select and assemble projects and programs into solution sets, or management strategies.

Evaluating Utility Programs

Utility programs are coordinated and planned activities with goals designed to help the Utility meet levels of service and address regulatory requirements. These include long-term or ongoing work activities that are supported by Utility staff and funded through operations budget. The Utility currently runs 18 programs falling into one of the following three categories:

- **Operational programs** help the Utility meet regulatory requirements, collect and analyze water quality data and asset information, perform routine inspections, and support overall Utility staff and resource management
- **Maintenance programs** include preventive and corrective maintenance including cleaning, repair, rehabilitation, and replacement of damaged or deteriorated Utility assets
- **Public involvement programs** educate and engage Shoreline's residents and ratepayers in surface water management and improving surface water quality

One of the major goals for the development of the 2018 Master Plan was to perform a thorough review of current programs and operational activities and their benefit to levels of service, needs identified in the basin plans, anticipated growth, and evolving regulations, and to develop detailed recommendations for improvements. The Utility evaluated the status of each existing program (as of 2017) and compared the program outcomes with level-of-service targets and upcoming regulatory requirements. Each of the evaluations resulted in one of three possible outcomes:

(1) maintain the existing program,
(2) enhance the existing program, or
(3) develop a new program to address potential needs.

Nine of the 18 existing programs were identified for enhancements, while nine new programs were also considered. Each of the programs was carried forward and prioritized based on LOS targets, and the highest-priority programs were selected for inclusion in management strategies.

Management Strategies

One of the key objectives of the 2018 Master Plan is to prioritize recommended programs and capital improvement projects, and to develop comprehensive management strategies based on those priorities. Programs and projects have considerable cost implications and must be prioritized for implementation over time and to ensure adequate funding.

A systematic process was developed, including a spreadsheet tool that applies a consistent set of criteria and procedures for scoring. Figure 1 below illustrates the prioritization and management strategy development process.

The Utility developed three alternative management strategies to comprise selected programs and projects. The three management strategies are defined as follows:

- **Minimum:** meet the minimum in terms of existing system needs and anticipated new regulatory requirements
- **Proactive**: minimum management strategy plus new high-priority projects and new/enhanced programs that address high-priority, long-term needs
- **Optimum:** proactive management strategy plus additional recommendations to enhance water quality and aquatic habitat

Program selections were based on prioritization scores, contributions toward meeting levels of service, and needs to address regulatory requirements. Selected programs are assumed to start within the next six years, while the remaining programs are deferred.

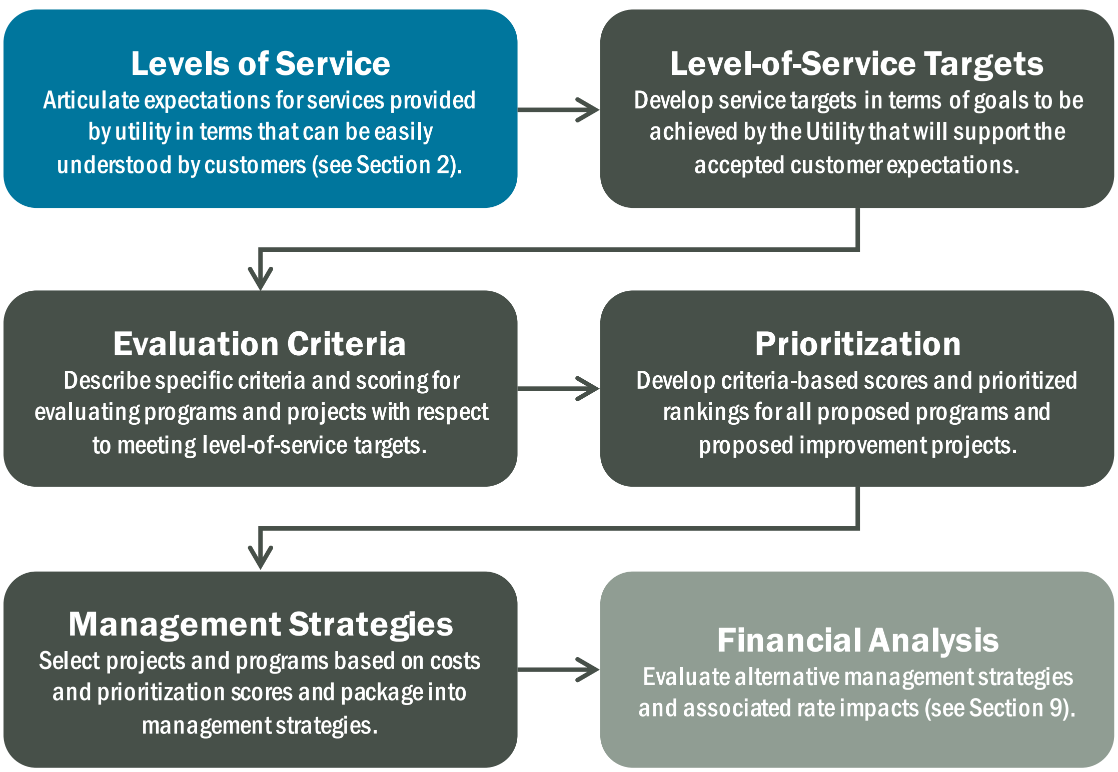

Figure 1. Prioritization process for developing management strategies

On August 7, 2017, Council provided direction for the Utility to pursue the *proactive management strategy*. This strategy includes construction of new high-priority projects and implement new/enhanced programs that address high priority long-term needs, as well as anticipated new regulatory requirements. More details on the projects and programs are provided in **Sections 8** and **10** of 2018 Master Plan and summarized below.

Programs

The *proactive management strategy* includes 24 programs: nine existing programs, nine enhanced programs, and six new programs. These programs have been developed to meet current and anticipated National Pollutant Discharge Elimination System (NPDES) permit requirements, implement Utility best management practices (BMPs), and reduce the backlog of existing programs. Table 2 presents a summary of the proactive management strategy by program category.

Table 2- Proactive Management Program Summary

Category	Program	Status	Planned Start Year
Operation	NPDES Compliance	Enhanced	2020[a]
	Floodplain Management	Existing	Ongoing
	Administration and Management	Existing	Ongoing
	Drainage Assessment	Enhanced	2018
	Water Quality Monitoring	Enhanced	2020[a]
	System Inspection	Enhanced	2018
	Condition Assessment	Enhanced	2018
	Private System Inspection	Enhanced	2019[b]
	Stormwater Permit	New	2019[b]
	Asset Management	Enhanced	2018
Maintenance	Street Sweeping	Existing	Ongoing
	System Maintenance	Existing	Ongoing
	Small Repairs	Existing	Ongoing
	SW Pipe Replacement	Enhanced	2019[b]
	Surface Water Small Projects	Enhanced	2018
	Catch Basin R&R	New	2018
	LID Maintenance	New	2018
	Pump Station Maintenance	New	2018
	Utility Crossing Removal	New	2018
Public involvement	Soak-It-Up Rebate	Existing	Ongoing
	Adopt-a-Drain	Existing	Ongoing
	Local Source Control	Existing	Ongoing
	Water Quality Public Outreach	Existing	Ongoing
	Business Inspection Source Control	New	2020[a]

a. Existing program to continue until enhanced program begins in noted year.
b. Program development begins in 2018; program implementation begins in noted year.

Projects

Twenty-five projects are included in the proposed 2018-2023 Six-year CIP as shown in Table 3. These projects ranked highest in the prioritization process and will be addressing existing system needs. Several of these projects are recommended for planning/pre-design/studies in the Six-year CIP to allow for development of specific solutions and applicable construction cost estimate where needed. Several projects were divided into phases where predesign/feasibility studies were needed or engineering and planning must be done well in advance of construction.

Table 3 – Proactive Management Project Summary

No	6-year CIP status[a]	Project Name
1	DC	25th Ave. NE Flood Reduction and NE 195th St. Culvert Replacement
2	P	Master Plan Update
3	PD	Springdale Ct. NW and Ridgefield Rd. Drainage Improvements
4	PDC	10th Ave. NE Stormwater Improvements
5	PD	Heron Creek Culvert Crossing at Springdale Ct. NW
6	DC	Hidden Lake Dam Removal
7	P	25th Ave. NE Ditch Improvements between NE 177th St. and 178th St.
8	PD	Pump Station 26
9	PD	Pump Station 30 Upgrades
10	P	6th Ave. NE and NE 200th St. Flood Reduction Project
11	PDC	Pump Station Misc. Improvements (Linden, Palatine, Pan Terra, 25, Ronald Bog, Serpentine)
12	C	NE 148th St. Infiltration Facilities
13	P	Boeing Creek Regional Stormwater Facility
14	P	System Capacity Modeling Study
15	PDC	NW 195th Pl. and Richmond Beach Dr. Flooding
16	P	Stabilize NW 16th Pl. Storm Drainage in Reserve M
17	P	Storm Creek Erosion Management Study
18	P	Climate Impacts and Resiliency Study
19	P	Boeing Creek Restoration
20	PD	NW 196th Pl. and 21st Ave. NW Infrastructure Improvements
21	P	18th Ave. NW and NW 204th St. Drainage System Connection
22	P	NW 197th Pl. and 15th Ave. NW Flooding
23	P	Lack of System and Ponding on 20th Ave. NW
24	P	12th Ave. NE Infiltration Pond Retrofits
25	P	NE 177th St. Drainage Improvements

a. Implementation status key: P = planning/predesign/study, D = design/permitting, C = construction

Funding

A financial analysis was prepared for capital projects and operations and maintenance (O&M) programs for a 20-year period (2017–2036) and therefore includes financial planning beyond the six-year period. The Financial Analysis (Section 9 of the 2018 Master Plan) describes the rate increases for the 2018–2023 projected rates and the 2024–2036 revenue requirements. Table 4 below provides the results of the projected rate analysis by year.

Table ES-1. Projected Percentage Rate Increases to Meet Proactive Level Program Expenditures

Rate Increase Summary	2017	2018	2019	2020	2021	2022	2023
Annual rate increases	NA	27.0%	15.0%	10.0%	10.0%	5.0%	5.0%
Single-family annual bill	$ 168.81	$ 214.38	$246.54	$ 271.19	$ 298.31	$ 322.18	$ 328.89
Increase over prior year	NA	$ 45.58	$ 32.16	$ 24.65	$ 27.12	$ 14.92	$ 15.66

Source: Table VI-1; City of Shoreline Surface Water Utility; Financial Analysis for 2017 Master Plan, FCS Group (November 2017) (Appendix L)

Measuring Program Success

As discussed earlier, programs included in the proactive management strategy have been developed to address high priority long-term needs, as well as anticipated new regulatory requirements. Over time, successful implementation of these programs will help the Utility meet the levels of service developed as part of the 2018 Master Plan.

As the Utility moves forward with implementing the programs included in the proactive management strategy, Staff will collect data and monitor the performance of these programs over time. The BC Team worked with Staff to assess each of the programs and describe the characteristics of a successful program. Staff then identified quantitative performance measures related to the successful implementation of each program. These performance measures were then narrowed down to one per program, and thresholds for success were set according to three possible ratings:

- **Meets Expectations:** program meets expectations and is consistent with meeting levels of service targets.
- **Needs Improvement**: program is active and is being implemented by staff, but still needs improvement to meet expectations and level of service targets.
- **Below Expectations:** program either does not exist, or falls short of meeting expectations and level of service targets.

An overall assessment of LOS can be made by combining the ratings of all related programs for a particular LOS. For example, if there are 11 programs that support Level of Service No. 1, the City can assess the status of each program and then determine an average rating. LOS Nos. 2, 3 and 4 have similar assessments. More details on monitoring program success are provided in Section 10.2.2 of the 2018 Master Plan.

Table 5 shows the overall ratings and planned improvements for how the programs will support the levels of service.

Table 5. Levels of Service and Level-of-Service Targets for the Surface Water Utility

	Level of Service	Level-of-Service Target	2017	2018	2023
1	Manage public health, safety and environmental risks from impaired water quality, flooding, and failed infrastructure	No verifiable health and safety issues or environmental damage caused by the stormwater services outside of risk tolerance.	🔴	🟡	🟢
2	Provide consistent, equitable standards of service to the citizens of Shoreline at a reasonable cost, within rates and budget	Meet the levels of service as measured by customer satisfaction and rate and revenue projections.	🟡	🟢	🟢
3	Engage in transparent communication through public education and outreach	Maintain a communication plan to inform the community on utility goals and progress	🟢	🟢	🟢
4	Comply with regulatory requirements for the urban drainage system	Meet regulatory requirements for NPDES Phase II and federal, state, and local regulations affecting surface water management	🔴	🟢	🟢

🟢 *Meets Expectations* 🟡 *Needs Improvement* 🔴 *Below Expectations*

Other 2018 Master Plan Elements

- **Asset Management Program Updates**
  Asset management is a major element of the 2018 Master Plan. An updated Asset Management Program will improve stewardship of the surface water system infrastructure and assure customers that funds are spent responsibly and effectively. A Utility Business Management Evaluation (UBME) was performed to examine current practices and identify specific actions for improving the Asset Management Program. Findings were used to develop an Asset Management Work Plan (AMWP) consisting of prioritized immediate, near-term, and long-term actions that will be included in the Asset Management Program recommendations. In addition, a conceptual framework was developed to guide the Utility on how to effectively manage assets and track operational activities and performance with respect to established levels of service.

- **Condition Assessment Management Plan**
  A Condition Assessment Management Plan (CAMP) has been developed to document data-driven and risk-based methodologies for managing condition assessment activities through ongoing inspections and collection of maintenance information for input to *Cityworks*. The CAMP provides recommendations for condition assessment management strategies for six stormwater asset groups

including pipes, catch basins, manholes, ditches, LID facilities, and pump stations. Each strategy addresses a range of management decisions including ongoing and routine maintenance activities, repair and replacement programs, and potentially increased inspection frequency where needed.

- **Stormwater Management Policy**
  Four key stormwater management policy issues were evaluated and, as noted above, discussed with Council on May 15, 2017. Prior Council guidance included support for three of the Staff recommendations including affirmation of current practices of using utility funds on private property and outside the Right-of-Way when public infrastructure is threatened, implementing permitting for the surface water utility, and using hard surfaces as chargeable area for surface water management fees.

- **Operations and Maintenance Manual**
  An Operation and Maintenance (O&M) Manual was developed to provide thorough documentation of the Utility's current O&M activities. The manual describes general work methods and provides photographic documentation for most types of stormwater assets in the Utility. The O&M Manual also provides guidance on frequencies for routine inspections and maintenance activities, as well as identifying conditions that trigger non-routine maintenance. In addition to documenting current O&M activities, new activities are also recommended such as an inspection program for large culverts, an improved pump station O&M and updates to the *Cityworks* system for improved record keeping.

- **System Capacity Modeling**
  A strategy for evaluating the stormwater system capacity was developed for the 2018 Master Plan. Capacity models for limited areas of the City's stormwater system have previously been done to help address specific issues. A data review and needs assessment found that hydrologic and hydraulic (H&H) modeling of the City's stormwater system would provide a valuable planning tool for evaluating drainage conveyance capacities under future development conditions, as well as analyzing existing deficiencies or capacity needs. However, infrastructure data (e.g., pipe size and elevations) will still need to be collected. The evaluation completed for the 2018 Master Plan recommends a phased approach for data collection and future modeling activities, and prioritizes the phases based on areas with existing capacity needs and where development densities are expected to significantly increase. Based on this recommendation, System Capacity Modeling is included as a new project targeted to be completed within the next six years, similar to the Basin Planning recommendation included in the 2011 Master Plan.

- **Stormwater Treatment Analysis**
  An analysis of stormwater treatment options has been developed for the 2018 Master Plan, examining the drainage areas contributing to each of the City's 148 mapped stormwater outfalls. Although the current Phase II NPDES Permit does not require existing stormwater systems be retrofitted to treat or control runoff, this could become a requirement in a future if federal regulations mandate

retrofitting, especially in areas draining to water bodies with Total Maximum Daily Loads (TMDLs). Stormwater control and treatment can be accomplished with centralized regional facilities or small distributed facilities (i.e., low impact development/green stormwater infrastructure like Rain Gardens). A high-level evaluation of these options was completed by dividing the areas contributing to the City's 148 outfalls into 53 discrete subbasins and examining development densities, potential constraints to infiltrating stormwater, and ballpark cost estimates. The cost comparison indicated that regional facilities may be less expensive than small distributed facilities in most subbasins, especially if significant infiltration can be achieved at the regional facility site. However, regional facilities can be more challenging to implement due to lack of suitable sites and the need for substantial up-front investment. Therefore, based on the high level analysis, system-wide stormwater treatment is not recommended.

PUBLIC OUTREACH

Public outreach has been an important component in developing the 2018 Master Plan. It ensures the City match customer expectations with the levels of service defined for the Utility and allows a process for residents feedback to be included in the plan development process.

The first public open house was held on Thursday, September 8, 2016, where a total of 23 Shoreline citizens attended. In addition, 177 Shoreline residents participated in a web-based survey. The findings from this outreach was incorporated in developing the project and program recommendations.

The second open house was held on Thursday, July 13, 2017, where a total of 8 residents attended, with a presentation on the three different management strategies. The residents were also asked to indicate their preferred stormwater management strategy by posting stickers on a display board outlining the three options.

In addition, a web-based survey was conducted to solicit feedback from the residents on the management strategies from July 5 through July 16, 2017. A total of 129 Shoreline Residents completed the survey and the complete results of the survey are provided in **Attachment B**. Key findings from the survey include the following:

- 48% of respondents prefer the "Proactive" management strategy
- 29% agree that City should increase the existing fees to assist with funding, with 27% strongly disagreeing with the City increasing fees.
- 47% rated stormwater issues as a moderate concern
- General concerns were relatively evenly distributed between flooding, water quality/pollution, and impacts to streams and wetlands.

RECOMMENDATION

Staff recommends the Comprehensive Plan be amended to include the updated 2018 Surface Water Master Plan. Currently, the Commission is scheduled to make a formal recommendation on the 2018 Comprehensive Plan Docket on October 4, 2018.

TIMING AND SCHEDULE

The schedule for the 2018 Master Plan through adoption with the 2018 Comprehensive plan includes:

- Public Comment on Draft Plan Document Ends– July 9, 2018
- Planning Commission Discussion on 2018 Surface Water Master Plan – July 5, 2018
- Public Hearing on 2018 Comprehensive Plan Docket - October 4, 2018
- Council discussion of 2018 Comprehensive Plan Docket – October 29, 2018
- Council adoption of 2018 Comprehensive Plan Docket – November 26, 2018

ATTACHMENTS

Attachment A: Draft 2018 Surface Water Master Plan
Attachment B: Draft 2018 Surface Water Master Plan Appendices
Attachment C: Capital Facilities Element Legislative Changes

DRAFT

Surface Water Master Plan

Prepared for

City of Shoreline

Shoreline, Washington

April 27, 2018

DRAFT

Surface Water Master Plan

Prepared for

City of Shoreline

Shoreline, Washington

April 27, 2018

This is a draft for internal review by City of Shoreline staff. This draft is not intended to be a final representation of the work done or recommendations made by Brown and Caldwell. It should not be relied upon; consult the final report.

Brown AND Caldwell

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Brown AND Caldwell

List of Abbreviations

§	section
2007 report	*2007 Bioassessment Report, Biological and Habitat Assessment of Shoreline Streams*
2016 Assessment	*2016 Fresh Water Assessment Report—State of Water Quality in Shoreline Streams and Lakes*
AMWP	Asset Management Work Plan
AKART	all known, available, and reasonable treatments
AO	Administrative Order
BC	Brown and Caldwell
BEACH	Beach Environmental Assessment, Communication and Health
B-IBI	Benthic Index of Biotic Integrity
BMP	best management practice
CAC	Community Assistance Contact
CAMP	*Condition Assessment Management Plan*
CCTV	closed-circuit television
CFR	Code of Federal Regulations
CIP	Capital Improvement Plan
CIPP	cured-in-place pipe
City	City of Shoreline
City Council	Shoreline City Council
Cityworks	Azteca Cityworks
CMMS	Computerized Maintenance Management System
CRS	Community Rating System
CWA	Clean Water Act
CWSRF	Clean Water State Revolving Fund
DEM	digital elevation model
DO	dissolved oxygen
Ecology	Washington State Department of Ecology
EDM	*Engineering Development Manual*
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
ET	evaporation and evapotranspiration
FEMA	Federal Emergency Management Agency
Financial Analysis Report	*Financial Analysis for 2018 Master Plan,* November 2017 (FCS Group 2017) (see Appendix K)
FIRM	flood insurance rate map
FTE	full-time equivalent
Fund	Surface Water Utility Enterprise Fund
GASB	Governmental Accounting Standards Board
GFC	General Facilities Charge
GIS	geographic information system
GMA	Growth Management Act
GO	General Obligation
GSI	green stormwater infrastructure
H&H	hydrologic and hydraulic
HPA	Hydraulic Project Approval
hr	hour(s)
IDDE	illicit discharge detection and elimination
LID	low impact development
LOS	level of service
Master Plan	*Surface Water Master Plan*
MEP	maximum extent practicable
MS4	municipal separate storm sewer system
N/A	not applicable
NEPA	National Environmental Policy Act
NFIP	National Flood Insurance Program
NMF	North Maintenance Facility
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
O&M	operations and maintenance
O&M Manual	*City of Shoreline Surface Water Utility Operation and Maintenance Manual*
Phase II Permit	NPDES Phase II Municipal Stormwater Permit
PLC	programmable logic controller
PSLC	Puget Sound LiDAR Consortium
PWTF	Public Works Trust Fund
QA/QC	quality assurance/quality control
RCW	Revised Code of Washington

ROW	right-of-way
R&R	repair and replacement
RSMP	Regional Stormwater Monitoring Program
SCADA	supervisory control and data acquisition
SEPA	State Environmental Policy Act
SFAP	Stormwater Financial Assistance Program
SMC	Shoreline Municipal Code
State	State of Washington
Stormwater Manual	*Stormwater Management Manual for Western Washington*
SWPP	stormwater pollution prevention plan
SWPRRP	Stormwater Pipe Repair and Replacement Project
TMDL	total maximum daily load
UBME	Utility Business Management Evaluation
USC	United States Code
Utility	Surface Water Utility
WAC	Washington Administrative Code
WDFW	Washington Department of Fish and Wildlife
WQI	Water Quality Index
WRIA	Water Resource Inventory Area
yr	year(s)

Executive Summary

Since incorporating in 1995, the City of Shoreline (City) has strengthened its municipal services over time, including a steady improvement of surface water management. The Surface Water Utility (Utility) and Surface Water Utility Enterprise Fund (Fund) were established in 2006. Shortly thereafter, in 2007, the City became a National Pollutant Discharge Elimination System (NPDES) Phase II Municipal Stormwater Permit (Phase II Permit) holder, which allows the City to discharge stormwater to surface waters of the state[1].

The Utility is the City's lead agency for maintaining Phase II Permit compliance, and is responsible for implementing the City's Stormwater Management Program. The Utility is also responsible for maintaining stormwater infrastructure, reducing flooding, and protecting surface water quality. The Utility prepared this 2018 *Surface Water Master Plan* (Master Plan) to guide activities for the next 5 to 10 years and address current challenges in stormwater management. In preparing this Master Plan, the following objectives were achieved:

- Develop updated levels of service (LOSs) for the Utility that align with customer expectations
- Review current policies, programs, and operational activities for the Utility and make recommendations for improvements
- Advance the Asset Management Program to improve stewardship of the surface water system infrastructure, and assure customers that funds are spent responsibly and effectively
- Prepare an operations and maintenance (O&M) manual to establish clear processes and protocols
- Assess the current state of the City's surface water systems
- Create an updated set of proposed capital improvement projects and prepare updated planning-level cost estimates
- Prioritize project and program recommendations for implementation
- Develop management strategies based on selected projects and programs
- Conduct a financial analysis to support funding and rate recommendations

Levels of Service

Functions and services provided by the Utility are shaped by the vision and values of the community, and are driven by State of Washington (State) and federal regulations. Levels of service are common-language statements that describe characteristics or attributes of services provided by the Utility to meet the community's basic needs and expectations. Levels of service should align with overall strategic goals of the organization and support its business drivers. Levels of service help Utility managers focus efforts and resources, communicate service expectations, and reconcile budgetary limitations.

[1] "Surface waters of the state" means all waters defined as "waters of the United States" in 40 CFR 122.2 that are within the boundaries of the state of Washington. This includes lakes, rivers, ponds, streams, inland waters, wetlands, ocean, bays, estuaries, sounds, and inlets. WAC 173-226-030.

As part of this 2018 Master Plan, the Utility has developed updated levels of service. The Utility started by considering the community's vision and values; reviewing the strategic goals of the City; and then engaging in a series of discussions with the public, City staff, and Shoreline City Council (City Council). The final levels of service and associated level-of-service targets are provided in Table ES-1.

Table ES-1. Levels of Service and Level-of-Service Targets for the Utility

Level of Service		Level-of-Service Target
LOS 1: Surface Water Impacts	Manage public health, safety, and environmental risks from impaired water quality, flooding, and failed infrastructure	No verifiable health and safety issues or environmental damage caused by the stormwater services outside of risk tolerance
LOS 2: Equitable Service	Provide consistent, equitable standards of service to the citizens of Shoreline at a reasonable cost, within rates and budget	Meet the levels of service as measured by customer satisfaction and rate and revenue projections
LOS 3: Communication and Outreach	Engage in transparent communication through public education and outreach	Maintain a communication plan to inform the community on Utility goals and progress
LOS 4: Regulatory Compliance	Comply with regulatory requirements for the urban drainage system	Meet or exceed regulatory requirements for NPDES Phase II and federal, State, and local regulations affecting surface water management

The levels of service and level-of-service targets shown in Table ES-1 were used to develop a matrix of performance targets and performance measures, both of which provide a much higher level of detail and specificity. Performance targets were used to develop prioritization criteria for capital improvement projects and programmatic recommendations. By organizing and linking prioritization criteria back to levels of service, the Utility was better able to determine which projects and programs are likely to provide the greatest benefit toward achieving levels of service. The results of the prioritization, in combination with estimated costs, were used to select and assemble projects and programs into solution sets, or *management strategies*.

Identifying Improvement Projects

The Utility prepared six basin plans between 2009 and 2016 for all of the city's drainage basins. The *Thornton Creek Watershed Plan* (completed in 2009) preceded the 2011 recommendation for basin planning because substantial drainage problems existed within the basin that drove a special planning effort. The five other basin plans followed the 2011 Master Plan, with two completed in 2013, two in 2015, and the final plan completed in 2016.

Detailed evaluations that were performed for each of the basin plans generated project and program recommendations to address problems related to flooding, water quality, and aquatic habitat. Recommendations were prioritized within each basin (e.g., high, medium, and low) based on the likelihood of success, number of issues addressed, whether public infrastructure or public safety were protected, and availability of public property to address the need. Recommendations from each of the basin plans have been compiled and now provide a basis for comprehensive planning that accounts for citywide priorities and includes financial planning, funding considerations, and/or potential rate impacts. Projects identified in the basin plans were carried forward and prioritized based on level-of-service targets, and the highest-priority projects were selected for inclusion in management strategies.

Evaluating Utility Programs

Utility programs are coordinated and planned activities with goals designed to help the Utility meet levels of service and address regulatory requirements. Programs involve various work activities including Utility administration, system operation and maintenance, and public involvement and outreach. Programs entail long-term or ongoing work activities that are supported by Utility staff and funded through operations budget. The Utility currently runs 18 programs falling into one of the following three categories:

- **Operational programs** help the Utility meet regulatory requirements, collect and analyze water quality data and asset information, perform routine inspections, and support overall Utility staff and resource management
- **Maintenance programs** include preventive and corrective maintenance including cleaning, repair, rehabilitation, and replacement of damaged or deteriorated Utility assets
- **Public involvement programs** educate and engage Shoreline's residents and ratepayers in surface water management and improving surface water quality

One of the major goals for the development of this Master Plan was to perform a thorough review of current programs and operational activities and their benefit to levels of service, needs identified in the basin plans, anticipated growth, and evolving regulations, and to develop detailed recommendations for improvements. The Utility evaluated the status of each existing program (as of 2017) and compared the program outcomes with level-of-service targets and upcoming regulatory requirements. Each of the evaluations resulted in one of three possible outcomes: (1) maintain the existing program, (2) enhance the existing program, or (3) develop a new program to address potential needs. Nine of the 18 existing programs were identified for enhancements, while 9 new programs were also considered. Each of the programs was carried forward and prioritized based on level-of-service targets, and the highest-priority programs were selected for inclusion in management strategies.

Management Strategies

One of the key objectives of this Master Plan is to prioritize recommended programs and capital improvement projects, and to develop comprehensive management strategies based on those priorities. Programs and projects have considerable cost implications and must be prioritized for implementation over time and to ensure adequate funding. A systematic process was developed, including a spreadsheet tool that applies a consistent set of criteria and procedures for scoring. Figure ES-1 below illustrates the prioritization and management strategy development process.

The Utility developed three alternative management strategies to comprise selected programs and projects. The three management strategies are defined as follows:

- **Minimum:** meet the minimum in terms of existing system needs and anticipated new regulatory requirements
- **Proactive:** minimum management strategy plus new high-priority projects and new/enhanced programs that address high-priority, long-term needs
- **Optimum:** proactive management strategy plus additional recommendations to enhance water quality and aquatic habitat

Program selections were based on prioritization scores, contributions toward meeting levels of service, and needs to address regulatory requirements. Selected programs are assumed to start within the next 6 years, while the remaining programs are deferred. Three programs were considered for inclusion in the 6-year Master Plan but were not included.

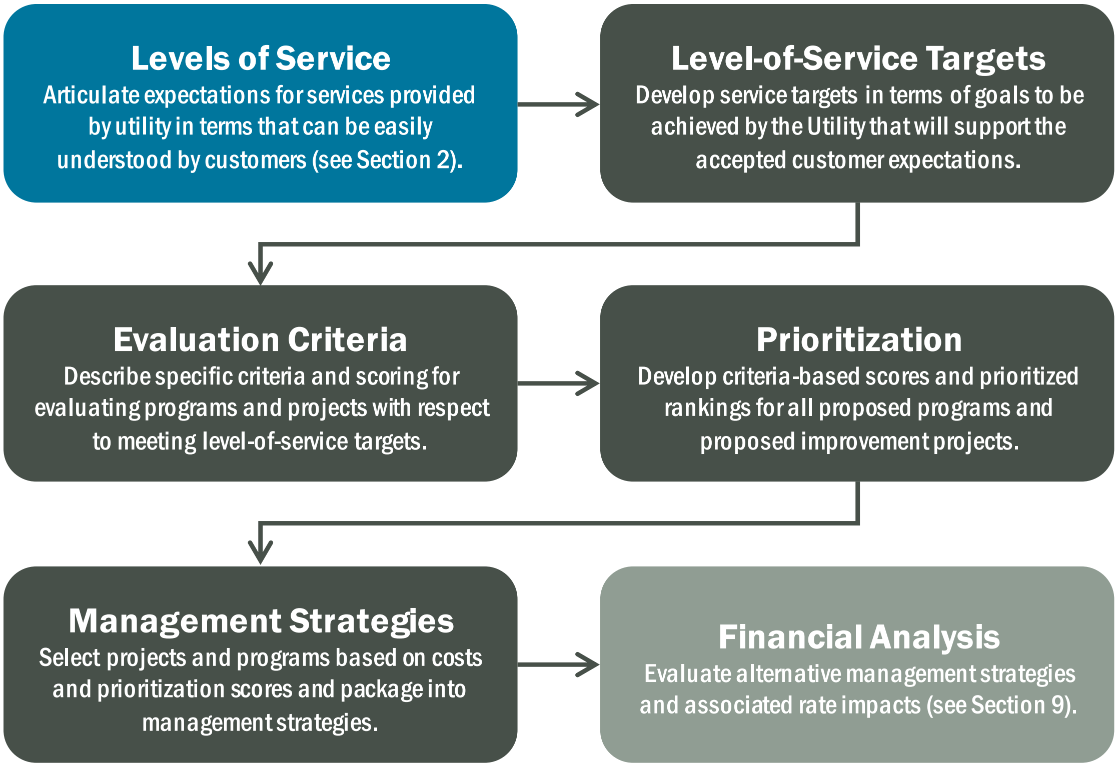


Figure ES-1. Prioritization process for developing management strategies

Projects were selected based primarily on prioritization scores, but with review and consideration for capital costs, project status (some projects have already been initiated), equitable distribution of projects throughout the city, and addressing a variety of project categories. Note that project selection is mostly a reflection of near-term versus long-term scheduling. Projects that were selected for each management strategy are to be included in the 6-year Capital Improvement Plan (CIP), with the remaining projects to be completed over a 20-year planning horizon. In some cases, projects are assumed to be initiated (e.g., planning, design, and permitting phases) during the 6-year planning; however, construction is assumed to be completed in subsequent years. Table ES-2 provides a summary of the number of projects and programs selected for the three management strategies, as well as a qualitative assessment of the benefits to the four levels of service.

Table ES-2. Management Strategy Summary with Cost and Levels of Service Impacts

Management Strategy	Number of Projects and Programs	Total Annual Program Cost, $ million [a]	Total 6-Year Project Cost, $ million [b]	Benefit to Levels of Service			
				Surface Water Impacts	Equitable Service	Communication and Outreach	Regulatory Compliance
Minimum	18 programs 6 projects	4.3	6.2	Low	Medium	Medium	Medium
Proactive [c]	24 programs 26 projects	6.0	11.1	Medium	High	High	High
Optimum	27 programs 30 projects	6.7	16.3	High	High	High	High

a. Includes $3.66 million of current program expenses.

b. Total 6-year project costs based on 2017 dollars.

c. City Council approved the Utility's recommended proactive management strategy based on financial analyses (see Section 9).

The Utility is responsible for funding all program and capital costs. The primary source of funding is a surface water management (SWM) fee assessed to all properties in the city. The fee is billed on King County's property tax statement. Nominal additional revenues are generated through interest earned on reserves and grants. The City controls the SWM fee and the City Council has the authority to adjust the fees as needed to meet financial objectives. A financial analysis was conducted to assess total system costs (capital and non-capital) and assessed funding sources (both current and potential additional funding sources) for each management strategy. Table ES-3 summarizes the annual revenue requirements based on the forecast of revenues, expenditures, fund balances, and fiscal policies that would be needed for each management strategy.

Table ES-3. Management Strategy Financial Analysis Summary

Management Strategy Rate Impact Summary	2017	Year 1 2018	Year 2 2019	Year 3 2020	Year 4 2021	Year 4 2022	Year 5 2023
Minimum							
Proposed increase	N/A	20%	5%	5%	4%	3%	3%
Resulting revenue	$4,488,372	$ 5,391,433	$ 5,666,666	$ 5,955,949	$ 6,200,381	$ 6,392,779	$ 6,591,147
Proactive							
Proposed increase	N/A	27%	15%	10%	10%	5%	5%
Resulting revenue	$4,488,372	$ 5,705,933	$ 6,568,385	$ 7,232,449	$ 7,963,649	$ 8,370,193	$ 8,797,492
Optimum							
Proposed increase	N/A	42%	20%	10%	8%	5%	5%
Resulting revenue	$4,488,372	$ 6,379,862	$ 7,663,490	$ 8,438,269	$ 9,122,444	$ 9,588,145	$ 10,077,620

Source: Table IV-1, City of Shoreline Surface Water Utility; Financial Analysis for 2017 Master Plan, FCS Group (November 2017), Appendix L.

With the greatest number of programs and projects, the optimum strategy has the highest annual revenue requirements and thus the largest rate adjustment of the three scenarios. However, all scenarios require increases in annual revenue to meet new, required expenses as they relate to regulatory requirements and appropriately managing the system. In all three scenarios, an initial, larger, revenue increase is required in 2018 followed by subsequent smaller increases over the next 5 years. This is due to increases in O&M expenses to meet regulatory and basic management requirements for operating the Utility.

These expenses cannot be funded through debt and thus the rate impact cannot be spread out over time. Efforts were made to spread costs and delay projects where possible to mitigate initial rate impacts. The Utility staff recommends the proactive management strategy. This strategy allows the City to not only be compliant with permit requirements but also to attend to desired levels of service and pressing investment needs.

Recommendations for Implementation

Utility staff presented the management strategies and results of the financial analysis to the City Council in August 2017, recommending implementation of the proactive management strategy. The recommendation for the proactive management strategy is based on the expected level of service provided for the associated cost and impact on surface water management fees. The proactive management strategy provides the following:

- Programs that meet current O&M needs and regulatory requirements
- Programs to meet anticipated new regulatory requirements
- High-priority projects and programs that most directly help meet the four levels of service
- Equitable Utility services across the city's drainage basins

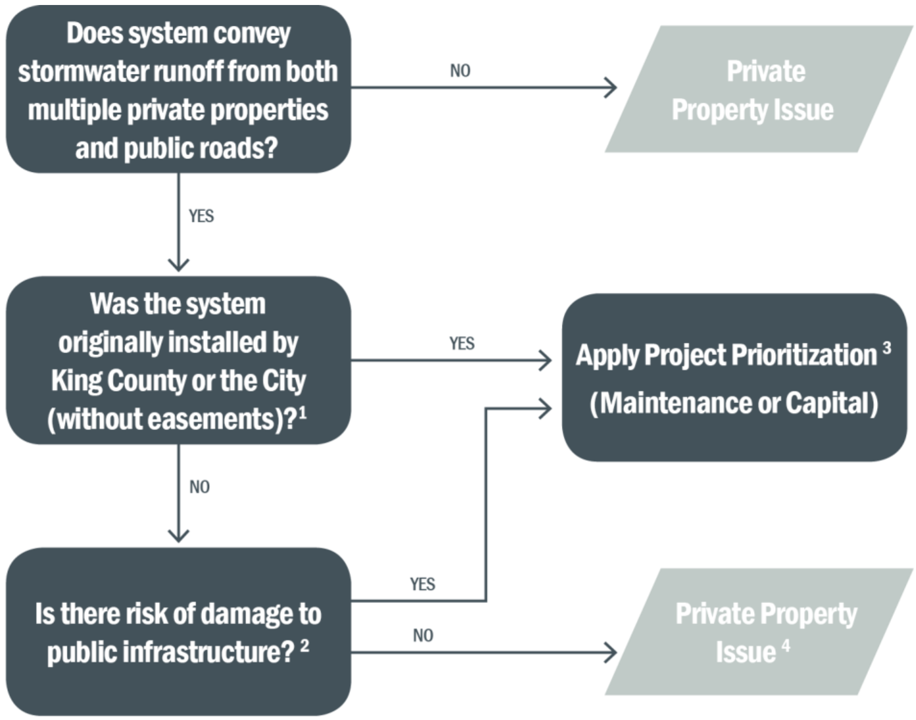
The City Council directed Utility staff to proceed with the proactive management strategy for preparing costs and financial information for the 2018–2023 CIP and 2018 City budget. The following sections summarize the policy recommendations, programs, and projects associated with implementation of the proactive management strategy.

Policy Recommendations

Utility staff conducted policy issue discussions with the City Council on four key policy issues. The following bullets summarize the recommended course of action based on the guidance provided by the City Council:

- **Use of Utility funds outside of the right-of-way (ROW):** The Utility will continue the practice of not expending Utility funds on private property unless City staff determine that the facilities in question are the responsibility of the City or public infrastructure is threatened. Utility staff will follow a "decision requirements" flow chart, shown in Figure ES-2 below. This flow chart shows the criteria Utility staff and the City Attorney will use to identify situations where it is appropriate to use Utility funds outside the ROW.
- **Stormwater Permit:** The Utility will establish a Stormwater Permit that consolidates all the onsite and ROW stormwater review activity into a single permit process covering all ongoing inspections, operations, maintenance, and enforcement of maintenance standards for private drainage systems as required by the Phase II Permit. The Stormwater Permit Program is intended to provide operating budget and staff resources for implementing this recommendation.
- **Surface water management fee-chargeable area:** The Utility will change the chargeable area for surface water fees to be based on hard surfaces. The chargeable area was updated in the surface water management rate table (Shoreline Municipal Code [SMC] 3.01.400) when the City Council approved the 2018 budget.
- **Private facility inspection and maintenance:** The Utility will continue with the current inspection and maintenance program but will embark on a pilot program offering private properties the option to participate in a self-certification program. The Utility estimated an operating budget for the Utility staff to develop the self-certification process over the next 6 years.

The Utility is expected to proceed as described above on each policy issue. Actions required by the Utility have been incorporated into program recommendations where applicable.



Footnotes:

1. In some areas, King County constructed improvements without securing easements. In these cases, there may be a legal justification for the City to secure drainage easements and assume maintenance, particularly if it is a trunk system that serves multiple properties. The City may require that the system be brought up to City standards and that the easement be provided to the City at no cost.
2. Includes flooding or erosion that results in (or could result in future) damage to public roads, infrastructure, or structures.
3. Determine resolution, if possible through a Drainage study/Assessment, then apply project prioritization criteria established in the 2018 Master Plan for prioritization and scheduling. This will include easement acquisition or relocating to the ROW.
4. The City may offer technical guidance.

Figure ES-2. Decision requirements for use of Utility funds outside the ROW

Programs

The proactive management strategy includes 24 programs: 9 existing programs, 9 enhanced programs, and 6 new programs. These programs have been developed to meet current and anticipated NPDES requirements, implement Utility best management practices (BMPs), and reduce the backlog of existing programs. Table ES-4 presents a summary of the proactive management strategy by program category with additional annual operation costs and estimated staffing. Staffing needs were developed by identifying program activities and workload estimates for enhanced and new programs.

Table ES-4. Implemented Program Summary					
Category	Program	Status	Planned Start Year	Operating Cost (Additional to Existing)	Additional Staffing (FTE)
Operation	NPDES Compliance	Enhanced	2020[a]	$32,480	0.13
	Floodplain Management	Existing	Ongoing	-[c]	-[d]
	Administration and Management	Existing	Ongoing	-[c]	-[d]
	Drainage Assessment	Enhanced	2018	$175,640	0.20
	Water Quality Monitoring	Enhanced	2020[a]	$85,470	0.25
	System Inspection	Enhanced	2018	$47,021	0.25
	Condition Assessment	Enhanced	2018	$160,340	0.34
	Private System Inspection	Enhanced	2019[b]	$62,192	0.40
	Stormwater Permit	New	2019[b]	$47,840	0.33
	Asset Management	Enhanced	2018	$69,200	0.25
Maintenance	Street Sweeping	Existing	Ongoing	-[c]	-[d]
	System Maintenance	Existing	Ongoing	-[c]	-[d]
	Small Repairs	Existing	Ongoing	-[c]	-
	SW Pipe Replacement	Enhanced	2019[b]	$651,520	0.52
	Surface Water Small Projects	Enhanced	2018	$400,000	0.16
	Catch Basin R&R	New	2018	$354,100	0.20
	LID Maintenance	New	2018	$53,732	0.10
	Pump Station Maintenance	New	2018	$63,600	0.10
	Utility Crossing Removal	New	2018	$18,400	0.15
Public involvement	Soak-It-Up Rebate	Existing	Ongoing	-[c]	-[d]
	Adopt-a-Drain	Existing	Ongoing	-[c]	-[d]
	Local Source Control	Existing	Ongoing	-[c]	-[d]
	Water Quality Public Outreach	Existing	Ongoing	-[c]	-[d]
	Business Inspection Source Control	New	2020[a]	$86,780	0.10
Average annual O&M effort for infrastructure associated with proactive management strategy				$33,867	0.02
			Total	$2,342,182	3.50

a. *Existing program to continue until enhanced program begins in noted year.*

b. *Program development begins in 2018; program implementation begins in noted year.*

c. *Costs for existing programs assumed to be included within existing operation costs.*

d. *Staffing for existing programs assumed to be covered by existing staff.*

Projects

The City Council approved staff's recommendation for the implementation of the proactive management strategy, which includes 25 projects, 21 of which are construction projects and 4 of which are studies or plans. The proactive projects include high-priority construction projects and studies that help meet the level-of-service targets. Projects selected for the 6-year CIP were then examined in closer detail with respect to implementation. Several projects were divided into phases where predesign/feasibility studies were needed or engineering and planning must be done well in advance of construction. Table ES-5 lists the proactive management strategy projects in order of priority with costs in 2017 dollars.

	Table ES-5. Proactive Management Strategy Project Summary			
No	6-year CIP status[a]	Project Name	6-Year CIP Cost [b]	Capital Cost [b]
1	DC	25th Ave. NE Flood Reduction and NE 195th St. Culvert Replacement	$2,674,000	$8,226,000
2	P	Master Plan Update	$500,000	$500,000
3	PD	Springdale Ct. NW and Ridgefield Rd. Drainage Improvements	$545,000	$2,058,000
4	PDC	10th Ave. NE Stormwater Improvements	$1,788,000	$1,788,000
5	PD	Heron Creek Culvert Crossing at Springdale Ct. NW	$226,000	$855,000
6	DC	Hidden Lake Dam Removal	$2,097,000	$2,097,000
7	P	25th Ave. NE Ditch Improvements between NE 177th St. and 178th St.	$141,000	$2,538,000
8	PD	Pump Station 26	$320,000	$891,000
9	PD	Pump Station 30 Upgrades	$90,000	$339,000
10	P	6th Ave. NE and NE 200th St. Flood Reduction Project	$22,000	$384,000
11	PDC	Pump Station Misc. Improvements (Linden, Palatine, Pan Terra, 25, Ronald Bog, Serpentine)	$732,000	$732,000
12	C	NE 148th St. Infiltration Facilities	$393,000	$393,000
13	P	Boeing Creek Regional Stormwater Facility	$83,000	$9,440,000
14	P	System Capacity Modeling Study	$300,000	$300,000
15	PDC	NW 195th Pl. and Richmond Beach Dr. Flooding	$747,000	$747,000
16	P	Stabilize NW 16th Pl. Storm Drainage in Reserve M	$28,000	$500,000
17	P	Storm Creek Erosion Management Study	$80,000	$80,000
18	P	Climate Impacts and Resiliency Study	$80,000	$80,000
19	P	Boeing Creek Restoration	$50,000	$7,630,000
20	PD	NW 196th Pl. and 21st Ave. NW Infrastructure Improvements	$83,000	$313,000
21	P	18th Ave. NW and NW 204th St. Drainage System Connection	$15,000	$261,000
22	P	NW 197th Pl. and 15th Ave. NW Flooding	$7,000	$119,000
23	P	Lack of System and Ponding on 20th Ave. NW	$81,000	$1,458,000
24	P	12th Ave. NE Infiltration Pond Retrofits	$38,000	$677,000
25	P	NE 177th St. Drainage Improvements	$9,000	$152,000
			$11,129,000	$51,920,000

a. Implementation status key: P = planning/predesign/study, D = design/permitting, C = construction

b. 2017 dollars. O&M and other life-cycle costs included in financial planning analysis.

Funding

A financial analysis was prepared for capital projects and O&M programs for a 20-year period (2017–2036) and therefore includes financial planning beyond the 6-year period. The Financial Analysis Report (Appendix L) describes the rate increases for the 2018–2023 projected rates and the 2024–2036 revenue requirements. The report also accounts for the associated costs for the debt servicing, reserve funds, and meeting the policy requirements over the planning period. The report then projects the rate increases necessary to support this level of programming. Table ES-6 below provides the results of the projected rate analysis by year.

Table ES-6. Projected Percentage Rate Increases to Meet Proactive Level Program Expenditures							
Rate Increase Summary	2017	2018	2019	2020	2021	2022	2023
Annual rate increases	NA	27.0%	15.0%	10.0%	10.0%	5.0%	5.0%
Single-family annual bill	$ 168.81	$ 214.38	$246.54	$ 271.19	$ 298.31	$ 322.18	$ 328.89
Increase over prior year	NA	$ 45.58	$ 32.16	$ 24.65	$ 27.12	$ 14.92	$ 15.66

Source: Table VI-1; City of Shoreline Surface Water Utility; Financial Analysis for 2017 Master Plan, FCS Group (November 2017) (Appendix L)

Surface water management fee rates are approved annually when the City's annual budget is approved. The rate increases required for the proactive management strategy are implemented for the 6-year planning period through the budget approval.

The analysis shows the need for the rate's highest increase in 2018 with gradually smaller increases in later years. For single-family residences, this reflects an increase in the annual surface water charge from $168.81 in 2017 to $328.89 by 2023. The same percentage increase would apply for every customer type. The current customer rates were adopted on November 20, 2017, when the City Council approved the 2018 budget; these are located in the SMC 3.01.400 Surface Water Management rate table.

Capital improvement estimates show a sustained increase in capital investments from 2024 through 2036. This increase currently results in an average of more than $3 million annually in additional capital expenditures as compared to the current 6-year spending average. Because of sustained above-inflation increases through 2023, current financial forecasts show that the City will require slightly lower rate increases starting in 2024 (of 7 percent) that reduce toward inflationary increases over time despite the higher projected capital expenditures. These forecasts are dependent on the City maintaining its current capital schedule and cost estimates.

It is important that the City revisit the identified rates annually to ensure that the rate projections developed remain adequate. Any significant changes should be incorporated into the financial plan and future rates should be adjusted as needed.

The City should take extra consideration of improved capital cost estimates and scheduling in the 2024–2036 planning period. While the current rate forecast plans for an increase in capital expenditures through this period, changes to costs and schedules will be important to incorporate.

Other financial planning recommendations include the following:

- Adopt rate structure presented for the proactive management strategy
- Revise City "CIP model" to include updated reserve requirements including:
  - 120 days of O&M expenses minimum operating reserve balance
  - 2 percent of assets minimum capital reserve balance
- Review rates and current operational and capital needs annually
- Conduct new financial analysis in 5 years to ensure that projected rates are in line with Utility expenses

Section 1

Introduction

Shoreline, Washington, is a community in northern King County comprising roughly 55,000 residents and covering an area of nearly 12 square miles. Since incorporating in 1995, the City of Shoreline (City) has strengthened its municipal services over time, including a steady improvement of surface water management. The City adopted its first drainage code and established the Surface Water Management Fund in 1995. Operations and maintenance (O&M) work and assessment activities followed in 1997. The Surface Water Utility (Utility) and the Surface Water Utility Enterprise Fund (Fund) were established in 2006. Shortly thereafter, in 2007, the City became a National Pollutant Discharge Elimination System (NPDES) Phase II Municipal Stormwater Permit (Phase II Permit) holder, which allows the City to discharge stormwater to surface waters of the state[2].

The Utility is the City's lead agency for maintaining Phase II Permit compliance, and is responsible for implementing the City's Stormwater Management Program. The Utility is also responsible for maintaining stormwater infrastructure, reducing flooding, and protecting surface water quality. The Utility prepared this 2018 *Surface Water Master Plan* (Master Plan) to guide activities for the next 5 to 10 years and address current challenges in stormwater management.

1.1 History of Planning Efforts

The City's first Master Plan was developed in 2005 to address prevailing needs for flood protection, water quality improvement, and stream habitat protection. The 2005 Master Plan focused on identifying problems and recommending specific structural projects and non-structural programs to address the identified problems. The 2005 Master Plan also included an evaluation of stormwater management activities necessary to comply with the forthcoming 2007 Phase II Permit[3]. The 2005 Master Plan included a financial analysis documenting the need for surface water management fees to support drainage improvements and mandatory compliance with the Phase II Permit.

An updated Master Plan was prepared in 2011 to address the Utility's growing needs, including the new and more stringent requirements anticipated with the 2013 Phase II Permit[4]. As services and regulatory compliance activities became more complex, the Utility required a more sophisticated approach to surface water planning and management. To address this need, the 2011 Master Plan established basic levels of service (LOSs) for the Utility, examined operations and policies, provided recommendations for improvements, and analyzed the rates needed to support the Master Plan. One of the key outcomes from the 2011 Master Plan was a schedule to complete a basin planning effort, which was designed to address stormwater management issues that are unique to each drainage area within the city.

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[2] "Surface waters of the state" means all waters defined as "waters of the United States" in 40 CFR 122.2 that are within the boundaries of the state of Washington. This includes lakes, rivers, ponds, streams, inland waters, wetlands, ocean, bays, estuaries, sounds, and inlets. WAC 173-226-030.

[3] The 2007–2012 Phase II Permit included new requirements for construction site and post-construction runoff control; IDDE, MS4, and O&M program requirements; and public education, outreach, and participation.

[4] The 2013–2018 Phase II Permit was issued in 2012 and became effective in 2013. New requirements in this permit included LID requirements for new development and redevelopment, and additional water quality data collection and documentation of financial contribution to the new RSMP administered by Ecology.

The Utility prepared six basin plans between 2009 and 2016 for all of the city's drainage basins. The *Thornton Creek Watershed Plan* (completed in 2009) preceded the 2011 recommendation for basin planning because substantial drainage problems existed within the basin that drove a special planning effort. The five other basin plans followed the 2011 Master Plan, with two completed in 2013, two in 2015, and the final plan completed in 2016. Figure 1-1 shows the areas covered by each of the basin plans. Table 1-1 summarizes the six basin planning documents.

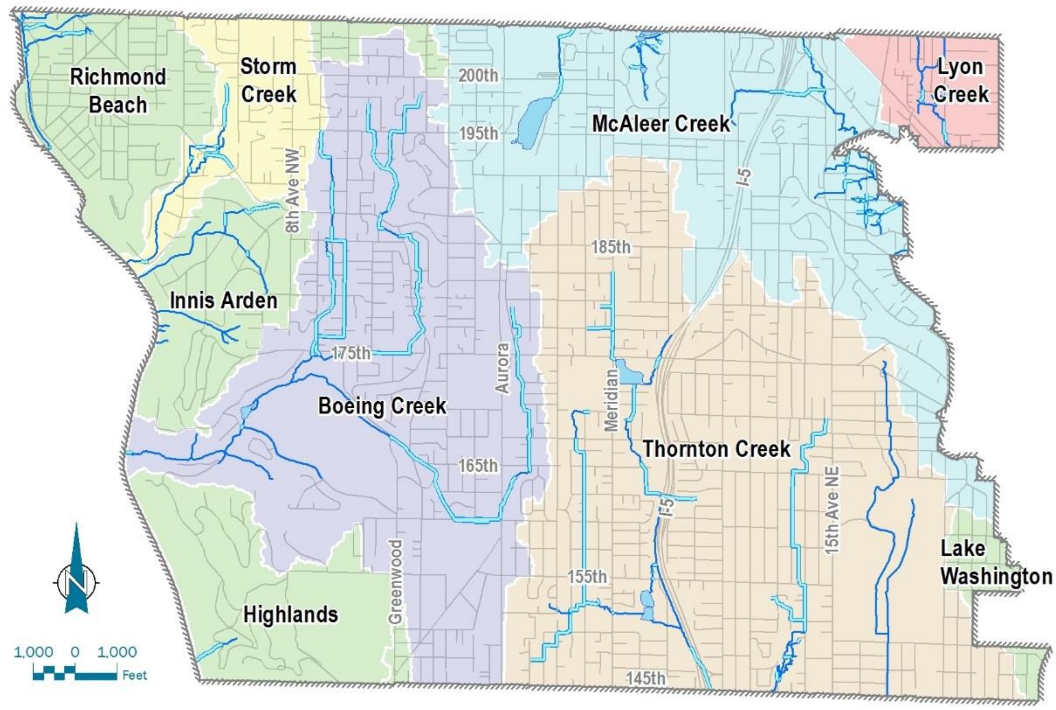

Figure 1-1. Shoreline surface water basins

Table 1-1. Summary of Basin Planning Efforts			
Basin Plan Title	Date Completed	Area Covered within the City (acres)	Key Outcomes
Thornton Creek Watershed Plan	November 2009	2,375	• Capital improvement projects [a] • Programmatic measures and studies [a] • Flood hazard mitigation and mapping [b] • Recommendations for development standards [b]
Storm Creek Basin Plan	March 2013	308	• Capital improvement projects • Programmatic measures and studies • Condition assessment for stormwater pipes [a]
Boeing Creek Basin Plan	March 2013	1,769	• Capital improvement projects • Programmatic measures and studies • Condition assessment for stormwater pipes
Lyon Creek Basin Plan	October 2015	178	• Capital improvement projects • Programmatic measures and studies • Condition assessment for stormwater pipes • Risk-based prioritization of pipe repair and replacement (R&R) [a]
McAleer Creek Basin Plan	November 2015	1,370	• Capital improvement projects • Programmatic measures and studies • Condition assessment for stormwater pipes • Risk-based prioritization of pipe R&R
Puget Sound Drainages Basin Plan (including Lake Washington and other small basins)	December 2016	1,402	• Capital improvement projects • Programmatic measures and studies • Condition assessment for stormwater pipes • Risk-based prioritization of pipe R&R

a. *Indicates a key outcome included subsequent basin plans.*

b. *Indicates a difference in key outcomes compared to preceding basin plans.*

Detailed evaluations that were performed for each of the basin plans generated project and program recommendations to address problems related to flooding, water quality, and aquatic habitat. Recommendations were prioritized within each basin (e.g., high, medium, and low) based on the likelihood of success, number of issues addressed, whether public infrastructure or public safety were protected, and the availability of public property to address the need. Detailed recommendations from each of the basin plans have been compiled and now provide a basis for comprehensive planning that accounts for citywide priorities and includes financial planning, funding considerations, and/or potential rate impacts.

1.2 Purpose and Objectives

The purpose of this Master Plan is to provide a comprehensive update to the 2011 Master Plan and prioritize the recommendations from the recent basin planning efforts. This Master Plan will guide the Utility for the next 5 to 10 years and addresses emerging issues associated with rapid growth, increasing regulations, and aging infrastructure. In preparing this Master Plan, the following objectives were achieved:

- **Develop updated levels of service for the Utility that align with customer expectations:** The Utility worked closely with customers, Public Works staff, and the Shoreline City Council (City Council) to develop refined language for levels of service. The new levels of service reflect current customer expectations and provide a firm basis for operational decisions and priorities.
- **Review current policies, programs, and operational activities for the Utility and make recommendations for improvements:** Because of recent and anticipated growth and evolving regulations, the Utility worked with Public Works staff and the City Council to develop new policies, as well as recommendations for new and enhanced programs to address current needs. Program recommendations include details regarding costs, additional staffing needs, and performance measures for monitoring program success over time.
- **Advance the Asset Management Program to improve stewardship of the surface water system infrastructure, and assure customers that funds are spent responsibly and effectively:** Asset management ties expenditures to customer service levels, and through increased accountability aims to ensure that all asset decisions reflect the lowest life-cycle cost needed to meet customer expectations at responsible levels of risk. The Utility evaluated its current business practices and developed an Asset Management Work Plan (AMWP) to address gaps and develop near- and long-term actions for improving asset management practices.
- **Prepare an O&M manual to establish clear processes and protocols:** The Utility developed an updated and substantially expanded O&M manual to document the function and frequency of periodic maintenance activities, maximize the use of its Computerized Maintenance Management System (CMMS), and support improvements in asset management practices.
- **Assess the current state of the City's surface water systems:** The Utility synthesized available information from multiple sources, including basin plans, condition assessment data, previous modeling efforts, geospatial databases, and other available documents. In addition, the Utility evaluated water quality treatment options and developed a framework for system-wide capacity modeling.
- **Create an updated set of proposed capital improvement projects and prepare updated planning-level cost estimates:** The Utility developed an updated database of capital improvement projects that were identified through basin planning efforts, pump station condition assessment, the drainage assessment program, and ongoing pipe inspection and condition assessment programs. Project updates included the development of updated project cost estimates using a consistent set of costing assumptions.
- **Prioritize project and program recommendations for implementation:** The Utility established transparent and repeatable processes to prioritize projects and programs based on their potential to support meeting the level-of-service targets. The Utility used the prioritization results to select projects for the 6-year Capital Improvement Plan (CIP) and programs to be implemented over the same time frame.
- **Develop management strategies based on selected projects and programs:** Projects and programs were selected and packaged into management strategies that were evaluated with respect to meeting levels of service and costs to the Utility.

- **Conduct a financial analysis to support funding and rate recommendations:** Implementation of new and revised policies, programs, and projects requires financial planning that provides for implementation of a selected management strategy. The Utility conducted a financial analysis to determine the rates and revenue required to meet the operational, debt service, and capital improvement costs associated with implementation of each of the identified management strategies. The results were used to select a preferred management strategy for the Utility.

1.3 Planning and Review Process

The City retained Brown and Caldwell (BC) to assist with development of the 2018 Master Plan; work began in July 2016. During the process for plan development, the City held two public meetings and obtained input from the City Council. In addition, two Web-based public surveys were conducted to provide input on this Master Plan. More information about these efforts is included in the following paragraphs.

1.3.1 Public Meetings

Obtaining public input is an important way to match customer expectations with the levels of service that are defined for the Utility. A public meeting and open house were held at Shoreline City Hall on September 8, 2016. A total of 23 Shoreline citizens attended and listened to a short presentation on the surface water master planning process and development of levels of service for the Utility. The presentation was followed by many questions from the attendees, ranging from a general discussion on surface water to specific drainage problems experienced by residents. City staff were on hand to answer questions, interact with attendees, and gather feedback.

After the questions portion of the meeting, residents were encouraged to visit each of the two work stations set up within the room. The first work station focused on general surface water topics and planning processes. The second work station exhibited draft levels of service for the Utility and attendees interactively posted stickers indicating, in their view, the priorities of the Utility. Questions, comments, and priority notes from the open house were compiled and used to inform the development of levels of service and level-of-service targets.

A second open house was held at Shoreline City Hall on July 13, 2017. Eight residents attended and listened to a short presentation on the progress of the 2018 Master Plan. The presentation included an overview of project and program recommendations and a brief discussion of three proposed management strategies for the Utility. Work stations were set up within the room and residents were also asked to indicate which of the three stormwater management strategies they preferred by posting stickers on a display board outlining the three options. Figure 1-2 illustrates the basic steps of the 2018 Master Plan development process and the points where open houses were used to solicit feedback from the public.

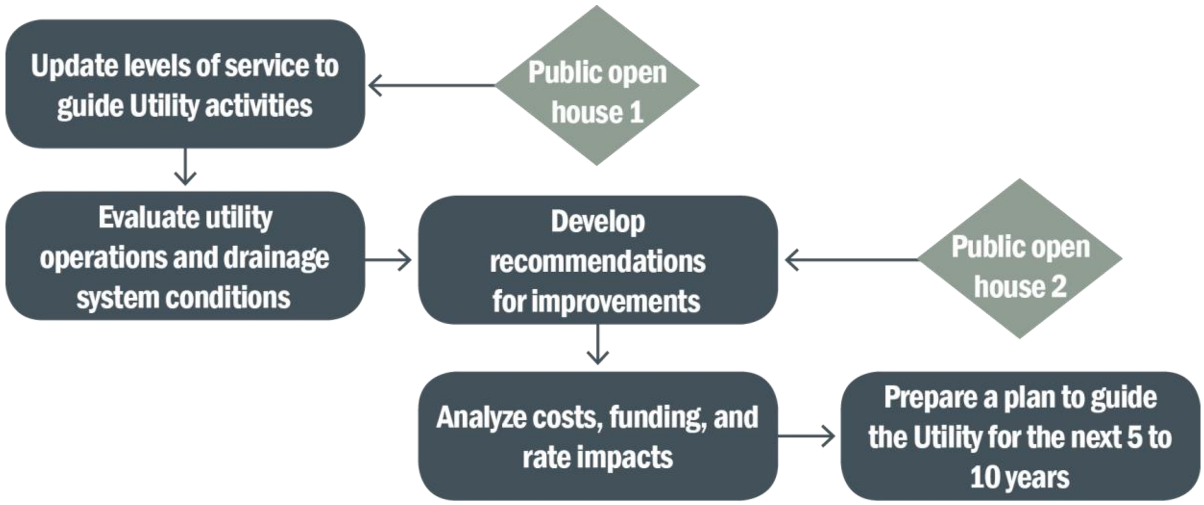

Figure 1-2. Public input was obtained through two open houses held during development of this Master Plan

1.3.2 Public Surveys

Public surveys were conducted in conjunction with each of the two public open houses to solicit direct feedback on levels of service and management strategies for the Utility (Table 1-2). In each case, the Web-based survey was released in advance of the public open house through various channels including Shoreline Alerts, Shoreline Area News, neighborhood associations, and the City's website. Survey questionnaires were also available to the attendees of each public open house. Public survey results are provided in Appendix A.

Table 1-2. Public Survey Activities

Survey Number	Dates of Survey	Number of Responses	Primary Topic
1	September 2–16, 2016	177	Proposed levels of service
2	July 5–16, 2017	129	Proposed management strategies

1.3.3 Reports to City Council

Utility staff provided updates to the City Council at five key points throughout the planning process. Staff reports were prepared in advance of scheduled City Council meetings, and presentations were given during each meeting, followed by questions from council members. These updates were not intended only to inform the City Council of progress on the 2018 Master Plan, but also to provide council members with opportunities to provide feedback and direction throughout the planning process. The following is a summary of the City Council meetings:

- **City Council meeting 1:** On October 10, 2016, the City Council received an introduction to the 2018 Master Plan planning process and reviewed the draft levels of service and level-of-service targets that were to be used in development of the 2018 Master Plan recommendations.
- **City Council meeting 2:** On May 15, 2017, the City Council discussed and provided direction on four key policy issues related to operation of the Utility, the outcomes for which have been incorporated into the program recommendations for the 2018 Master Plan.
- **City Council meeting 3:** On July 17, 2017, the City Council reviewed management strategies, which consisted of different groupings of projects and programs. The City Council also reviewed a summary and provided feedback on the prioritization process and management strategies being evaluated in the financial analysis.

- **City Council meeting 4:** On August 7, 2017, the City Council discussed and provided direction on a preferred management strategy for use in developing rates and financial analysis for the 2018 Master Plan and 2018–2023 rates.
- **City Council meeting 5:** On December 4, 2017, the City Council reviewed the new and enhanced Utility programs scheduled to begin in 2018 along with performance measures that will be used to monitor the success of the programs.

1.3.4 State Environmental Policy Act

The State Environmental Policy Act (SEPA) requires State of Washington (State) and local agencies to consider the likely environmental consequences of a proposal before approving or denying that proposal. This process provides a way to identify possible environmental impacts that may result from governmental decisions. As the lead agency, the City is responsible for identifying and evaluating the potential adverse environmental impacts of this Master Plan. This evaluation will be documented in the form of an environmental checklist and sent to other agencies and the public for their review and comment. See Appendix B for SEPA compliance documentation.

1.4 Organization of the Document

This Master Plan has been written for a variety of audiences ranging from Utility staff to City executives, and is intended to be available to the public and customers of the Utility. The body of this document is divided into the following nine sections:

Section 1. Introduction	Brief discussion of previous planning efforts, list of current planning objectives, and an overview of the planning process.
Section 2. Levels of Service	Summary of Utility services and a discussion on the development of updated levels of service.
Section 3. Drainage Systems	Description of the current conditions of the Utility's stormwater infrastructure and drainage basins.
Section 4. System Evaluation	Summary of technical evaluations, including a conditions assessment and needs for conveyance capacity modeling.
Section 5. Regulatory Compliance	Description of current and future regulations impacting Utility planning and operation.
Section 6. Policies and Procedures	Background on organizational structure and a review of relevant City policies, Shoreline Municipal Code (SMC), and recommendations for policy changes.
Section 7. Utility Programs	Review of current programs and development of recommendations for new and enhanced programs.
Section 8. Management Strategies	Discussion of program and project recommendations, including a summary of the prioritization process and selection of a preferred management strategy.
Section 9. Financial Analysis	Summary of the financial analysis and determination of rates needed to support the selected management strategy.
Section 10. Implementation	Summarizes the costs and staffing needs associated with the preferred management strategy, including the recommended funding plan.

The Master Plan starts with defining levels of service, then evaluates the need for projects and programs to meet those levels of service, and finally makes recommendations for implementing improvements. Section 2 describes the development of updated levels of service for the Utility, providing a basis for subsequent evaluations of system performance, operations, and asset management. Sections 3 and 4 describe and evaluate the condition of the drainage system, including recommendations for improvements from the recent basin planning efforts and condition assessment activities. Section 5 provides an overview of relevant regulations. Sections 6 and 7 discuss Utility policies, procedures, and programs and present recommendations for improvements. Section 8 describes how all recommended improvements were prioritized and selected for alternative management strategies. Section 9 describes the financial analysis used to identify a preferred management strategy for implementation. Section 10 provides additional details regarding implementation of the preferred management strategy. Additional supporting technical information is provided in the appendices.

Section 2

Levels of Service

The Utility is responsible for maintaining stormwater infrastructure and protecting surface water quality in the city of Shoreline. The Utility provides surface water management services within city limits through constructed drainage systems that connect with the streams, wetlands, and lakes of Shoreline's drainage basins, as well as the drainage systems of neighboring jurisdictions. The Utility is the lead agency for compliance with State and federal regulatory requirements relating to surface water resources (e.g., streams and rivers), such as the Phase II Permit.

Functions and services provided by the Utility are shaped by the vision and values of the community, and are driven by State and federal regulations. Levels of service are common-language statements that describe characteristics or attributes of services provided by the Utility to meet the community's basic needs and expectations. Levels of service should align with overall strategic goals of the organization and support its business drivers. Levels of service help Utility managers focus efforts and resources, communicate service expectations, and reconcile budgetary limitations. More specifically, levels of service are used to:

- Provide customers with an understanding of the services offered
- Focus asset management activities on what is needed most
- Measure performance and track progress of the Utility
- Examine the costs and benefits of the services offered
- Assess suitability, affordability, and equity of the services offered

As part of this 2018 Master Plan, the Utility has developed updated levels of service. The Utility started by considering the community's vision and values; reviewing the strategic goals of the City; and then engaging in a series of discussions with the public, City staff, and City Council. The following section summarizes the outcome of this process.

2.1 Community Vision

In 2009, the City Council adopted the *Vision 2029* document (City 2009). *Vision 2029* envisions Shoreline as "a thriving, friendly city where people of all ages, cultures, and economic backgrounds love to live, work, play, and—most of all—call home." The document further describes Shoreline as a:

> … regional and national leader for living sustainably. Everywhere you look there are examples of sustainable, low-impact, climate-friendly practices: cutting edge energy-efficient homes and businesses, vegetated roofs, rain gardens, bioswales along neighborhood streets, green buildings, solar-powered utilities, rainwater harvesting systems, and local food production, to name only a few. Shoreline is also deeply committed to caring for its seashore, protecting and restoring its streams to bring back the salmon, and making sure its children can enjoy the wonder of nature in their own neighborhoods (City 2009).

In support of this vision, the City's Public Works Department seeks to support a sustainable and vibrant community through stewardship of the public infrastructure and natural environment, with a vision for a legacy of enduring quality of services provided for the community and natural environment through excellent infrastructure and innovative practices. Likewise, the Utility seeks to implement the vision and goals of the community through the services that it provides.

Sustainability. *Vision 2029* outlines a commitment to being a sustainable city in all respects. This emphasis on sustainability includes goals to conserve and protect our environment and natural resources; encourage restoration, environmental education, and stewardship; and apply innovative and environmentally sensitive development practices (City 2009). The City has also prepared an environmental sustainability strategy that underscores the use of green infrastructure, including the following recommendations:

- Promote green building and low impact development (LID) by training select staff, providing outreach information, and revising building and development codes
- Prioritize green streets planning, design, and implementation
- Promote natural solutions to stormwater management in private and public development with both incentives and requirements by revising engineering and development code standards, implementing CIP projects, and through public outreach (City 2008)

The City's commitment to environmental protection, sustainability, and natural solutions is also reflected in the natural environment goals in the *City of Shoreline Comprehensive Plan* (Comprehensive Plan), including the following goals related to surface water (City 2012):

- **Goal NE VI:** Manage the stormwater system through the preservation of natural systems and structural solutions to protect water quality; provide for public safety and services; preserve and enhance fish and wildlife habitat, and critical areas; maintain a hydrologic balance; and prevent property damage from flooding and erosion.
- **Goal NE VII:** Continue to require that natural and onsite solutions, such as infiltration and rain gardens, be proven infeasible before considering engineered solutions, such as detention.
- **Goal NE VIII:** Preserve, protect, and (where feasible) restore wetlands; shorelines; and streams for wildlife, appropriate human use, and the maintenance of hydrological and ecological processes.

Social Equity. *Vision 2029* and the Comprehensive Plan expand the goals for environmental sustainability to incorporate goals for advancing economic development and social equity (i.e., using a triple-bottom-line approach) (City 2009; City 2012). The importance of equity is also reflected in the values of the Public Works Department, honoring diversity and fairly representing all members of the community. The Comprehensive Plan includes the following relevant goals for utilities:

- **Goal U I:** Facilitate; support; and/or provide citywide utility services that are consistent, reliable, and equitable; technologically innovative, environmentally sensitive, and energy efficient; sited with consideration for location and aesthetics; and financially sustainable.
- **Goal U II:** Facilitate the provision of appropriate, reliable utility services, whether through City-owned and operated services, or other providers.

This Master Plan supports the community's vision for sustainability and social equity by providing a financially viable plan for improving surface water management, including recommendations for projects and programs that preserve natural systems, protect water quality, and reduce risks to public safety. Sustainability and equity goals were important considerations in the development of levels of service, as described in the next section.

2.2 Defining Levels of Service

Levels of service provide for a common understanding between the customer (i.e., residents and businesses) and the service provider (i.e., the Utility). When developing levels of service, it is useful to examine various aspects of the services provided by the Utility in terms of what is important to the customer; these often involve health and safety, environmental impacts, quality, reliability, availability, and affordability. Level-of-service statements should articulate intended objectives for delivering services and should be written in a way that can be understood by the end user.

Draft levels of service were developed from the levels of service described in the 2011 Master Plan, the City's Comprehensive Plan, and from the 2015–2017 City Council Work Plan and Goals. Utility staff then participated in several workshops facilitated by BC and FCS Group to develop and refine level-of-service statements. At the same time, level-of-service targets were defined as specific goals for how the Utility would meet the levels of service. The suggested language for levels of service and draft level-of-service targets was presented to the public at an open house on September 8, 2016, and part of a public survey run from September 2–16, 2016. Both the open house and survey were used to obtain feedback from the public and gain a better understanding of the public's priorities.

The draft levels of service, level-of-service targets, and results from the public open house and public survey were presented to the City Council for discussion on October 10, 2016. The City Council agreed with the levels of service and the levels of service did not change throughout the development of the Master Plan. The final levels of service and associated level-of-service targets are provided in Table 2-1.

Table 2-1. Levels of Service and Level-of-Service Targets for the Utility

Level of Service		Level-of-Service Target
LOS 1: Surface Water Impacts	Manage public health, safety, and environmental risks from impaired water quality, flooding, and failed infrastructure	No verifiable health and safety issues or environmental damage caused by the stormwater services outside of risk tolerance
LOS 2: Equitable Service	Provide consistent, equitable standards of service to the citizens of Shoreline at a reasonable cost, within rates and budget	Meet the levels of service as measured by customer satisfaction and rate and revenue projections
LOS 3: Communication and Outreach	Engage in transparent communication through public education and outreach	Maintain a communication plan to inform the community on Utility goals and progress
LOS 4: Regulatory Compliance	Comply with regulatory requirements for the urban drainage system	Meet or exceed regulatory requirements for NPDES Phase II and federal, State, and local regulations affecting surface water management

The levels of service and level-of-service targets shown in Table 2-1 were used to develop a matrix of performance targets and performance measures, both of which provide a much higher level of detail and specificity. Performance targets were used to develop prioritization criteria for capital improvement projects and programmatic recommendations (see Section 8). By organizing and linking prioritization criteria back to levels of service, the Utility was better able to determine which projects and programs are likely to provide the greatest benefit toward achieving levels of service.

Prioritization scoring and estimated costs were used to select and schedule projects and programs for implementation. The resulting group of projects and programs and schedule for implementation is referred to as a management strategy. Section 8 describes the process used to develop the following three alternative management strategies:

- **Minimum:** Meet the minimum in terms of existing system needs and anticipated regulatory requirements. Programs should focus on the fourth level of service, meeting existing and anticipated regulatory requirements. Projects should included those that are currently in progress.
- **Proactive:** Minimum management strategy plus new high-priority projects and new/enhanced programs that address high-priority, long-term needs and benefit all four levels of service. Programs in addition to the minimum should include enhanced existing programs or new programs meeting long-term needs for system inspection and maintenance.
- **Optimum:** Proactive management strategy plus additional recommendations to enhance water quality and aquatic habitat that provide the highest level of service.

The minimum, proactive, and optimum management strategies were analyzed for rate and funding impacts (Section 9), and a preferred management strategy was recommended for implementation after consulting with the City Council (Section 10).

Section 3

Drainage Systems

Shoreline is in the northern portion of King County bounded by Puget Sound to the west, Snohomish County to the north (including the cities of Mountlake Terrace, Edmonds, and the town of Woodway), Lake Forest Park to the east, and the city of Seattle to the south. Shoreline can be divided into seven distinct drainage basins: Thornton, Boeing, Storm, Lyon, and McAleer creeks; Middle Puget Sound; and West Lake Washington. Shoreline surface waters drain to either Lake Washington (Thornton, McAleer, and Lyon creeks, and West Lake Washington drainages) or Puget Sound (Boeing and Storm creeks, and the Middle Puget Sound drainages). Figure 1-1 (see Section 1) is a map of Shoreline's drainage basins. Figures 3-1 through 3-5 show the city drainage basins at a larger scale.

The city is nearly fully developed with about 1 percent of the total land area considered vacant (City 2017). On average, the city's land cover is currently 38 percent impervious. In buildout conditions (i.e., land use matches zoning allowances) imperviousness is estimated to be 50 percent.

Over the past 7 years, the City has completed basin planning for each of the city's drainages. Basin plans for the city's five largest creeks (Thornton, Boeing, Storm, McAleer, and Lyon) were completed first. The *Puget Sound Drainages Basin Plan* (AltaTerra 2016) included information for the city's remaining smaller drainages within the Middle Puget Sound and West Lake Washington basins. All six basin plans provide detailed evaluations of the drainage systems and recommendations for improvements that, when implemented, will help the Utility meet the levels of service defined in Section 2. Projects identified in the basin plans will be carried forward and prioritized based on level-of-service targets, and the highest-priority projects will be selected for inclusion in management strategies (see Section 8).

Table 3-1 presents an inventory summary of the basins' natural and built characteristics based on the basin planning work, the City's GIS and recent water quality evaluations. The sections following the table provide a summary for Shoreline with descriptions of smaller basins included in sections of larger adjacent basins. The summary includes a basin description, water quality data trends, and basin needs as identified in basin plans.

Table 3-1. Summary of Drainage Basins							
Basin	In-City Basin Size (acres)	Percent of City Area	Percent Impervious		Geology Soils	Receiving Water Body	Projects Identified
			Existing	Buildout			
Thornton Creek	2,391	32	40	55	Vashon Till with Esperance Sands	Lake Washington via city of Seattle	22
Boeing Creek	1,764	24	40	57	Glacial till	Puget Sound	26
Storm Creek	298	4	38	51 (north) 47 (south)	Till (plateau) with Esperance Sands and lacustrine clay-silt (slopes)	Puget Sound	25
McAleer Creek	1,377	18	41	58	Esperance Sands (east) with glacial till and hardpan (west)	Lake Washington via cities of Mountlake Terrace, and Lake Forest Park	14
Lyon Creek	184	3	42	64	Esperance Sands with small portion of transitional beds along the lower portion of the creek near the city limits	Lake Washington via cities of Mountlake Terrace and Lake Forest Park	9
Middle Puget Sound	1,312	17	33	--	Glacial till (higher elevation) with advanced outwash and transitional beds of silt and clay (lower elevation)	Puget Sound	16
West Lake Washington	119	1	38	58	Alderwood gravelly sandy loam	Lake Washington and small portion to Lake Washington via Seattle	2

3.1 Thornton Creek

The Thornton Creek basin, located east of Aurora Avenue N, drains south through the city of Seattle to Lake Washington. The basin is the largest in the city with 2,391 acres (approximately one third of the 7,402-acre total basin area) within the city limits. See Figure 3-1.

The Thornton Creek basin is almost completely developed with single-family residential and commercial land use. The Thornton Creek basin contains several subareas that have been rezoned for higher density, including the 145th and 185th Street Light Rail Station Subareas. The 185th Street Light Rail Station Subarea spans portions of the Thornton and McAleer Creek basins, with approximately 60 percent of the 559-acre subarea in the Thornton Creek basin. As these areas redevelop, the Utility has the opportunity to mitigate impacts of increased impervious surfaces with stormwater management practices including LID, stormwater treatment, and detention facilities.

The headwaters of Thornton Creek begin within the city just north of Ronald Bog. Currently, a large portion of the former headwaters of Thornton Creek are piped water courses. Relative to all streams in the city, Thornton Creek contains the least amount of natural channel with an estimated 46 percent of the creek conveyed in closed conveyance. Significant features in the basin include the pond and wetland areas of Ronald Bog and Twin Ponds, Meridian wetland, and Thornton and Littles creeks.

The 2009 Thornton Creek (RW Beck 2009) basin plan lists several needs that have been addressed since the plan was published. These projects include capital projects that have alleviated flooding for the Ronald Bog area, flooding of 12th Avenue NE between NE 170th and 175th streets, and infrastructure improvements at N 167th Street and Wallingford Avenue N.

Needs reported in the 2009 plan that are currently relevant include:

- Basin-wide pipe inspection, condition assessment, and pipe repair and replacement (R&R)
- Localized flooding appears to be related to hydraulic constrictions in the system
- Wetland and buffer areas along the east edge of Ronald Bog Park lack a diverse native plant assemblage and habitat structures
- Portions of Hamlin Creek lack habitat in-stream structure, native vegetation, and canopy cover
- Water quality is of moderate concern because of fecal coliform

While the flooding issues associated with the Ronald Bog area have been addressed, a handful of localized flooding issues remain. These issues include areas with little or no formal drainage and retrofit opportunities for Littles Creek and existing infiltration ponds. Water quality and aquatic habitat remain key issues in the Thornton Creek basin. Approximately 46 percent of the creek channel is in pipes, and the open-channel portions have limited riparian habitat. Notable losses in aquatic habitat include enclosed portions of Hamlin Creek, wetland areas near Ronald Bog, and the coarse sediment-starved portions of Thornton Creek streambed. The Utility has proposed a public outreach program to address Thornton Creek basin resident behavior and activity.

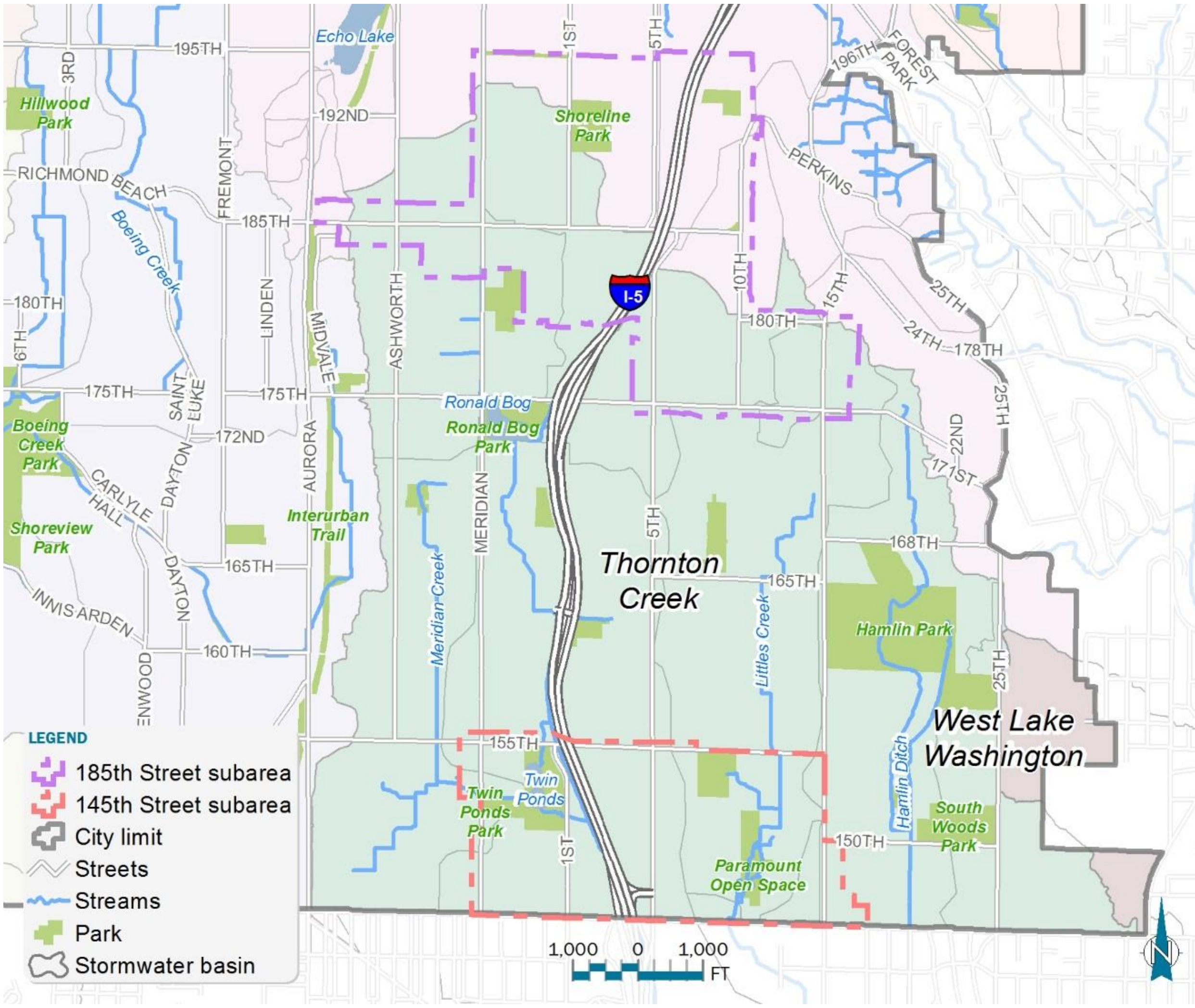

Figure 3-1. Thornton Creek/West Lake Washington basins

3.2 Boeing Creek

The Boeing Creek basin, the second-largest basin in the city, encompasses approximately 1,740 acres and is contained almost entirely inside the city limits. Most of the basin lies west of Aurora Avenue N and drains to Puget Sound. Land use in the basin is single-family residential with a smaller portion of commercial/industrial development along Aurora Avenue N. Focused areas of redevelopment include the Town Center subarea and the Aurora Square Community Renewal Area, both along Aurora Avenue N. See Figure 3-2.

The upper portions of the creek are piped because of previous and historical development. The lower 1.55 miles of the lower Boeing Creek main stem is open channel. This portion is located below Carlyle Hall Road.

The Boeing Creek basin has three dams managed by the Utility. The M1-dam and North Dam provide flood control on the south and north branches of upper Boeing Creek, respectively. Hidden Lake Dam, located on the main stem downstream of the north fork and south fork confluence, was originally constructed to build a fishing pond in the early 20th century. Hidden Lake has required ongoing sedimentation dredging and has been identified as a fish barrier along Boeing Creek. The City decided to stop dredging the lake in 2014 and begin a phased approach to remove Hidden Lake Dam and restore Boeing Creek at the Hidden Lake site.

The Boeing Creek basin plan (Windward 2013) identified erosion and water quality (presence of fecal coliform bacteria) as two of the primary surface water-related issues in the Boeing Creek basin. The plan also identified infrastructure needs including pipe R&R based on condition assessment, as well as stormwater management facilities to mitigate runoff impacts. The following issues identified in the basin plan associated with the built surface water system and infrastructure remain relevant today:

- Approximately 7 percent of the pipes inspected were recommended for repair.
- Multiple impassable fish barriers limit upstream access for anadromous fish, and potentially limit movement of resident fish confined to the upper reaches of Boeing Creek.
- Stormwater management facilities to mitigate runoff from developed areas are limited primarily to large, in-stream facilities at the heads of the open channel sections of Boeing Creek. Management of stormwater closer to the source could improve conditions and augment the functionality of these facilities.
- Glacial outwash geology in areas of steeper slopes is very erodible. Geologic conditions, combined with excessive stormwater inputs from upstream development, have contributed to major hillslope and channel instability issues in and adjacent to Boeing Creek.
- Sediment input from hillslope and bank erosion is deposited in low-gradient reaches, causing aggradation of sedimentation in spawning gravels, as well as maintenance issues in Hidden Lake.
- Low Benthic Index of Biotic Integrity (B-IBI) scores in Boeing Creek indicate poor aquatic habitat conditions
- Localized flooding appears to be related primarily to clogged culverts and ditches, rather than hydraulic constrictions in the system.
- Water quantity is of concern in the Boeing Creek basin, as evidenced by the Washington State Department of Ecology's (Ecology's) recent decision to close the basin to further appropriation of surface water and groundwater. Several applications for new water rights have been denied.

With the exception of localized areas lacking formal drainage or experiencing flooding, most of the surface water needs for Boeing Creek are associated with the open-channel portions of the basin. A key need to improve the natural function of the lower portion of the stream is to allow fish passage through a creek restoration project. Areas in the upper portions of the basin with flooding and/or highly erosive runoff rates should be addressed prior to, or simultaneously with, a lower creek restoration project. One potential near-term project is the removal of the Hidden Lake Dam (see Figure 3-2). Removing the dam would not only eliminate a fish barrier, the sediment deposited behind the dam will no longer need to be dredged. A long-term project in the upper basin of the Boeing Creek south fork is a regional stormwater facility for planned redevelopment in the Aurora Square Community Renewal Area between 160th and 145th streets, west of Aurora Avenue N. This project will help to control erosive flows and provide some water quality benefits.

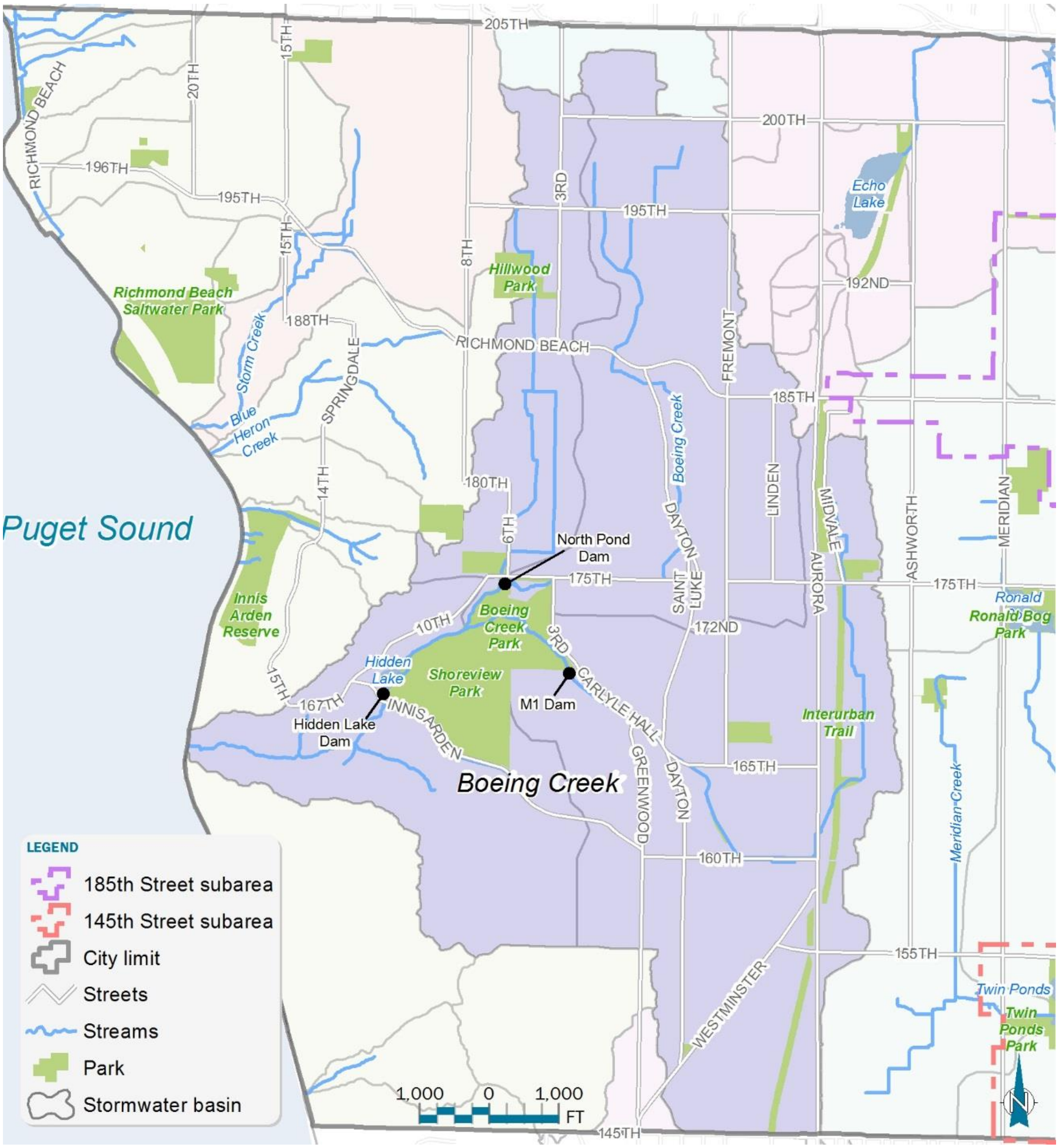

Figure 3-2. Boeing Creek basin

3.3 Storm Creek

As a small creek within the larger Middle Puget Sound regional drainage basin, Storm Creek (unlike Boeing Creek) is typically not distinguished from other small Middle Puget Sound drainages by other governmental entities such as King County and Washington State. However, localized flooding and streambank erosion within this small basin led the City to create a Storm Creek Basin Plan separate from the later Puget Sound Drainages Basin Plan. Because of this basin planning decision, the Storm Creek basin is often listed alongside the larger basins in the city. Approximately 298 acres of the Storm Creek basin are located within Shoreline city limits. The remaining portion, 176 acres, is located within the city of Edmonds. The basin lies west of Aurora Avenue N and drains to Puget Sound. Land use in the basin is single-family residential with a small portion of retail business along Richmond Beach Road. See Figure 3-3.

The upper portions of the creek are piped because of previous and historical development. The lower 1 mile of the Storm Creek main stem is open channel. This portion begins near 15th Avenue NW and NW 190th Street near the Innis Arden Club House. Notable surface water features in the Storm Creek basin include the three wetlands (Syre 1 and 2, and Eagle Reserve).

The Storm Creek basin (Windward 2013) provides the following issues associated with the built surface water system and infrastructure:

- Approximately 8 percent of the pipes inspected are recommended for repair.
- Stormwater management facilities to mitigate runoff from developed areas are not present in the Storm Creek basin.
- Geology of the Puget Sound-facing bluffs and in other areas with steeper slopes is very erodible and has contributed to channel down-cutting in Eagle Reserve.
- Water quality is of moderate concern, primarily because of fecal coliform bacteria and nutrients.
- Localized flooding appears to be related primarily to clogged culverts and ditches, rather than hydraulic constrictions in the system.

Channel erosion in the lower reaches of Storm Creek and high runoff rates generated from developed impervious surfaces remain the primary concerns in the Storm Creek basin. The 2013 basin plan outlined several high-priority projects to address these concerns. These projects include a study to evaluate runoff reductions using alternatives such as out-of-basin transfers and deep-well injection. Another potential project is to convert roadside ditches within the basin into infiltrating bioswales, which would not only reduce runoff rates, but also improve the quality of the stormwater discharged to the creek.

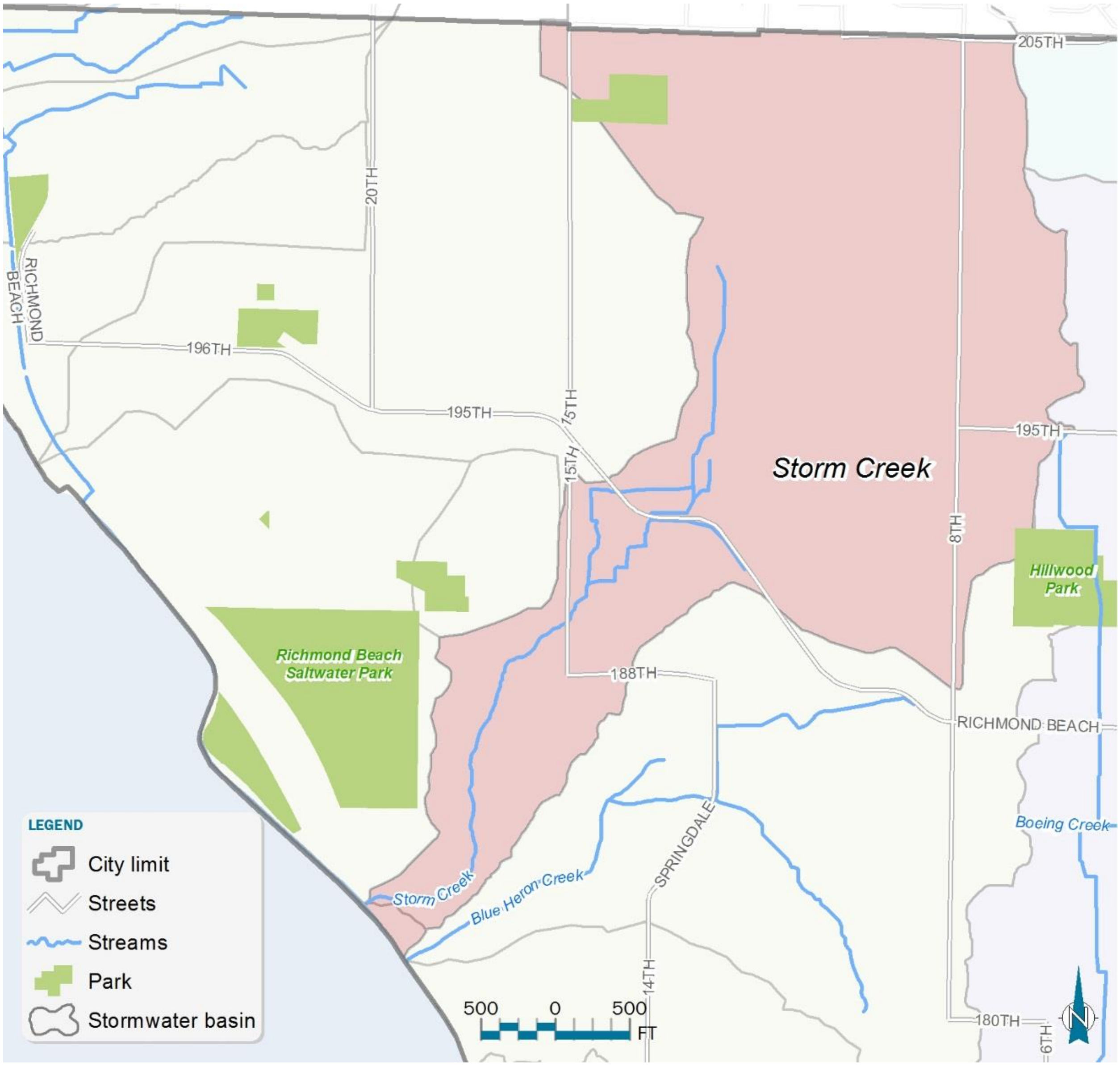

Figure 3-3. Storm Creek basin

3.4 McAleer Creek Basin

The portion of the McAleer Creek basin located in the northeast section of Shoreline city limits represents 1,377 acres of the drainage basin's 5,300-acre total. See Figure 3-4.

The McAleer Creek basin land use is predominantly residential with commercial industrial development along Aurora Avenue, Ballinger Way, NE 205th Street, and Interstate 5. The 185th Street Light Rail Station Subarea spans portions of the Thornton and McAleer creek basins, with approximately 40 percent of the 559-acre subarea in McAleer Creek basin.

The reach of McAleer Creek located within the city is roughly 4,000 feet long. Much of the city's McAleer Creek basin is composed of headwater areas to tributary systems. One of the headwaters originates south of Echo Lake, within the city of Shoreline, and flows north to Echo Lake. Echo Lake then drains north toward Lake Ballinger. Several other streams, the largest being Halls Creek located on the north end of Lake Ballinger in the city of Lynnwood, feed Lake Ballinger. McAleer Creek flows east out of Lake Ballinger, and is joined by the Cedar Brook Creek tributary at the boundary with the city of Lake Forest Park. It flows through the Nile Golf Course and the city of Lake Forest Park to Lake Washington. Other notable water features include the two lakes, Echo (13.5 acres) in the city of Shoreline and Ballinger (101.4 acres), which is located in the cities of Mountlake Terrace and Edmonds. One stormwater detention control structure located on the main stem of McAleer Creek at NE 196th Street, was designed to reduce downstream peak flows and alleviate past flooding. (SAIC 2011).

The entire main stem of McAleer Creek within the city of Shoreline up to Interstate 5 is used by anadromous fish. Little is known about the anadromous use of the various tributaries.

McAleer Creek is on the State 303(d) list for fecal coliform bacteria, dissolved oxygen (DO), water temperature, and low B-IBI scores. Washington State Department of Ecology (Ecology) has established a total maximum daily load (TMDL) to limit phosphorus discharges to Lake Ballinger, which receives drainage from a portion of Shoreline (McAleer Creek flows out of Lake Ballinger). Portions of McAleer Creek in Lake Forest Park downstream of Shoreline city limits are listed for several 303(d) parameters (DO and fecal coliform).

The McAleer Creek basin plan (AltaTerra 2015b) provides the following issues associated with the built surface water system and infrastructure:

- Approximately 6 percent of the pipes inspected are recommended for repair or replacement.
- Persistent erosion and/or flooding problem drainage areas are located at:
  - 6th Avenue NE and 200th Avenue NE west of Interstate 5
  - NE 192nd Street between 15th Avenue NE and 18th Avenue NE
  - 25th Avenue NE near 177th Street
  - NE 177th Street near 22nd Place NE
- Groundwater seepage (associated with some of the problem drainage areas above)

The highest-priority surface water issues in the McAleer Creek basin are improvements to the existing drainage system to address deficient systems, limited capacities, and/or erosion problems within the existing system. Green stormwater infrastructure projects such as bioretention swales are considered feasible and viable solutions for both water quality treatment and reduction of runoff rates. However, in some areas steep roadway ditches that exhibit erosion will require more structural solutions.

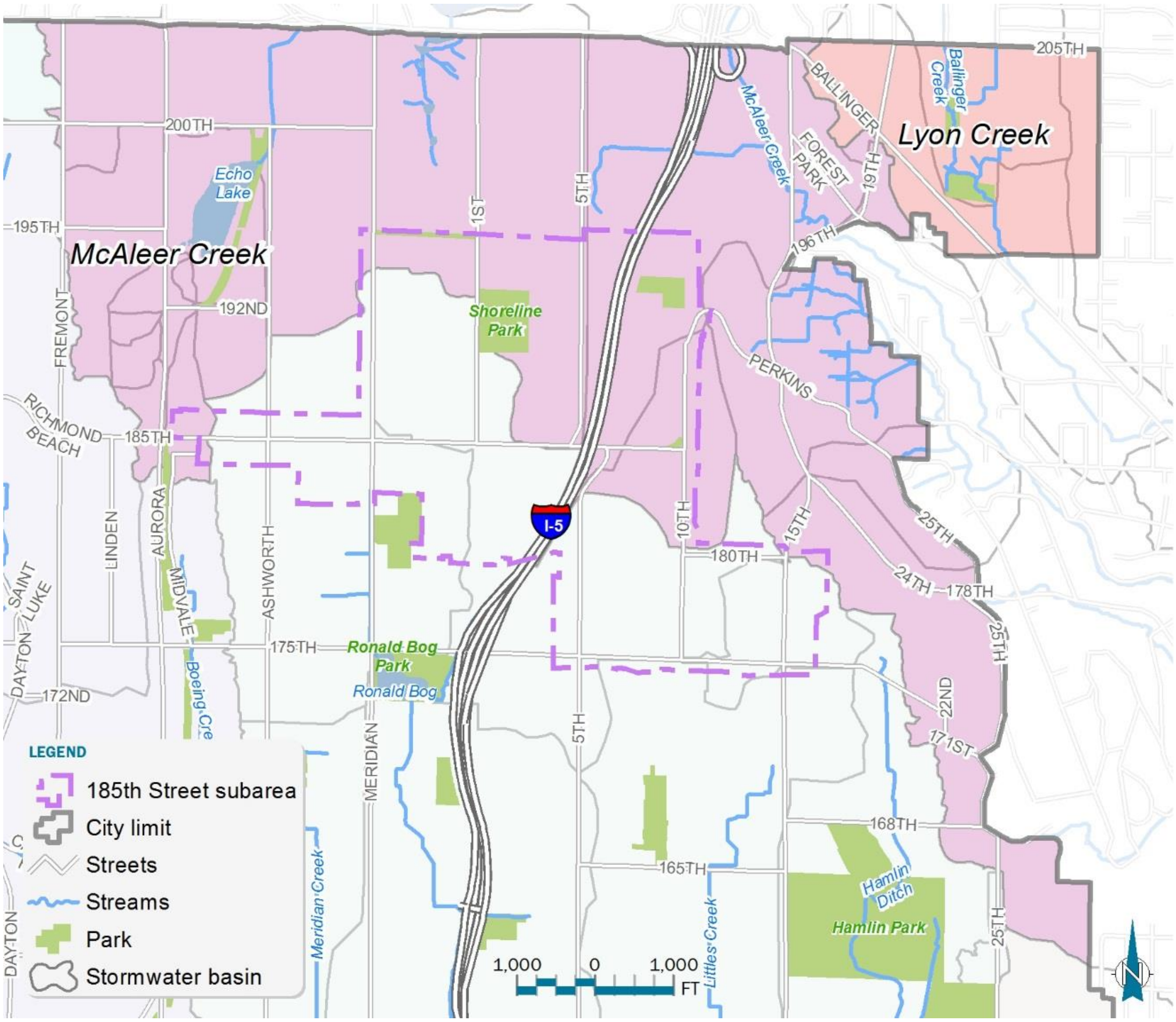

Figure 3-4. McAleer and Lyon creek basins

3.5 Lyon Creek

The Lyon Creek watershed comprises approximately 2,500 acres and lies within five municipal jurisdictions with most of the basin located in the cities of Mountlake Terrace, Brier, and Lake Forest Park. The size of the basin within Shoreline's city limits is approximately 184 acres. See Figure 3-4.

Ballinger Creek is the tributary of Lyon Creek that flows southeast through the city of Shoreline and into Lake Forest Park before discharging into Lake Washington. The portion that flows through Shoreline has a length of 2,200 feet. Notable surface water features associated with Ballinger Creek include the wetland areas of Ballinger Open Space and Brugger's Bog, which provide some natural stream buffer.

The predominant land use is single-family and multifamily residential, but there are clusters of nonresidential development including commercial development, a large school complex, and the City's North Maintenance Facility (NMF). A major current City project within the basin is the 25th Avenue NE Flood Reduction Project. The goal of the project is to reduce the flooding of Ballinger Creek near Brugger's Bog and along 25th Avenue NE. The project is in the predesign stage with several proposed improvements: daylighting Ballinger Creek along 25th Avenue NE, creating floodplain storage at the City's NMF site, and replacing the NE 195th Street culvert (within the city of Lake Forest Park, requiring coordination with Lake Forest Park).

Since 2001, the City has performed water quality monitoring on the 2,200-foot-long section of Ballinger Creek within the city. The monitoring results indicate that water quality parameters DO, water temperature, and turbidity may be improving. Results for pH showed no apparent trend (AltaTerra 2015a).

The Lyon Creek basin plan (AltaTerra 2015a) provided the following issues associated with the built surface water system and infrastructure:

- Approximately 6 percent of the pipes inspected were recommended for repair or replacement.
- Few stormwater management facilities are present in Shoreline or upstream in Mountlake Terrace to mitigate runoff from developed areas.
- Several undersized culverts are not able to convey surface water flows and contribute to frequent flooding along 25th Avenue NE.
- Because of topography, geology, and other drainage conditions, some developments built at lower elevations within the basin experience high groundwater conditions and/or localized flooding in basements and other depressions.

The primary surface water issue in the Lyon Creek basin is the flooding that occurs along 25th Avenue NE between Brugger's Bog Park and NE 195th Street. A capital improvement project to address flooding in this area is currently in the predesign stage, including several of the proposed improvements discussed above.

3.6 Middle Puget Sound

Middle Puget Sound Basin drainages within the city consist of four geographically distinct drainage areas (with each of these areas, except the Edmonds Way drainage, comprising multiple smaller hydraulically separate drainages) that discharge into Puget Sound (see Figure 3-5):

- **Middle Puget Sound-Richmond Beach drainages:** 434 acres northwest of Storm Creek basin, including Barnacle Creek
- **Middle Puget Sound-Innis Arden drainages:** 387 acres south of Storm Creek and north of Boeing Creek basins, including Heron and Coyote creeks
- **Middle Puget Sound-Highlands/Seattle Golf Club drainages:** 430 acres south of Boeing Creek basin
- **Middle Puget Sound-Edmonds Way drainage:** 61 acres along the city's northern boundary between 8th Avenue NW and Fremont Avenue N

The City does not manage surface water in the Middle Puget Sound-Highlands/Seattle Golf Club drainages as they are located within the private Highlands community and private Seattle Golf Club, and do not contain any City stormwater infrastructure.

Current land use in these drainages is mostly single-family residential. Small areas are developed as multifamily, schools, commercial, and parks and open space.

Drainage in these areas typically begins as urban runoff or as seepage from hillsides. The headwaters of North Barnacle Creek in the Middle Puget Sound-Richmond Beach drainage is located beyond city limits in the cities of Woodway and Edmonds. The handful of other small streams within these drainages originate from wetlands, hillside seeps, and urban runoff within the city of Shoreline (SAIC 2011).

The *Puget Sound Drainages Basin Plan* (AltaTerra 2016) provides the following issues associated with the built surface water system and infrastructure:

- Approximately 13 percent of the pipes inspected are recommended for repair or replacement
- Persistent drainage problems and flooding at Springdale Court NW and NW Ridgefield Road in the Middle Puget Sound-Innis Arden drainage
- Groundwater seepage in the following Middle Puget Sound-Innis Arden drainages:
  - Heron Creek
  - Coyote Creek area
- Ditch filling by some homeowners
- Lack of stormwater system or downstream connections

The 61-acre Middle Puget Sound-Edmonds Way drainage is adjacent to the northern portion of the Boeing Creek basin and drains to Puget Sound through the city of Edmonds. See Figure 3-5. Basin land use is residential and does not contain any wetlands or creeks. The City maintains pipes, ditches, and connecting structures located in the basins' right-of-way (ROW). The drainage concerns in this area are localized flooding because of clogged conveyance. The basin was evaluated in the *Puget Sound Drainages Basin Plan* (AltaTerra 2016) and no projects were identified.

The Utility identified 10 high-priority drainage problem areas in the Middle Puget Sound-Richmond Beach and Middle Puget Sound-Innis Arden drainages. More than half of the problem areas were related to a lack of formal drainage or lack of connectivity in the drainage system. In some cases, the ditches serving these locations have been filled by residents. Other drainage problems such as flooding and erosion are a result of existing infrastructure (ditches, pipes, and catch basins) needing to be repaired or replaced because of insufficient capacity or poor condition.

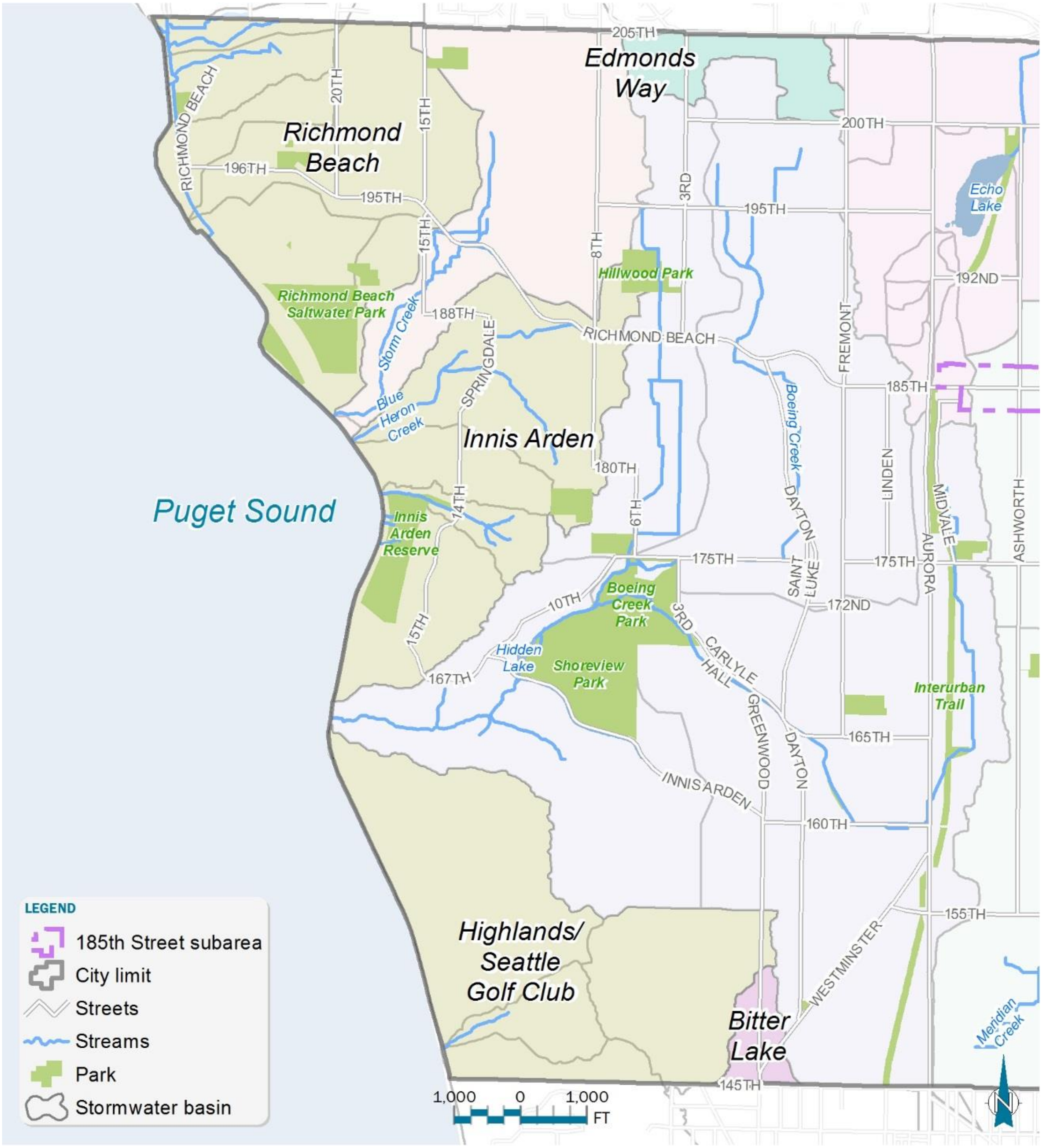

Figure 3-5. Middle Puget Sound drainages and Bitter Lake drainage to West Lake Washington

3.7 West Lake Washington

The city contains West Lake Washington basin drainages in three locations: two are located in the southeast corner of the city; the third is roughly 3 miles west of the other two located along the southern city boundary in the vicinity of Greenwood Avenue N and N 145th Street. No portion of this basin within the city of Shoreline contains streams.

The two eastern drainages of the West Lake Washington basin comprise approximately 90 acres (of a larger 450-acre drainage) and drain eastward to Lake Washington (see Figure 3-1). These two drainages flow to Lake Washington through the city of Lake Forest Park. Land use within these drainages is mostly residential, with small areas of commercial use along Bothell Way. Drainage occurs as overland flow or through drainage ditches, roadway culverts, and storm sewers. No wetlands were identified in the basin (SAIC 2011).

The city's third drainage within the West Lake Washington basin is the 29-acre Bitter Lake drainage (see Figure 3-5). This basin drains southward to the city of Seattle's Densmore basin, which discharges to Lake Washington far to the southeast. Land use within these drainages is mostly residential, with small areas of commercial use along Westminster Way N and N 145th Street. The City maintains pipes, ditches, and connecting structures located in the basins' ROW.

The West Lake Washington basin drainages in the city were reviewed as part of the *Puget Sound Drainages Basin Plan* (AltaTerra 2016). The basin plan noted current stormwater-related issues including high groundwater seepage in lower levels of private residences and a lack of stormwater system and downstream connections for the eastern drainages. No issues were noted for the Bitter Lake drainage.

Section 4

System Evaluation

This section summarizes evaluations of surface water systems, including a summary of condition assessment activities, and discussions regarding conveyance system capacity, water quality, and aquatic habitat conditions. Evaluations such as those described in this section are conducted to characterize surface water conditions, and identify system deficiencies and/or gaps in performance related to the Utility's desired levels of service.

4.1 Condition Assessment

Stormwater infrastructure can deteriorate over time; it is important to know the structural condition of Utility assets to minimize the potential for failures. Structural condition assessment activities can identify problems and enable timely maintenance, repair, or replacement. The City's Condition Assessment Program involves a combination of inspection techniques and the conversion of the observed or recorded data into assessment knowledge. This knowledge is then used to prioritize and schedule maintenance, repair, rehabilitation, and/or replacement activities.

Following the 2011 Master Plan, in parallel with subsequent basin planning efforts, the Utility initiated a program to inspect and assess approximately 134 miles of stormwater pipes owned and maintained by the City. The Utility also initiated a catch basin condition assessment program to address Phase II Permit maintenance standard requirements for catch basins and inlets. Over a 3-year period starting in 2014, the Utility inspected and assessed all 7,461 catch basins to achieve compliance with the Phase II Permit.

As part of the development of this Master Plan, the Utility prepared a *Condition Assessment Management Plan* (CAMP) to document, improve, and plan for continual asset condition assessment (see Appendix C). With the development of the CAMP, the Utility improved and refined the documented condition assessment methodologies for pipes, catch basins, and manholes. In addition, new methodologies were developed for ditches and LID facilities (e.g., bioretention, swales, and permeable pavement). Below is a summary of condition assessment work.

4.1.1 Pipes

The Utility has completed initial pipe condition assessments for all of the city's drainage basins except the Thornton Creek basin. The Thornton Creek Basin Plan was completed prior to the recommendation for pipe condition assessment in the 2011 Master Plan, so a pipe condition assessment was not completed at the time of the basin planning effort. Pipe inspections and condition assessment within the Thornton Creek basin began in 2017 and is anticipated to be completed in 2020. Approximately one third of the Utility's pipe network is located within the Thornton Creek basin.

Substantial portions of pipe networks in already-assessed basins were not completed because of issues caused by debris or structural blockages, utility crossing conflicts, improper and poor fitting connections, or because access points are located outside the ROW or easements. To address these issues and continue assessing pipe condition, the following ongoing pipe maintenance and inspection programs are recommended:

- **Condition Assessment Program** is an ongoing inspection program identified in the Basin Plans and in the CAMP (included in Appendix C). The program inspects pipes under two conditions: (1) routine pipe inspections, which occur on a 20-year inspection cycle, and (2) pipes that were not inspected or had an incomplete inspection because of access constraints. The Condition Assessment Program is described in Section 7.1.8.
- **Utility Crossing Removal Program** provides resources for coordinating with other utilities to remove their lines and repair storm drains that have been damaged because of crossings. The Utility Crossing Removal Program is described in Section 7.2.9.
- **Improper Connection Repair Program** fixes non-standard or improperly installed stormwater drains not included in other capital improvement projects by adding properly designed structures. The Improper Connection Removal Program is described in Section 7.2.10.

Based on the results of the inspection and condition assessment efforts to date, the Utility has projected that nearly 800 sections of pipes will require repair or replacement over the next 20 years with an average of 40 sections of pipe replaced per year. The goal is to repair or replace the failing pipes prior to the beginning of the next 20-year inspection cycle. Prior to 2018, the Utility had allocated sufficient resources to repair or replace 20 sections of pipe per year with the Stormwater Pipe Repair and Replacement Program (SWPRRP). This current rate would result in near failing sections of pipe not being repaired or replaced for up to 30 years. The Utility recommends an enhanced version of this program to repair and replace pipe no later than 20 years from the condition assessment and prior to scheduled re-inspection. The enhanced SWPRRP is described in Section 7.2.4.

4.1.2 Manholes and Catch Basins

The Utility's Phase II Permit requires periodic inspection and maintenance of catch basins and manholes. The City owns and maintains 7,461 catch basins and 736 manholes. Between 2014 and 2017, the Utility inspected all known catch basins and approximately 37 percent of the manholes.

Approximately 90 percent of the inspected catch basics were in good condition and another 8 percent were in fair condition. The remaining 2 percent received a poor condition assessment score and were identified for minor repair or replacement. Catch basins in good condition have no structural issues with the walls or bottom of the basin, no large holes in the basin cover, and no cracks in the grout connecting the pipes to the basin. Catch basins in poor condition have severe structural issues with the walls or bottom of the basin, large holes in the basin cover, and large cracks in the grout connecting the pipes and basin. A catch basin in fair condition shows moderate deficits in one or more areas. Catch basins in fair condition may be inspected more frequently.

Beginning in 2018, the Utility will inspect catch basins every other year and perform necessary maintenance within 6 months of inspection or within 2 years for CIP rehabilitation costing less than $25,000. With the increased frequency of inspection, the Utility estimates that the number of catch basins needing repair will increase to 3 percent per year and 1 percent per year will need to be replaced. To remain compliant with the 6-month maintenance time frames, the Utility recommends additional resources for a Catch Basin Repair and Replacement Program. See Section 7.2.6 for more details on this program.

All inspected manholes were assessed as being in good condition. Manholes will continue to be inspected annually through the Utility's ongoing System Inspection Program (see Section 7.1.7). Manholes that are part of the Condition Assessment Program are inspected when pipes are inspected. All accessible manholes within the Puget Sound and Lake Washington drainage basins were inspected as part of the *Puget Sound Drainages Basin Plan* project in 2016. The Utility

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recommends including the inspection of manholes in the enhanced Condition Assessment Program; see Section 7.1.8.

4.1.3 Ditches

The City owns and maintains approximately 24 miles of ditches. The Utility completed a full circuit of ditch inspection and maintenance between 2008 and 2013. Beginning in 2014, ditches were re-inspected every 3 years, with approximately one third of the ditches maintained if needed per year. Ditches are inspected in early summer and maintenance is typically performed within 1 month of inspection.

Condition assessment scoring based on inspection results between 2014 and 2017 indicated that approximately 28 percent of ditches were in poor condition, requiring maintenance. Ditches in poor condition show signs of contamination and/or erosion, and excessive sediment and vegetation, which can prevent the flow of water to the ditch from the roadway or in the ditch channel. The Utility recommends continuing with the current ditch inspection and maintenance efforts included in the existing System Inspection Program and System Maintenance Program; see Sections 7.1.7 and 7.2.2, respectively.

4.1.4 Low Impact Development Facilities

The Utility-owned and operated LID facilities are inspected on an annual basis to meet the requirements of the Phase II Permit. Inspection data are analyzed after the inspections are completed. Following inspection, corrective work orders are created based on specific failure possibilities. LID facilities include permeable pavement, bioretention, and swales.

Based on annual inspection information, approximately 70 percent of permeable pavement installations received a poor condition assessment. Approximately 86 percent of bioretention facilities and 19 percent of swales received a poor condition rating. To maintain compliance with the Phase II Permit, the Utility must complete necessary maintenance of all surface water assets including LID facilities within 1 year of inspection. The Utility recommends additional resources to perform the required cleaning, structural repair, or structural replacement of LID facilities in the LID Maintenance Program. This new program would also enhance the existing vegetation management effort the Utility implements for its biofiltration facilities. See Section 7.2.7 for more details on this program.

4.1.5 Pump Stations

The Utility's eight pump stations received an extensive condition and capacity inspection and assessment in 2016 (Kennedy/Jenks 2016). The condition assessment resulted in a list of recommended pump station improvements, and is summarized in Table 4-1. Two of the pump stations were recommended for replacement. The recommendations for the remaining pump stations include adding supervisory control and data acquisition (SCADA) instrumentation, redundant pumps, and site access and safety. The Utility recommends including the three projects to the 6-year projects that are outlined in the 2016 report, namely replacement of pump stations 26 and 30, and the upgrade of the remaining pump stations, as recommended. These projects are listed in Section 8 which includes a project prioritization summary. Details on project costs are included in Appendix D-5. In addition to pump station upgrades, the Utility recommends the allocation of resources for an ongoing Pump Station Maintenance Program. See Section 7.2.8 for more details about this program.

Table 4-1. Recommended Pump Station Improvements	
Pump Station	**Condition Summary and Upgrade Recommendation**
Linden Avenue	Upgrade electrical components, add SCADA, provide signs and bollards, purchase redundant pump, and improve wetwell access
Palatine	Upgrade electrical components, add SCADA, provide signs, purchase redundant pump, and improve wetwell access
Pan Terra	Add SCADA, add pressure gauges, improve hatches, and provide guardrail
25	Upgrade/revise PLC program, improve hatches, and provide guardrail
26	Demolish and rebuild station and reuse existing wetwell
30	Demolish and rebuild station, reuse existing wetwell, provide site improvements around wetwell, and upgrade power service
Ronald Bog	Add SCADA, add pressure gauges, and provide bollards
Serpentine	Add SCADA, add pressure gauges, improve hatches, and provide grading improvement

Source: Kennedy/Jenks 2016 report.

4.2 Conveyance Capacity

As part of the Condition Assessment topic, the Utility reviewed the adequacy of existing data to build new hydrologic and hydraulic (H&H) models. Data for the principal conveyance elements and network connectivity appear to be generally complete; however, there are gaps in key attributes such as pipe size, pipe materials, and invert elevations.

The Utility recommends a phased and prioritized approach to H&H modeling, focusing on data collection and then on model development. Data collection activities can be performed prior to model development and can also provide near-term benefits to asset management and O&M activities. For example, cross-referencing under-capacity pipes with condition assessment results would identify which structurally deficient pipes need to be upsized during replacement. Model development should be performed according to priorities, tailored to specific needs, and refined over time. The Utility recommends allocating resources to develop a System Capacity Modeling Study for inclusion in the 6-year CIP. This study would provide new and updated modeling analyses to forecast future system demands, identify capacity deficiencies, and evaluate improvement projects. This project is listed in the Section 8 project prioritization summary. Details on the project are included in Appendix D-5.

4.2.1 Subbasin Priorities

The Utility created new subbasin delineations prior to determining subbasin priorities. These delineations were developed by first performing automated delineations using a digital elevation model (DEM) obtained from the Puget Sound Light Detecting and Ranging (LiDAR) Consortium (PSLC 2006). Automated delineations were then adjusted where stormwater infrastructure crossed subbasin boundaries. New subbasin identifiers were assigned and a numbering system sequenced from upstream to downstream was used Figure 4-1 shows the subbasins and the direction of stormwater discharge at each subbasin outlet.

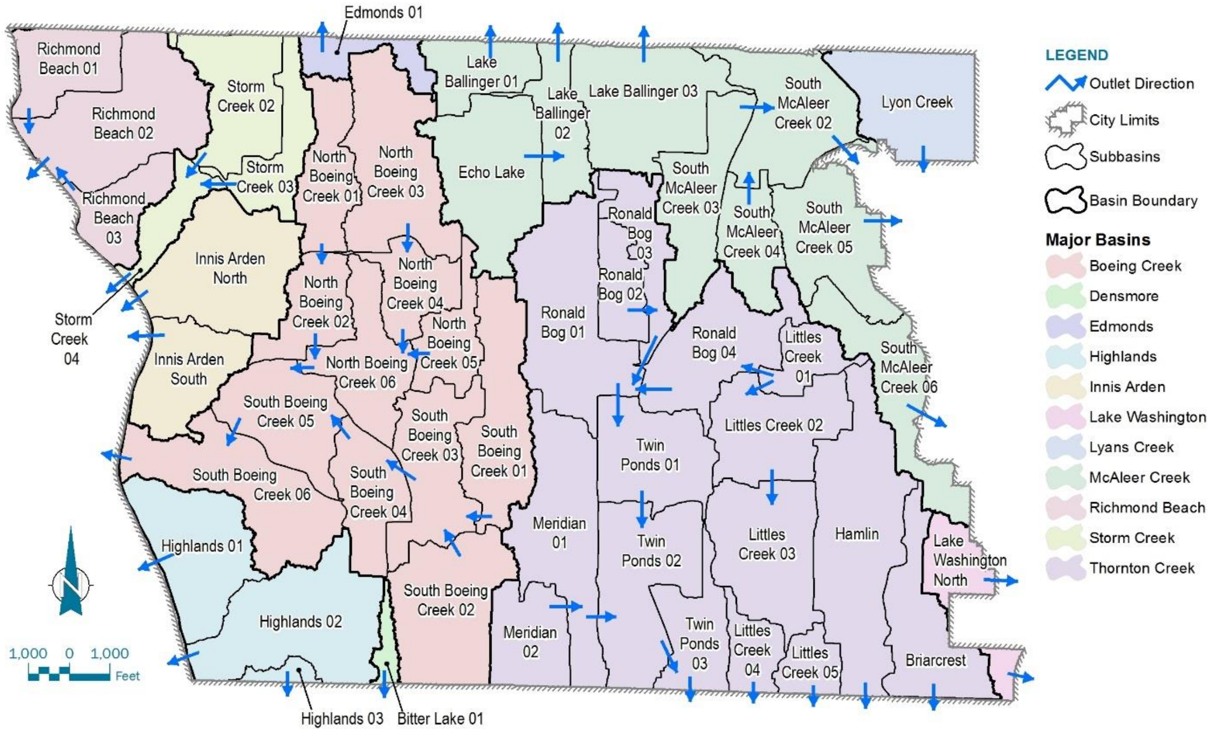

Figure 4-1. Newly delineated subbasins and connectivity

Data collection and modeling efforts should progress in phases as shown in Figure 4-2, which is based on a prioritization scoring system, where the higher score indicates a higher priority. Prioritization accounts for the following factors:

- Known capacity problems or localized flooding
- Existence of a subarea plan where significant growth is expected
- Potential increase in impervious area due to development
- Discharge to a TMDL receiving water or “waters of concern”
- Geotechnical constraints to stormwater infiltration
- Infrastructure data needs

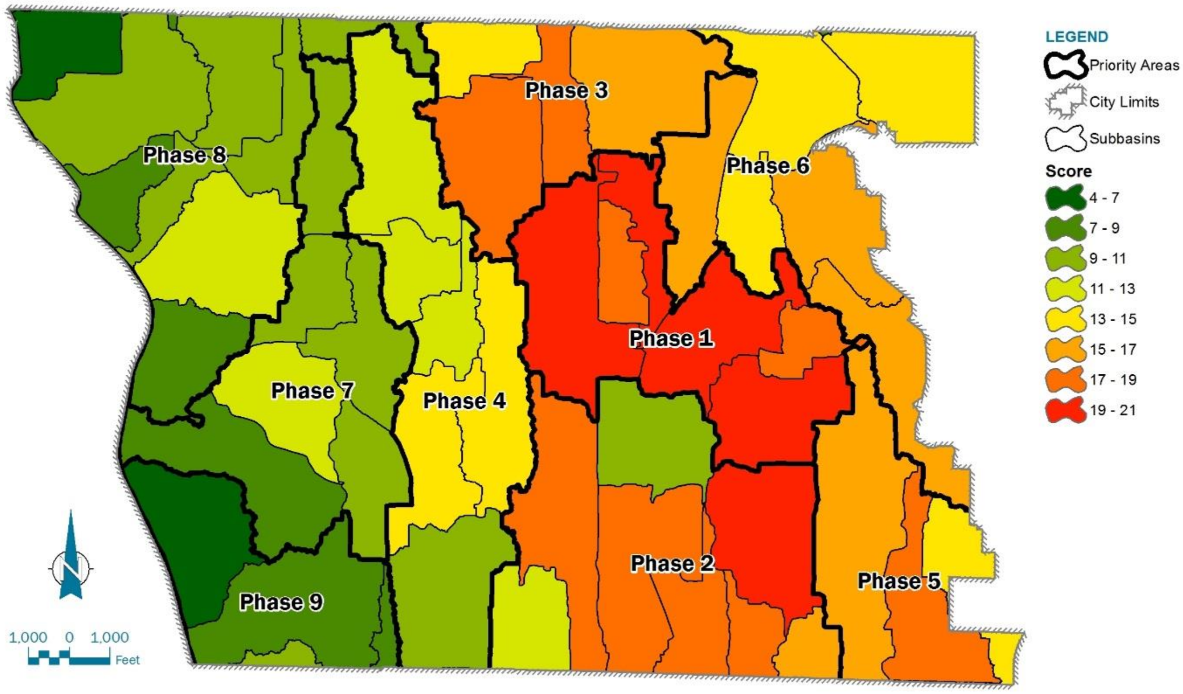

Figure 4-2. Subbasin priority scores and groupings for phased data collection and model development activities

4.2.2 Data Collection

One of the first steps in conducting H&H modeling will be to collect the requisite data. While some pipe and cross-section data are available along major streams and drainage ways, additional data need to be collected to develop more comprehensive drainage system models. Meteorological data—primarily precipitation—as well as spatial data, such as land cover and soil types, are needed to model runoff and inflows to the conveyance network. Table 4-2 provides a general summary of the data needs for H&H modeling.

Table 4-2. Typical Data Needs for H&H Modeling	
Types of Inputs	Typical Data Needs
Meteorological data	• Precipitation records, design storms, and/or intensity-duration-frequency statistics • Evaporation and evapotranspiration (ET) records, or meteorological inputs to calculate ET
Spatial data	• Topography: contours, digital elevations models, or terrain surfacing • Impervious areas and, if possible, classification of areas into categories such as roadways, parking lots, sidewalks, etc. • Pervious areas and, if possible, vegetative cover categories such as wetlands, woodlands, grasslands, etc. • Soil characteristics related to infiltration and storage capacities, hydrologic soil groups, general classifications • Land use and zoning • Parcel boundaries
System data	• Pipes: diameter, upstream invert elevation, downstream invert elevation, depth below grade, depth below rim, length, and pipe material • Manholes: type, size, depth, rim elevation • Ponds, vaults, and other storage facilities: dimensions, stage-storage curve, stage-discharge curve, invert elevations for inlets and outlets • Special structures (flow diversions, splitters, weirs, pump stations, gates, and other hydraulic controls): dimensions, floor elevations, hydraulic control elevations, inlet/outlet capacities, storage curves, and operating rules • Open channels and ditches: surveyed cross-sections, slope, culvert dimensions, culvert material, bridge dimensions, roadway elevations, and invert elevations for all structures
Calibration data	• Continuous flow/discharge measurements • Peak flow/discharge measurements • Water levels/flow depths • Historical anecdotal information

4.2.3 Model Development and Analyses Framework

As data are collected, H&H modeling can be performed to address specific projects or study needs. BC recommends beginning with the top priority (Phase 1) subbasins and developing a tailored modeling plan that focuses on the specific needs to be addressed in those subbasins. Developing the modeling plan should involve the following basic steps:

1. **Clarify the problem(s):** Defining and analyzing a problem occurs at several levels. The aim is to translate the problem understanding from the planner or policymaker to the modeler to ensure that the modeling effort answers the appropriate questions and provides useful results to inform decisions. The modeling team should craft a problem description and carefully analyze the nuances of the problem to understand the domain, characteristic time scale, spatial scale, and relevant physical processes.
2. **Define the objectives:** Building on the problem definition, the goals of the modeling effort should be established and then articulated through specific modeling objectives. There are often goals and objectives for the overarching plan (e.g., the 2018 Master Plan)—and, while these are related, they are not the same as modeling objectives. This is where the understanding of the problem and the questions at hand are transformed into specific actions that will yield specific results. For example, the modeler should determine which scenarios will be simulated and how those will be defined in model space. Such translations are potentially great sources of misunderstanding and should therefore receive careful and deliberate attention.
3. **Specify requirements:** As a modeling approach is developed, the modeling team can identify project-specific requirements for achieving the modeling objectives. Requirements should address the quality of the calibration and subsequent results, expertise needed to carry out the analyses, time constraints and deadlines for major milestones, communications and reporting

protocols, quality assurance/quality control (QA/QC) procedures, and data management practices.

Appendix E is a technical memorandum titled *Approach to Performing Hydrologic and Hydraulic Modeling Analyses,* developed as part of the 2018 Master Plan work, which describes this process and includes a modeling plan for the Phase 1 subbasins as shown in Figure 4-2 above. As model development activities continue for subbasins in subsequent phases, the modeling plan can be revisited and improved to address new objectives and apply lessons learned from previous phases.

4.3 Water Quality

Stormwater pollution from the City's municipal separate storm sewer system (MS4) is regulated by the Phase II Permit, which requires treatment and flow control for stormwater discharges from new development and redevelopment projects that exceed certain thresholds. New development projects that add 5,000 square feet of new hard surfaces, or that convert 0.75 acre of vegetation to lawn or landscaping, typically must treat runoff and control flow rates from the new and replaced hard surfaces or lawn/landscaped areas. Redevelopment projects that exceed these criteria typically must treat and control pollution and flows from the new hard surfaces and converted pervious areas. Redevelopment projects must also treat the replaced hard surfaces if the valuation of the proposed improvements exceeds 50 percent of the valuation of the existing site improvements.

The Phase II Permit requires application of LID principles and LID best management practices (BMPs) (also known as green stormwater infrastructure [GSI]) to make LID the preferred and most commonly used approach to site development. Examples of LID BMPs or GSI include bioretention, rain gardens, permeable pavement, vegetated roofs, downspout controls, and dispersion. Other types of stormwater BMPs, such as wet ponds or media filters, can be implemented to meet permit requirements for new development and redevelopment projects where LID opportunities are limited by site conditions.

In certain situations, regional facilities may be used instead of onsite BMPs to meet permit requirements for multiple new development or redevelopment projects within a catchment area. However, the regional facility must be operational before the new development or redevelopment activity occurs and the permittee must demonstrate that the regional facility will fulfill the new development and redevelopment requirements, such that onsite treatment is not needed.

4.3.1 Watersheds Affected by Total Maximum Daily Loads

Although the current Phase II Permit (2013–2018) does not explicitly require treatment or flow control for runoff from existing development, it does require compliance with TMDLs established for water bodies that receive municipal stormwater runoff. Phase II permittees whose stormwater drains to TMDL water bodies might need to implement regional projects, distributed BMPs, and/or GSI to reduce stormwater pollutant loads from existing development.

McAleer Creek is the only water body within Shoreline on the current 303(d) list, and several watersheds within the city contribute flow to downstream 303(d)-listed water bodies. Figure 4-3 shows the areas potentially affected by TMDLs for 303(d)-listed water bodies.

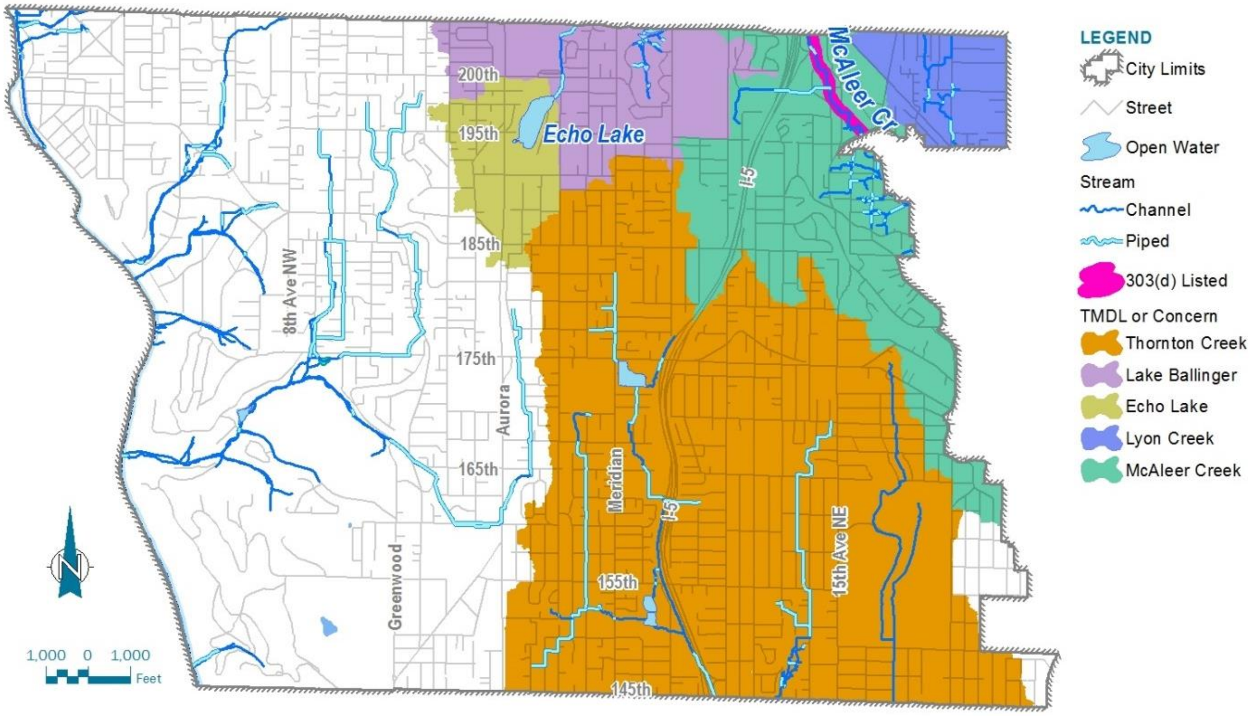

Figure 4-3. Areas potentially affected by TMDL or "waters of concern"

McAleer Creek is on the 303(d) list for fecal coliform bacteria, DO, water temperature, and low B-IBI scores. Ecology has established a TMDL to limit phosphorus discharges to Lake Ballinger, which receives drainage from a portion of the city. Reaches of Thornton Creek downstream of Shoreline are on the 303(d) list for bacteria, DO, and water temperature. Echo Lake is listed as a water body of concern because of elevated fecal coliform bacteria concentrations.

TMDL requirements are enforced through NPDES permits for MS4 and wastewater discharge to affected water bodies. A TMDL could require treatment or removal of stormwater pollution from existing developed areas that drain to the impaired water bodies. The next Phase II Permit will include an appendix listing all TMDL requirements for each permittee. Future TMDLs could affect stormwater treatment requirements for the highlighted areas on Figure 4-3.

4.3.2 Stormwater Treatment Options

Regional facilities, GSI, and/or distributed BMPs may be used to meet Phase II Permit requirements for new development and redevelopment, as well as future TMDL requirements. The Utility prepared a set of pros and cons comparing regional facilities and distributed BMPs and a rough cost comparison for subbasins around the city. This analysis is included in Appendix F.

The cost comparison indicated that regional facilities may be less expensive than distributed BMPs in most subbasins, especially if infiltration can be achieved at the regional facility site. Allowable infiltration capacity is clearly the most important factor in determining the cost feasibility of a project. A study completed by KPG for the City in 2015 looked at the feasibility of a regional facility for the Aurora Square Community Renewal Area (KPG 2014) and found that the cost to manage 1 acre of impervious surface with distributed/onsite facilities with no infiltration is more than nine times the cost compared to a regional facility with infiltration. Another key factor regarding cost-effectiveness is that regional facilities tend to have smaller unit costs (both capital and O&M) as the size of the facility (and treated area) increases because of economies of scale. Regional facilities could also be used to help meet other City objectives such as encouraging redevelopment and economic growth, creation of green space, or other community amenities.

Regional facilities can be more challenging to implement than GSI or distributed BMPs for several reasons:

- Feasibility and cost for a regional facility depend, to a large extent, on the availability, ownership, size, and suitability of a site.
- Regional facilities are generally larger and more capital-intensive to build when compared to distributed BMPs. It is difficult to break up regional facilities into phases if capital funding is limited.
- Regional facilities that are intended to meet Phase II Permit requirements for new development or redevelopment must be built *before* the development takes place. The jurisdiction or developer must make an upfront investment to build the regional facility.

For these reasons, financing can often be more challenging than the technical issues associated with regional stormwater facilities.

In summary, the optimum treatment approach for a given situation will vary depending on site constraints and opportunities, regulatory requirements, stakeholder interests, and other social issues. Regional facilities and distributed BMPs can both be feasible, cost-effective solutions in the right circumstances. Focused studies like the one performed for Aurora Square can be conducted to evaluate site constraints and opportunities for specific areas of the city. Furthermore, given the importance of infiltration capacity, site investigations may be warranted even at the planning stage.

4.3.3 Stream and Lake Water Quality Summary

The Utility has monitored water quality in the city's key streams and lakes since 2002. The water quality data collected from 2002–2009 were described in the *2009 Fresh Water Assessment Report—State of Water Quality in Shoreline Streams, Lakes and Wetlands* (City 2010). The *2016 Fresh Water Assessment Report—State of Water Quality in Shoreline Streams and Lakes* (City 2017d) describes the water quality data collected from 2010–2015. These reports summarize water quality data for Thornton, Littles, McAleer, Cedar Brook, Storm, and Boeing creeks, as well as Hidden and Echo lakes. The monitoring included DO, water temperature, pH, and turbidity. These parameters must remain within certain limits to support fish and other aquatic organisms. The monitoring also included measurement of fecal coliform bacteria in water samples. The fecal coliform results were compared to State water quality criteria for protection of recreational users of the water bodies.

The City also used the monitoring results to calculate Water Quality Index (WQI) scores for each monitoring location. The WQI is intended to serve as a general indicator of overall water quality. It is calculated based on monitoring results for DO, pH, total phosphorus, total nitrogen, turbidity, total suspended solids, temperature, and fecal coliform bacteria, using the King County method. WQI scores can range from 1 to 100, with the higher number indicating higher water quality. The City's 2009 report calculated WQI scores based on 2007–2009 monitoring data, while the 2016 report used data collected from 2009–2015. The WQI scores were then sorted into three categories: (1) low concern (score 80 and above), (2) moderate concern (score between 40 and 80), and (3) high concern (score below 40).

Overall, the water quality in the city's streams and lakes is typical of urban water bodies in the Puget Sound lowlands. The following bullets summarize the City's water assessment for each drainage basin:

- The Thornton Creek basin includes monitoring locations on Thornton and Littles creeks. DO and fecal coliform often did not meet water quality criteria. Both the 2009 and 2016 reports note that both Thornton and Littles creeks are in the "high concern" category based on their WQI scores (City 2010, 2017d).
- The Boeing Creek basin includes stream monitoring locations on the north and south forks of Boeing Creek, and Hidden Lake. For the north fork, the 2009 report notes excursions from the DO criterion, while the 2016 report mentions excursions for DO and fecal coliform. For the south Boeing Creek location, the 2009 report notes excursions for DO and the 2016 report notes excursions for fecal coliform. Both branches of Boeing Creek are in the "moderate concern" category based on their WQI scores. Monitoring results presented in both the 2009 and 2016 reports indicate an excursion from the water quality standard for fecal coliform bacteria from Hidden Lake (City 2010, 2017d).
- The Storm Creek basin includes one monitoring location on Storm Creek. The 2009 report notes excursions for DO and fecal coliform and the 2016 report notes excursions for DO, pH, turbidity, and fecal coliform. Storm Creek is predominantly in the "highest concern" category based on its WQI scores (City 2010, 2017d).
- The McAleer Creek basin includes monitoring locations McAleer and Cedar Brook creeks and Echo Lake. For both creeks, the 2009 and 2016 reports cite excursions for DO, turbidity, and fecal coliform. Both the 2009 and 2016 reports note that both McAleer and Cedar Brook creeks are in the "moderate concern" category based on their WQI scores. Monitoring results presented in both the 2009 and 2016 reports for Hidden Lake indicated consistent excursions for all water quality parameters (City 2010, 2017d).
- The Lyon Creek basin includes one monitoring location on Ballinger Creek within the city. Water quality results for Ballinger Creek are included in the Lyon Creek Basin Plan for monitoring occurring during 2002–2013. A WQI score was not completed but the results were compared to the State water quality criteria. The monitoring results indicate that water quality parameters DO, water temperature, and turbidity may be improving. Results for pH showed no apparent trend (AltaTerra 2015a).
- The Middle Puget Sound basin includes one marine monitoring location at Richmond Beach. King County collects weekly samples at Richmond Beach Saltwater Park during the swimming season (approximately 14 weeks). The samples are analyzed for fecal indicator bacteria to confirm that the water is safe for recreational uses. King County's 2017 Beach Environmental Assessment, Communication and Health (BEACH) Program annual report indicates that Richmond Beach Saltwater Park met the swimming standards during all periods sampled (Ecology 2018).

4.4 Aquatic Habitat

The Utility conducted biological and habitat evaluations in its *2007 Bioassessment Report, Biological and Habitat Assessment of Shoreline Streams* (2007 report) (Watershed Company 2009). The 2007 report found that urbanization impacts were the likely cause of low B-IBI scores observed at all five stream locations included in the study (Thornton, McAleer, Lower Boeing, Upper Boeing, and Storm creeks). The 2007 report noted that "streams with larger forested riparian buffers tended to have relatively higher quality physical habitat than streams with narrower riparian buffer" and "silt and sand were generally a dominant substrate type in many of the survey areas." The silt and sand substrates negatively affect the macroinvertebrate community and the successful spawning habitat for fish species (Watershed Company 2009).

The City's 2016 Water Quality Assessment Report (City 2017d) included the following recommendations to improve aquatic habitat conditions in the city:

- Conduct riparian vegetation surveys to assess presence of non-native species and replace with appropriate native vegetation. This action will help to reduce streambank erosion, reduce turbidity, and improve in-stream habitat. This effort is included in the Aquatic Habitat Improvement Program (see Section 7.3.7).
- Perform fish surveys on Boeing, Storm, McAleer, and Thornton creeks. A fish survey will help establish a baseline condition and can be used to measure future changes. Fish surveys can be performed programmatically or as part of a related project. For the 2018 Master Plan, the fish surveys are recommended as a part of a project.
- Install temperature loggers at priority stream sites for continuous temperature recording.
- Consider climate change in future studies, plans, ongoing maintenance, and infrastructure design. Climate change could cause current conditions to decline if not mitigated (City 2017d). This effort is included in the *Climate Impacts and Resiliency Study*. Details on the study are included in Appendix D-5 of the Master Plan.

Section 5

Regulatory Compliance

The Utility must establish and maintain programs that comply with State and federal regulations pertaining to surface water, including natural water bodies and the MS4. The City achieves compliance by incorporating these requirements into its own policies, regulations, and ordinances. Compliance with stormwater regulations is an important responsibility of the Utility (see LOS 4, Regulatory Compliance, Table 2-1).

This section summarizes the federal and State regulations and programs that drive the Utility's work. Other City regulations including the Shoreline Municipal Code (SMC) are briefly described in Section 6.2.4. The City designed these regulations in accordance with federal and State requirements.

The primary regulatory driver for the Utility work is the Phase II Permit issued by Ecology. The Phase II Permit which allows the Utility to discharge stormwater runoff from the City's municipal drainage system into Washington State waters as long as the Utility implements programs to protect water quality by reducing the discharge of nonpoint source pollutants to the maximum extent practicable (MEP) through application of Phase II Permit-specified BMPs.

5.1 Federal Requirements

The Utility directly or indirectly adheres to the requirements of the following five federal government-based requirements:

- **National Environmental Policy Act (NEPA):** requires documentation of environmental impact of projects with federal permits
- **Clean Water Act (CWA):** requires permits and adherence to permit requirements to maintain or improve water quality
- **Endangered Species Act (ESA):** requires O&M practices conducive to habitat conservation
- **National Flood Insurance Program (NFIP):** requires flood-prone cities to adopt and enforce ordinances that meet or exceed Federal Emergency Management Agency (FEMA) requirements to reduce the risk of flooding
- **Governmental Accounting Standards Board (GASB):** requires the City to adhere to requirements of established governmental accounting and financial reporting

The requirements from these federal and nationally based regulations and their impact on the Utility operations and management are presented below.

5.1.1 National Environmental Policy Act (43 CFR 1500–1508)

Passed in 1970, NEPA requires that all proposed activities (such as surface water capital projects) with federal funding or needing federal permits prepare documentation that describes the environmental impacts of proposed actions, and perform public outreach and review opportunities. The documentation includes disclosure to the public of the following information: the federal-related actions and a mechanism for public input, preparation of environmental impact statements, and presentation of alternatives and mitigation for major project components that might impact the environment.

5.1.2 Clean Water Act (33 USC 1252 [a])

The CWA is the 1972 amendment to the 1948 Federal Water Pollution Control Act. The main purpose of the CWA is to achieve the goal of restoring and maintaining the chemical, physical, and biological integrity of the nation's waters. To achieve that goal, the CWA directs the U.S. Environmental Protection Agency (EPA) to administer programs to (1) regulate the discharge of pollutants (e.g., through permits), and (2) implement water quality standards. The relevant portions of these two programs are summarized below.

In 1999, EPA adopted rules to implement Phase II of the MS4 Program, which applied to smaller communities. These smaller communities were identified as those located in urbanized areas as defined by the U.S. Census. The Phase II Permit is described in Section 5.2.1, Phase II Permit (CWA 402-NPDES).

5.1.3 Wetland-Related Permits (CWA §404)

Section 404 of the CWA regulates water body filling, particularly wetland areas, with a permit program. The U.S. Army Corps of Engineers administers the permit program to ensure no net loss of wetland areas. Under this permit program, capital projects that impact wetlands would need to include alternatives to avoid, minimize, or compensate for any wetland loss. In cases where a wetland area is impacted, the permit program regulates wetland replacement through a mitigation process.

5.1.4 Endangered Species Act

The National Oceanic and Atmospheric Administration (NOAA) listed Puget Sound Chinook salmon (*Oncorhynchus tshawytscha)* and Puget Sound Steelhead as threatened species under the ESA on March 24, 1999, and May 11, 2007, respectively. Both species' threatened status was confirmed on April 14, 2014. The ESA provides for both the conservation and protection of plant and animal species that face the threat of extinction, as well as for the supporting ecosystems. To prevent further decline of the species and to encourage restoration, the ESA prohibits "take" of listed animals, which includes significantly modifying its habitat. The ESA requires that a plan be developed and implemented to address recovery of the species.

Shoreline is located within Water Resource Inventory Area (WRIA) 8 (Lake Washington, Cedar/Sammamish Watershed and Water) and participates in this group's Chinook salmon conservation planning efforts for streams discharging to Lake Washington and Puget Sound (WRIA 8 2017). The City continues to protect Chinook salmon with a range of BMPs and public education. The only water body with documented Chinook presence is McAleer Creek. Steelhead trout also have a documented presence in McAleer Creek.

NOAA listed the southern resident population of killer whales (*Orcinus orca*) as endangered species under the ESA on November 18, 2005, and updated status on April 14, 2014. The southern resident population of killer whales spends summers and fall in Puget Sound, which is considered critical habitat. Urban surface runoff has been identified as one of several sources of pollution that degrades water quality and can affect killer whales through bioaccumulation of contaminants in prey (Industrial Economics 2006). Boeing and Storm creeks, and the Middle Puget Sound drainages discharge to the Puget Sound. Activities such as road maintenance, culvert replacement, surface water asset O&M, and land use regulations can impact aquatic habitat. These activities can be subject to the requirements of the ESA.

5.1.5 Governmental Accounting Standards Board Statement 34

The City needs an accurate inventory of its stormwater infrastructure to comply with GASB 34 requirements. Financial reporting by public utilities must adhere to requirements set by the GASB, which is the agency responsible for developing standards of State and local governmental accounting and financial reporting. Most prominent is GASB Statement 34, "Basic Financial Statements—and Management's Discussion and Analysis—for State and Local Governments," which was issued in June 1999. The main objective of Statement 34 requirements is to develop financial reports that are more comprehensive and easier to understand by the public. Statement 34 consists of several components, which can be seen in full in paragraphs 3 through 166 of the GASB publications (GASB 2017).

5.2 State Requirements

State regulatory requirements and federal requirements administered by the State that are relevant to the Utility are described below. Two sections of the federal CWA administered by the State through Ecology protect water quality include the Phase II Permit (CWA 402-NPDES) and TMDL Listing (CWA 303(d)). For convenience, the federal and State requirement for flood protection and mitigation are described together below. Other State requirements, such as the planning requirements associated with the Growth Management Act (GMA) and permitting requirements outlined in the Hydraulic Code, are also discussed.

5.2.1 Phase II Permit (CWA 402-NPDES)

Shoreline is a Phase II permitted community and received its first Phase II Permit from Ecology in 2007. The 2007 Phase II Permit was updated and reissued to Phase II Permit holders in August 2012 with an effective date of August 2013. In January 2014, some modifications were made to the City's Phase II Permit and Ecology issued an errata sheet in 2015.

5.2.1.1 Current Phase II Permit (effective 2013–2018, with extension to 2019)

The Phase II Permit allows municipalities to discharge stormwater runoff from their municipal drainage systems into Washington State water bodies (e.g., streams, rivers, lakes, and wetlands) under conditions specified in the Phase II Permit. Municipalities must implement programs to protect water quality by reducing the discharge of pollutants to the MEP and by applying all known, available, and reasonable treatments (AKART). Stormwater pollution reduction is accomplished through the application of structural and non-structural BMPs. The stormwater management activities specified in the Phase II Permit are documented in a *Stormwater Management Program Plan* and broken out by the following program components (City 2017e):

- *Stormwater Management Program* administration
- Public education and outreach
- Public involvement and participation
- Illicit discharge detection and elimination (IDDE)
- Control of runoff from new development, redevelopment, and construction sites
- Municipal O&M
- Monitoring and assessment

The Phase II Permit also requires compliance with established TMDLs as described in Section 5.2.2.

On March 31 of each year, the Phase II Permit requires the City to submit a report to Ecology on the status of compliance with the Phase II Permit. The City must also submit a stormwater management program plan each year that describes the activities for the coming year. Implementation of specific Phase II Permit conditions are staggered throughout the 5-year Phase II Permit term.

In the 2013 Phase II Permit, there were changes and updates from the 2007 Phase II Permit. Two significant changes were as follows:

- LID requirements were included for new development and redevelopment to mimic natural drainage processes. Existing standards were changed to apply to sites smaller than 1 acre.
- A Regional Stormwater Monitoring Program (RSMP) was included covering collection of water quality, habitat, and biota monitoring information; program effectiveness tracking; a source identification information repository; publicly accessible monitoring data; and identification of Ecology as the program administrator for the 2013–2018 Phase II Permit term, with funding from each permittee.

5.2.1.2 Future Phase II Permit (2019–23)

The 2013–2018 Phase II Permit was extended 1 year. Ecology plans to issue a new Phase II Permit in 2019. Ecology held public meetings in 2017 and presented preliminary draft language for the new Phase II Permit, which includes the following:

- **Business Inspection Source Control Program:** To continue reduction of illicit discharges and build on existing public outreach and education efforts of Ecology's Local Source Control Partnership, the new Phase II Permit may require a source control program for the existing Development Program, similar to what is currently required of Phase I Permit holders (e.g., City of Seattle, King County). The new source control program would require updates to SMC as well as additional resources to manage the program and perform inspections.
- **Illicit discharge tracking and documentation:** The previous Phase II Permit provided guidance for tracking and documenting illicit discharges. To better review illicit discharge information, Ecology will require Phase II Permit holders to document incidents and submit a file with an annual report containing the information in the manner Ecology prescribes. This will require Phase II Permit holders to use the Ecology system to document the illicit discharge incidents or to develop a data programming tool to convert the data collected in the City's system into the Ecology prescribed format.
- **Minor updates to mapping and water quality monitoring:** The new Phase II Permit will include minor modifications to the continuing mapping and monitoring requirements. For mapping, Phase II Permit holders will be required to record size and material attributes for all known MS4 outfalls. For the Utility, this requirement is partially met with 80 percent of the mapped outfalls with size and material attribute information complete. For water quality monitoring, the new Phase II Permit is asking for more detail in annual report summary responses and changes in payment time for regional status and trend monitoring.
- **Language clarification:** Although not resulting in substantive or actionable changes, the new Phase II Permit will include language clarification and provide overall clarity to the "Controlling Runoff from New Development, Redevelopment and Construction Sites" and "Public Education and Outreach" sections.
- **Update to education and outreach requirements**: The new permit will include "actionable changes," to the education and outreach requirement including, a new evaluation of an existing program, implementing either changes to that program or a new program altogether, and correlating outreach efforts to actual water quality data, which has not been done previously.

- **Long-term MS4 planning:** Ecology is proposing a watershed-scale planning requirement for both Phase I and Phase II Permit holders. The planning effort would require permit holders to prioritize subbasins based on the needs of local receiving waters and prepare plans with targeted capital projects and BMPs that directly contribute to preventing and reducing impacts to receiving waters.
- **Stormwater Management Manual for Western Washington update**: Ecology is updating the 2014 *Stormwater Management Manual for Western Washington* (Stormwater Manual) to enhance usability and improve overall clarity.

5.2.2 Total Maximum Daily Load Listing (CWA 303(d))

Ecology performs a statewide Water Quality Assessment every 2 to 4 years to identify water bodies that do not meet the State water quality standards. Water bodies that do not meet standards are placed on the CWA 303(d) list. Ecology develops TMDLs for the water bodies on the 303(d) list to bring them into compliance with water quality standards. TMDLs typically apply to the watershed areas that contribute flow to the 303(d)-listed reaches.

McAleer Creek is the only water body within Shoreline on the current 303(d) list. Echo Lake is listed as a water body of concern, which means there are indications of a water quality problem, but not an ongoing impairment. Other watersheds within the city contribute flow outside of Shoreline city limits to downstream water quality impaired water bodies. For example, the Thornton Creek watershed contributes flows to 303(d) reaches of Thornton Creek outside of Shoreline. Similarly, portions of the city's McAleer Creek watershed contribute flow to the TMDL-listed Lake Ballinger located in the cities of Mountlake Terrace and Edmonds.

TMDLs for water bodies downstream of Shoreline could trigger pollutant load reduction requirements for stormwater discharges in Shoreline. TMDL requirements will become a special condition of the next Phase II Permit after the TMDL has been developed by Ecology and approved by EPA. The TMDL could require treatment or removal of stormwater runoff from existing developed areas that drain to the affected water bodies. Thus, TMDLs could affect future stormwater treatment or removal of stormwater runoff from existing developed areas that drain to the affected water bodies. See Appendix F, for more details on 303(d) and TMDL information.

5.2.3 National Flood Insurance Program and Floodplain Management (RCW 86.16)

In 1968, the U.S. Congress created the NFIP to provide financial protection to property owners from flood damage. The NFIP offers flood insurance to homeowners, renters, and business owners if their community participates in the NFIP. Participating communities agree to adopt and enforce ordinances that meet or exceed FEMA requirements to reduce the risk of flooding (see FloodSmart.gov for details about the program). The City is a participating community in FEMA's NFIP. To participate in the program, the City adopted and enforces a floodplain management ordinance that regulates development, SMC 13.12 Floodplain Management.

The City updated SMC 13.12 in 2017 to meet FEMA recommendations developed during a Community Assistance Contact (CAC) assessment. The updates were administrative in nature and provided consistency with updated FEMA regulations. The updates ensured that the City remained in compliance with FEMA regulations, and maintained its eligibility for the NFIP. The current FEMA flood insurance rate maps (FIRMs) affect properties along the Puget Sound shoreline, Boeing Creek, and the north fork of Thornton Creek.

Revised Code of Washington (RCW) Chapter 86.16, "Floodplain Management," establishes statewide authority for floodplain management as provided through the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. Ecology is identified as the responsible State agency to carry out this program. Under Washington Administrative Code (WAC) Chapter 173-158, Ecology requires local governments to adopt and administer regulatory programs compliant with the minimum standards of the NFIP. Ecology provides technical assistance to local governments for both identifying the location of the 100-year (base) floodplain and administering their floodplain management ordinances.

The City currently does not participate in FEMA's Community Rating System (CRS). The CRS is an incentive program that encourages communities to adopt floodplain management activities exceeding the minimum NFIP requirements. Participants receive discounts on flood insurance.

5.2.4 Growth Management Act (RCW Chapter 36.70A)

The Washington State Legislature enacted the GMA in 1990 to address rapid population growth and concerns with suburban sprawl, environmental protection, quality of life, and related issues.

The GMA provides a framework for regional coordination of land development. Under the GMA, local comprehensive plans, such as the Comprehensive Plan, must include the following elements: land use, housing, capital facilities, utilities, transportation, economic development, parks and recreation, and, for counties, a rural element. City master planning documents, such as the 2018 Master Plan, are coordinated with the City's comprehensive planning process through an annual Comprehensive Plan amendment process. During this amendment process, the Master Plan and capital projects therein are integrated with the capital facilities element of the Comprehensive Plan.

5.2.5 Hydraulic Project Approval (State Hydraulic Code RCW 77.55)

The Washington Department of Fish and Wildlife (WDFW) requires a Hydraulic Project Approval (HPA) for construction activities that use, divert, obstruct, or change the natural flow or bed of any waters of the state. The purpose of the requirement is to protect fish habitat in stream channels, prevent erosion, and protect freshwater and nearshore marine aquatic life. Construction activity such as bridge painting, channel improvements, stream restoration, or culvert replacements within the ordinary high water mark of any stream would typically require an HPA. Flood-damage repair and prevention activities may be permitted as a 5-year plan, avoiding the need to permit each individual activity. WDFW generally may require modifications to plans and specifications that avoid or mitigate project impacts on fish ecology. Possible modifications include, and are not limited to, the following:

- Making a culvert fish passable
- Providing large woody debris in a stream channel
- Moving grading limits outside the ordinary high water mark
- Specifying construction practices that prevent entry of construction equipment and/or materials into the watercourse
- Specifying bed material, construction methods, the construction period, riparian vegetation, and any required mitigation

If it is more cost-effective, the applicant may be permitted to perform offsite mitigation, provided that it will generate equal or greater biological functions and values as compared to onsite mitigation.

Table 5-1 provides a summary list of the federal and State regulations and programs relevant to the Utility's responsibilities.

Table 5-1. Federal and State Regulations and Programs Relevant to the Utility's Responsibilities		
Title	Regulation or Program	Application to the City
Federal		
NEPA	Regulation	All projects with federal funding or needing federal permits are required to submit a NEPA review to describe environmental ramifications, disclose federal actions, provide a mechanism for public input, prepare an environmental impact statement, and consider alternatives and mitigation for actions.
CWA	Regulation	Originally passed in 1972 to address point sources of pollution and to restore the chemical, physical, and biological integrity of the nation's water (33 USC 1251 [a]). Several sections are administered by Ecology through permission of EPA including §303(d), §401, and §402-NPDES as described in RCW 90.48.260. These sections of the CWA are described in the State and Regional subsection of this table. Different sections of the CWA require permits and adherence to permit requirements to maintain or improve water quality.
CWA §404 wetlands	Regulation	Permit program for capital projects that is administered by the U.S. Army Corps of Engineers to ensure no net loss of wetland areas. Permits are obtained when work occurs in or near a designated wetland area. The City's designated wetlands are mapped in the City's GIS.
ESA	Regulation	Stormwater capital improvement projects that involve federal permitting or funding could require consultation with federal agencies under §7 of the ESA. ESA consultation could increase project timelines and costs. For the Utility, ESA-regulated activities require O&M practices conducive to habitat conservation.
GASB Statement 34	Program	Requires the City to adhere to established governmental accounting and financial reporting such as accurate inventory of the City's stormwater infrastructure.
State and Regional		
SEPA	Regulation	Each capital improvement project requires SEPA review prior to implementation, unless that project qualifies as exempt. May increase project costs and schedules. Planning documents that outline proposed capital projects and programs such as the Master Plan require programmatic SEPA review to evaluate cumulative impacts.
CWA §303(d) TMDL listings [a]	Regulation	TMDLs could lead to more stringent stormwater quality controls in future NPDES permits. The City does not currently have any TMDLs. The City has one water body with a 303(d) listing, McAleer Creek.
CWA §401 water quality certification [a]	Regulation	Individual projects that require §404 permit (projects with the federal connection) or other federal permits would also require a §401 certification from Ecology. A §401 certification could include requirements for site-specific mitigation measures, which could affect capital improvement project design and costs.
CWA §402 MS4 NPDES permit [a]	Regulation	Includes requirements focused on stormwater quality management in the city. The Phase II Permit requires the reduction of pollutant loads to the MEP. Washington State may establish TMDLs for water bodies that violate the standards. TMDLs can become Phase II Permit requirements.
NFIP and floodplain management [b]	Regulation	Washington State's RCW 86.16, "Floodplain Management," establishes statewide authority for floodplain management as provided through the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. Provides guidance and regulations for City's Floodplain Development Permit and participation in NFIP.
GMA and *City of Shoreline Comprehensive Plan*	Regulation	The GMA is a significant driver for land use and permitting decisions. The 2012 *City of Shoreline Comprehensive Plan* (as amended) is required by the GMA, and includes language preventing adverse surface water impacts from land development (City 2012).
State hydraulic code	Regulation	Projects that involve work in waters of the state such as streams and culverts that convey stream flow require an HPA permit. HPA permitting and mitigation measures could affect project costs.
Archaeological and cultural coordination	Regulation	If capital improvement projects are near known or suspected archaeological sites, they must coordinate with the Department of Archaeology and Historic Preservation, local Indian tribes, and King County Historic Preservation.

a. *Portions of the CWA are delegated to Ecology entities for administration.*

b. *The NFIP is a federal program administered by FEMA, but is presented here with Washington State-administered floodplain management requirements.*

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Section 6

Policies and Procedures

Utility services are provided by City staff who perform administrative activities, operations, maintenance, public involvement, and capital improvement planning in accordance with established policies and procedures. This section describes the organizational structure of the staff supporting the Utility, provides background on existing policies and procedures, and summarizes policy discussions and recommended policy changes evaluated as part of the master planning process.

6.1 Staff Organization

The Utility is part of the City's Public Works Department. Utility staff are located primarily under the Surface Water Utility; however, shared staff also fall under Street Operations and Engineering. Additional staffing funds may be allocated to other City departments, such as Administrative Services or Planning and Community Development, but this varies from year to year depending on the needs of the Utility. Figure 6-1 provides an organizational chart for Utility personnel with the full-time equivalent (FTE) allocations for 2017.

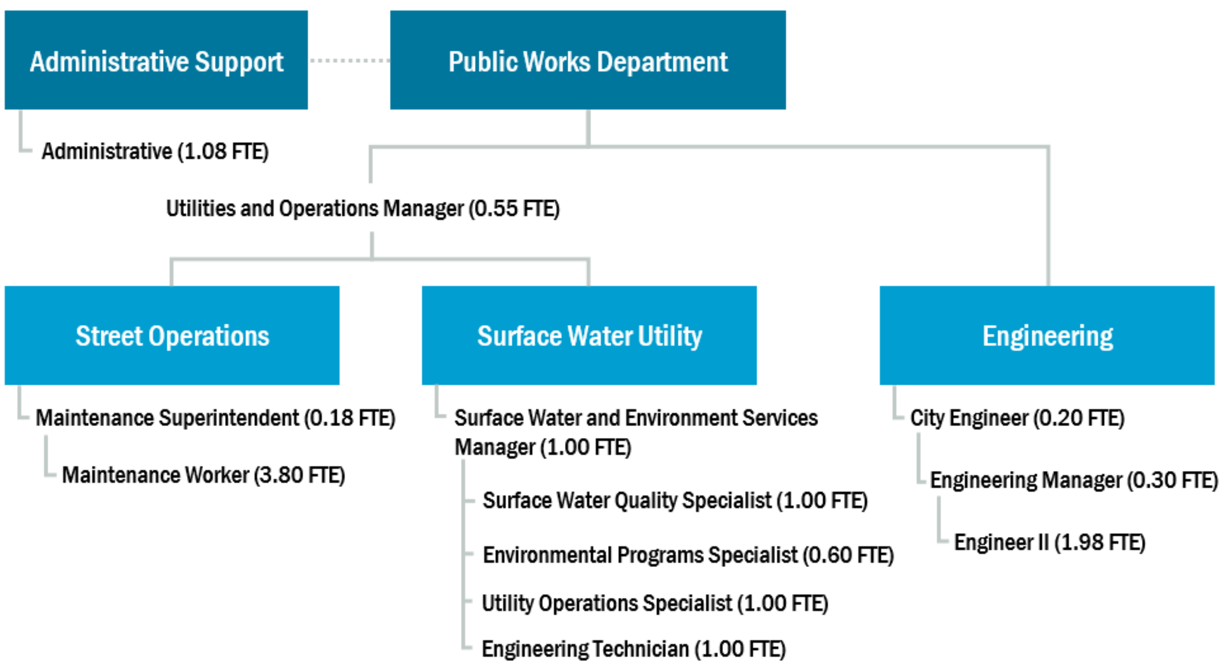

Figure 6-1. Organization of personnel contributing to Utility with FTE allocations for 2017

6.2 Existing Policies and Procedures

The Surface Water and Environmental Services Manager, Utilities and Operations Manager, Public Works Director, and City Manager work collectively to establish policies and procedures for the Utility, many of which are approved by the City Council through municipal ordinances or as part of the annual budgeting process. Policies and procedures are developed as staff recommendations, and are approved through a process that potentially involves three levels of City administration: Public Works Department, City Manager's Office, and the City Council. For example, policies that result in changes to municipal code or that affect the City's annual budget require the Public Works Director to coordinate with the City Manager's Office to prepare recommendations for the City Council. In contrast, minor updates to the *Engineering Development Manual* (EDM) or Administrative Orders (AOs) interpreting existing code are simply approved at a departmental level by the Public Works Director.

The following sections summarize key policies and procedures for the Utility.

6.2.1 O&M Manual

As part of the development of this Master Plan, the Utility prepared the *City of Shoreline Surface Water Utility Operation and Maintenance Manual* (O&M Manual), which contains the latest policies and procedures for operating and maintaining the City's surface water infrastructure (see Appendix G). The updated O&M Manual documents the policies and procedures that improve asset management and comply with regulatory requirements. Key updates include:

- Process details for O&M procedures in accordance with the Phase II Permit and asset management BMPs
- O&M work flow process relative to the Computerized Maintenance Management System (CMMS)
- Inspection and maintenance guidance for the various types of publicly owned surface water assets
- References to other O&M activities such as severe weather response, IDDE procedures, and private facility inspection

6.2.2 Engineering Development Manual

The 2016 Shoreline EDM is a guide for public and private development within the city. The EDM is a supplement to the city code and provides minimum engineering criteria and specifications. The Public Works Director is given authority to create and update the EDM through SMC 20.70.020, Engineering and Utilities Development Standard. The EDM is updated on an ongoing basis and typically re-published every other year.

The EDM manual includes four divisions:

- **Division 1:** Administration contains information related to permits
- **Division 2:** Right-of-way presents standards and other information related to development within the ROW
- **Division 3:** Surface Water contains surface water policies, as well as design standards that apply to public and private development
- **Division 4:** Construction and Inspection provides the basics regarding construction and inspection in the City ROW

Division 3 of the EDM consolidates City policy, procedures, and BMPs guidance for development related to surface water. Table 6-1 summarizes the nine chapters of Division 3.

Table 6-1. Summary of EDM Division 3 Surface Water Standards and Policies

Chapter	Relevance to Utility
18. Surface Water Standards	Provides references to standards documents including the 2012 Stormwater Manual, as amended in December 2014 and the King County *Surface Water Design Manual* (Stormwater Manual)
19. Stormwater Manual Modifications	Lists modifications to the requirements of the Stormwater Manual especially where the Stormwater Manual notes an item is optional or up to the jurisdiction
20. General Requirements	Provides additional requirements to documents listed in Chapter 18, Surface Water Standards
21. Infiltration	Provides additional information about infiltration for LID and relative to City-specific development permits
22. Surface Water Project Classification	Includes guidance and descriptions about the four development project classifications to help with following the requirements of the Stormwater Manual and City development permits
23. Site Development Plan	Provides reference to site development discussion in the Stormwater Manual and additional City-specific guidance on BMPs for site design
25. Stormwater Pollution Prevention Plan	Provides reference to stormwater pollution prevention plans (SWPPPs) and additional City-specific requirements for preparing a SWPPP
26. Flood Control	Lists areas within the city that are identified as floodplain areas and provides reference to SMC
27. Conveyance System	Lists design specifications for pipe, drop structures, wall crossing, and ditch modifications

The EDM incorporates or provides references to AOs, which are code interpretations issued by department directors. Currently one AO is related to surface water activities, AO 000019 121300. This AO states that a detention pond can be placed in all land use zones. Unlike parking, detention is not a function of land use, but a function of impervious surface and drainage area.

6.2.3 Budget and Capital Improvement Plan

An annual City budget and the 6-year CIP recommendations are prepared as part of an overall budget process and are approved by the City Council annually. There are also budget amendments and budget carryover processes that occur during the year.

Financial policies associated with the City's annual budgeting process are included in the appendices of the annual *Capital Improvement Plan* (City 2017b). These policies were considered during the CIP cost development and rate structure analysis of this Master Plan:

- **Fund reserve:** The City shall maintain an operating reserve within the Fund in an amount equal to or greater than 20 percent of budgeted operating revenues.
- **CIP O&M costs:** CIP projects, as approved by the City Council, shall have a funding plan for O&M costs identified in the project description. These costs will be included in the City's long-term financial planning.

6.2.4 Shoreline Municipal Code

SMC Chapter 13.10, Surface Water Utility, establishes the requirements for the Utility. The City Council adopts amendments to the SMC on an ongoing basis as recommendations are provided by the City Manager's office and department directors. Compliance with Phase II Permit regulations is a common driver for code amendments related to the Utility. For example, the City adopted SMC language to promote and not inhibit the use of LID to maintain compliance with the 2013 Phase II

Permit requirements. Code amendments are also needed when surface water management fees change. Utility staff recommended new surface water management fees for 2018 to fund the recommended projects and programs identified in the 2018 Master Plan. The City Council updated the surface water management rate table, SMC 3.01.400 with the adoption of the 2018 annual budget and CIP. This section of code also included language changes relative to chargeable area as discussed in Section 6.3.3.

Table 6-2 presents a summary of the current SMC relevant to the Utility and its level-of-service goals.

Table 6-2. Summary of Shoreline Municipal Code Relevant to Utility

Code	Relevance to Utility
3.01.400 Surface Water Management Rate Table	Presents the current surface water management rate table, rate credits and adjustment, and Soak It Up program rebate rate.
3.35.080 Surface Water Utility Enterprise Fund	Establishes the Surface Water Utility Enterprise Fund and restrictions of its use.
13.10 Surface Water Utility	Establishes the Utility and its goals, and provides guidance and requirements for water quality pursuant to federal (NPDES Permit) and State (Chapter 90.48 RCW) requirements including prohibited discharges, inspections, investigations, and illicit discharges. Includes guidance for facility design and construction, construction inspection, and record drawings and certification.
13.12 Floodplain Management	Outlines the City's approach, standards, and adherence to State and federal guidance for floodplain management to protect public health, safety, and welfare relative to flooding.
20.30 Subchapter 9. Code Enforcement	Declares public nuisance and enforcement. Includes code enforcement procedures for SMC. Outlines enforcement procedures relevant to violations outlined in other sections of SMC such as the pollution of public waters, commercial facility maintenance, floodplain management, and public nuisances as defined by the RCW. Outlines the escalation of enforcement for code violations as declared in SMC 20.30.740. Relevant to the inspection and maintenance enforcement of privately owned stormwater facilities, detection and elimination of illicit discharges, and floodplain management.
20.70 Engineering and Utilities Development Standard	Establishes the engineering regulations and standards including naming the EDM as the City standard for surface water asset design and maintenance.
20.70.140 Dedication of Stormwater Facilities	Outlines maintenance responsibilities for stormwater facilities within and outside of the public ROW, including processes for accepting or releasing facility dedication. Relevant to the inspection and maintenance enforcement of privately owned stormwater facilities.
20.70.330 Surface Water Facilities	Establishes that stormwater facilities must meet requirements outlined in SMC 13.10, Surface Water Utility, and SMC 20.30.440, Installation of Improvements. Relevant to the inspection and maintenance enforcement of privately owned stormwater facilities.
20.80 Critical Areas: 20.80.260–300 Fish and Wildlife Habitat 20.80.310–350 Wetlands 20.80.360–380 Flood Hazard 20.80.420–450 Aquifer Recharge	Includes critical area ordinances for fish and wildlife habitat, wetlands, flood hazard areas, and aquifer recharge areas that include designating and rating, mapping and delineation, development standards, or alteration. Critical area information is considered for CIP planning and cost estimates.
20.200 Shoreline Master Plan	Requires a master plan as specified by the Shoreline Protection Act. Outlines regulations relevant to shoreline protection including no net loss of ecologic function of the city's shorelines. Considered for surface water CIP and cost estimates.
20.230 SMP Shoreline Policies and Regulations	Includes surface water policies and regulations associated with shoreline areas for surface water in general and for stormwater management facilities.

6.2.5 City of Shoreline Comprehensive Plan

The Comprehensive Plan, the City's long-range planning document for the next 20 years, was originally adopted shortly after the City incorporated in 1995. A major review and revision to the Comprehensive Plan was completed in December 2012. While the Comprehensive Plan is a long-range planning document, it may be amended annually by the City Council via ordinance. Shoreline citizens and the City recommend amendments to the Comprehensive Plan's polices and goals, maps, and supporting analyses. City-initiated amendments occur as the City develops and adopts its various master planning documents (e.g., parks, transportation, and surface water) or as new planning issues and goals emerge. The Comprehensive Plan contains many policies relevant to the Utility. Utility staff reviewed the Comprehensive Plan goals and identified a subset of goals relevant to the Utility and the 2018 Master Plan, see Table 6-3.

Table 6-3. Shoreline Comprehensive Plan Goals Relevant to Utility

Comprehensive Plan Section	Policy and Goals Relevant to Utility
Land use, residential	LU41: Through redevelopment opportunities in station areas, promote restoration of adjacent streams, creeks, and other environmentally sensitive areas; improve public access to these areas; and provide public education about the functions and values of adjacent natural areas.
Land use, light rail station areas	LU69: Design, locate, and construct surface water facilities to: • Promote water quality • Enhance public safety • Preserve and enhance natural habitat • Protect critical areas • Reasonably minimize significant, individual, and cumulative adverse impacts to the environment
Land use, water quality, and drainage	LU70: Pursue state and federal grants to improve surface water management and water quality.
	LU71: Protect water quality through the continuation and possible expansion of City programs, regulations, and pilot projects.
	LU72: Protect water quality by educating citizens about proper waste disposal and eliminating pollutants that enter the stormwater system.
	LU73: Maintain and enhance natural drainage systems to protect water quality, reduce public costs, protect property, and prevent environmental degradation.
	LU74: Collaborate with Ecology and neighboring jurisdictions, including participation in regional forums and committees, to improve regional surface water management, enhance water quality, and resolve related interjurisdictional concerns.
	LU75: Where feasible, stormwater facilities like retention and detention ponds should be designed to provide supplemental benefits, such as wildlife habitat, water quality treatment, and passive recreation.
	LU76: Pursue obtaining access rights, such as easements or ownership, to lands needed to maintain, repair, or improve portions of the public drainage system that are located on private property, and for which the City does not currently have legal access.
Community design	CD28. Use the Green Street standards in the Master Street Plan to provide an enhanced streetscape, including street trees, landscaping, natural surface water management techniques, lighting, pathways, crosswalks, pedestrian and bicycle facilities, decorative paving, signs, seasonal displays, and public art.
Transportation	T10. Use LID techniques or other elements of complete or Green Street, except when determined to be infeasible. Explore opportunities to expand the use of natural stormwater treatment in the ROW through partnerships with public and private property owners.

Table 6-3. Shoreline Comprehensive Plan Goals Relevant to Utility	
Comprehensive Plan Section	Policy and Goals Relevant to Utility
Natural environment, geological, and flood hazards	NE11. Mitigate drainage, erosion, siltation, and landslide impacts, while encouraging native vegetation.
	NE14. Inform landowners about site development, drainage, and yard maintenance practices that affect slope stability and water quality.
	NE16. Prioritize the resolution of flooding problems based on public safety risk, property damage, and flooding frequency.
	NE17. Promote public education and encourage preparation in areas that are potentially susceptible to geological and flood hazards.
Natural environment, wetlands, and habitat protection	NE23. Participate in regional species protection efforts, including salmon habitat enhancement and restoration.
	NE24. Preserve critical wildlife habitat, including those identified as priority species or priority habitats by WDFW, through regulation, acquisition, incentives, and other techniques. Habitats and species of local importance will also be protected in this manner.
	NE25. Strive to achieve a level of no net loss of wetland function, area, and value within each drainage basin.
	NE26. Restore existing degraded wetlands where feasible.
	NE27. Focus on wetland and habitat restoration efforts that will result in the greatest benefit for areas identified by the City as priority for restoration.
Natural environment, streams, and water resources	NE28. Support and promote basin stewardship programs to prevent adverse surface water impacts, and to identify opportunities for watershed improvements.
	NE29. Stream alterations, other than habitat improvements, should occur only when it is the only means feasible, and should be the minimum necessary.
	NE30. Identify and prioritize potential stream enhancement projects through surface water basin planning and its public participation process. Enhancement efforts may include daylighting of streams that have been diverted into underground pipes or culverts, removal of anadromous fish barriers, or other options to restore aquatic environments to a natural state.
	NE31. Work with citizen volunteers, State and federal agencies, and Indian tribes to identify, prioritize, and eliminate physical barriers and other impediments to anadromous fish spawning and rearing habitat.
	NE32. Preserve and protect natural surface water storage sites, such as wetlands, aquifers, streams, and water bodies that help regulate surface flows and recharge groundwater.
	NE33. Conserve and protect groundwater resources.
	NE34. Provide additional public access to Shoreline's natural features, including the Puget Sound shoreline. The City will attempt to reach community and neighborhood agreement on any proposal to improve access to natural features where the proposal has the potential to negatively impact private property owners.
	NE35. Educate the public on BMPs regarding the use of pesticides and fertilizers to prevent chemical runoff and the pollution of water bodies.
Capital facilities	CF9. Improvements necessary to provide critical City services such as police, surface water, and transportation at designated service levels concurrent with growth shall have funding priority for City funds over improvements that are needed to provide capital facilities.
	CF10. Consider all available funding and financing mechanisms, such as utility rates, bonds, impact fees, grants, and local improvement districts for funding capital facilities.
	CF11. Evaluate proposed public capital facility projects to identify net costs and benefits, including impacts on transportation, stormwater, parks, and other public services. Assign greater funding priority to those projects that provide a higher net benefit and provide multiple functions to the community over projects that provide single or fewer functions.
	CF16. Promote water reuse and water conservation opportunities that diminish impacts on water, wastewater, and surface water systems, and promote conservation or improvement of natural systems.

Table 6-3. Shoreline Comprehensive Plan Goals Relevant to Utility	
Comprehensive Plan Section	Policy and Goals Relevant to Utility
Capital facilities, mitigation, and efficiency	CF17. Encourage the use of ecologically sound site design in ways that enhance provision of utility services.
	CF18. Support local efforts to minimize inflow and infiltration, and reduce excessive discharge of surface water into wastewater systems.
	CF25. Evaluate and establish designated levels of service to meet the needs of existing and anticipated development.
	CF26. Plan accordingly so that capital facility improvements needed to meet established level of service standards can be provided by the City or the responsible service providers.
	CF27. Identify deficiencies in capital facilities based on adopted levels of service and facility life cycles, and determine the means and timing for correcting these deficiencies.
	CF31. The City establishes the following levels of service as the minimum thresholds necessary to adequately serve development, as well as the minimum thresholds to which the City will strive to provide for existing development: surface water, consistent with the levels of service recommended in the most recently adopted Master Plan.
Utilities	U3. Encourage and assist the timely provision of the full range of utilities within Shoreline to serve existing businesses, including home businesses, and promote economic development.
	U4. Support the timely expansion, maintenance, operation, and replacement of utility infrastructure to meet anticipated demand for growth identified in the land use element.
	U5. Coordinate with other jurisdictions and governmental entities in the planning and implementation of multi-jurisdictional utility facility additions and improvements.

6.3 Recommended Policies and Procedures

As a part of the development of this Master Plan update, the Utility examined current policies and procedures considering the newly defined levels of service and potential improvements to Utility programs. Utility staff prepared policy issue discussions to receive City Council guidance. Based on guidance from the City Council, the Utility then prepared policy, code, and program recommendations for inclusion in the 2018 Master Plan. The following four topics were presented to the City Council:

- Use of Utility funds outside of the ROW
- Stormwater Permit
- Surface water management fee-chargeable area
- Private facility inspection and maintenance

Issues associated with each of the four topic areas are discussed below and include an evaluation of the status quo condition and alternatives with pros and cons. The outcome of the issues discussions based on City Council guidance and reference to implementation in the 2018 Master Plan is also noted.

6.3.1 Use of Utility Funds Outside the Right-of-Way

The Utility often receives requests to perform work on drainage systems that cross through private property. These requests may come from the affected property owner or a group of property owners, or others being impacted by the drainage system. The decision to use Utility funds on private property is based on the determination that the drainage facilities in question are clearly the responsibility of the City, or instances when public infrastructure, such as a road, is threatened if action is not taken. With technical guidance from Utility staff, the City Attorney makes the determination of City responsibility on a case-by-case basis with final determination made by the City Attorney's Office.

Two policy alternatives and their pros and cons were considered, as described in Table 6-4.

Table 6-4. Use of Utility Funds Outside the ROW Policy Alternatives and Pros/Cons

Policy Alternative	Pros	Cons
Alternative 1: Status quo: public infrastructure preservation • Continue the practice of not expending Utility funds on private property unless City staff determine that the facilities in question are the responsibility of the City or public infrastructure is threatened.	• Limits City involvement with private systems • Legally defendable • Requires the lowest funding level of the two alternative approaches considered • Provides clear policy direction	• May not satisfy some property owners who want the City to take certain actions • Would not allow City action in situations where there is only a water quality or environmental enhancement opportunity
Alternative 2: Identify critical private property infrastructure • City acquires easements or purchases properties containing critical stormwater infrastructure. City operates and maintains these facilities. • Create a program to develop and maintain inventory of drainage and water quality infrastructure on private property deemed critical to protect public infrastructure and provide public benefits (e.g., water quality and environmental enhancements)	• Provides a program for identifying and acquiring easement or ownership of critical drainage infrastructure on private property • Provides a method to consider public requests for City maintenance of private drainage systems where a broader public interest than preservation of public infrastructure may be present • Ensures a minimum level of maintenance for critical facilities added to the City's maintenance program	• Requires establishment of, and funding for, a new program to inventory and prioritize critical drainage infrastructure for easement or ownership acquisition and ongoing maintenance

The City Council agreed with the staff's recommended Alternative 1: Status quo: public infrastructure preservation. Staff refined a "decision requirements" flow chart developed in the 2011 Master Plan, shown in Figure 6-2. This flow chart shows the criteria Utility staff and the City Attorney will use to identify situations where it is appropriate to use Utility funds outside the ROW.

Establishing a clear and transparent process for use of Utility funds outside of the ROW helps the Utility provide consistent and equitable service to customers (see LOS 2, Equitable Service, Table 2-1).

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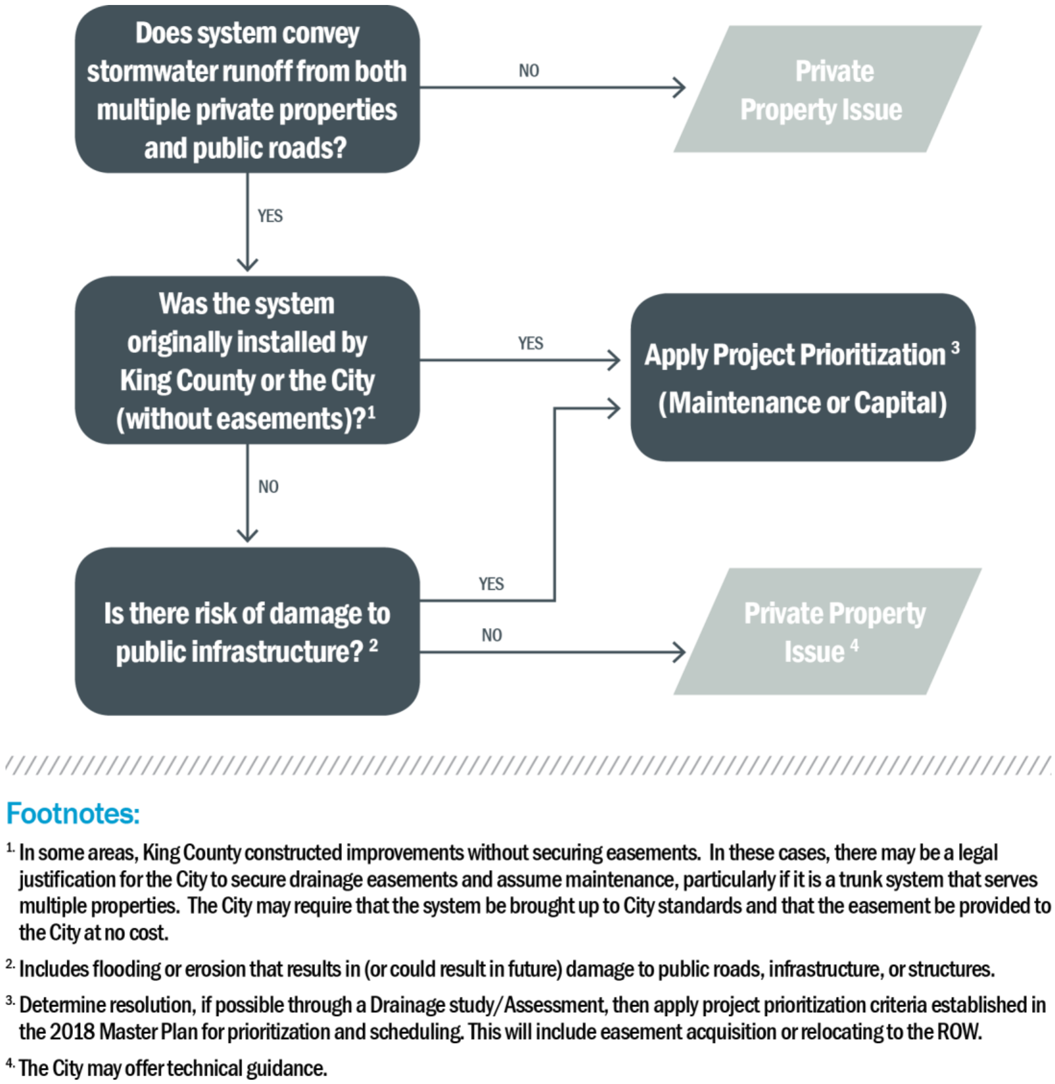

Figure 6-2. Decision requirements for use of Utility funds outside the ROW

6.3.2 Stormwater Permit

The Utility operates an MS4 that has connections from private onsite systems. However, there is no single standard process for permitting onsite stormwater systems and connections to the MS4. The City instead has multiple permitting processes for property owners to gain approval and implementation of onsite stormwater infrastructure and connection to the MS4. As permits are processed, the City's recorded actions related to onsite stormwater infrastructure and MS4 connections are filed in different locations. The result is that permit information related to stormwater is in several locations, and is difficult for Utility staff to review and access effectively and efficiently.

Two policy alternatives and their pros and cons were considered, as summarized in Table 6-5.

Table 6-5. Stormwater Permit Policy Alternatives and Pros/Cons		
Policy Alternative	**Pros**	**Cons**
Alternative 1: Status quo: use existing permit process Continue to rely on the current process that involves coordinating with up to four permitting processes where recorded actions related to onsite stormwater infrastructure and MS4 connections are located and managed in different permit records	• No new permit is required	• Significant interdepartmental coordination • Increased risk of not meeting regulations and maintenance standards • Information and approvals of stormwater management facilities reside in different documents • Responsibility remains dispersed among departments
Alternative 2: Establish a City stormwater permit Consolidate all the onsite and ROW stormwater review activity into a single permit and develop a process to manage ongoing inspections, operations, maintenance, and enforcement of maintenance standards for private drainage systems as required by the Phase II Permit	• Improved coordination with other permitting processes for stormwater management • Facilitate a comprehensive review, approval, implementation, and improved maintenance tracking of surface water management infrastructure	• New stormwater permit process and fee

The City Council agreed with staff's recommendation for Alternative 2: Establish a City Stormwater Permit. The Utility estimated an operating budget for Utility staff to develop the Stormwater Permit in 2018 and implement it in 2019. Details on the Stormwater Permit program are presented in Section 7.1.9.

Establishing a City Stormwater Permit provides the Utility with a consistent process to enforce standards that reduce risks to public health, safety, and the environment (see LOS 1, Surface Water Impacts, Table 2-1). In addition, a consistent permitting process provides a clearer line of communication with customers (see LOS 3, Communication and Outreach, Table 2-1).

6.3.3 Surface Water Management Fee Chargeable Area

Surface water management fees are currently based on impervious surface[5]. To comply with the Phase II Permit, the City requires that properties implement LID practices that reduce the amount of impervious surface area. In 2016, the SMC was updated to include LID language that included changing references from "impervious surface" to "hard surface" as defined by Ecology. The reference change had one exception: the term "impervious surface" is still used to define rate categories in the Surface Water Management rate table as presented in SMC 3.01.400.

Based on the current definition of impervious surface, permeable pavements and vegetated roofs would not be chargeable areas for surface water management fees; however, these surfaces are included in the "hard surfaces" definition. The City's level of service for stormwater conveyance requires the same downstream capacity and costs for both impervious and hard surfaces because the system must provide conveyance in the event of permeable surface system overload during storm events and/or permeable surface system failure. Inspections and oversight of onsite stormwater systems will remain the same with either definition.

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[5] Impervious surface means a non-vegetated surface area that either prevents or retards the entry of water into the soil mantle as under natural conditions prior to development, and causes water to run off the surface in greater quantities or at an increased rate of flow from the flow present under natural conditions prior to development. Common impervious surfaces include, but are not limited to, roof tops, walkways, patios, driveways, parking lots or storage areas, concrete or asphalt paving, gravel roads, packed earthen materials, and oiled, macadam, or other surfaces which similarly impede the natural infiltration of stormwater.

Two policy alternatives and their pros and cons were considered, as summarized in Table 6-6.

Table 6-6. Surface Water Management Fee Chargeable Area Policy Alternatives and Pros/Cons

Policy Alternative	Pros	Cons
Alternative 1: Status quo: maintain existing surface water management fees based on impervious surface Chargeable area will be based on the current definition of impervious surface	No SMC amendment required	• Possible revenue loss for development that reduces impervious surfaces through the use of permeable pavements or other permeable surface treatments • Potentially cause confusion among ratepayers with the terms “hard surface” and “impervious surface” used by Ecology
Alternative 2: Use hard surfaces for surface water management fees Replace the term “impervious surface” with “hard surface” for purposes of calculating surface water management fees in SMC 3.01.400	Ensures a consistent revenue stream as hard surfaces replace impervious surfaces and eliminates confusion among ratepayers with Ecology’s use of terms “hard surface” and “impervious surface”	• Requires an amendment to SMC 3.01.400 • Requires developing and maintaining an inventory and tracking process for managing the changes in hard surfaces

The City Council agreed with staff’s recommendation for Alternative 2: Use Hard Surfaces for Surface Water Management Fees, which would change the chargeable area for surface water fees to be based on hard surface. The chargeable area was updated in the surface water management rate table (SMC 3.01.400) when the City Council approved the 2018 budget.

Updating the surface water management fee definition will help meet LOS 2, Equitable Service, in Table 2-1 by ensuring a consistent revenue stream as hard surfaces replace impervious surfaces, and by reducing confusion among ratepayers related to inconsistent use of Ecology terminology.

6.3.4 Private Facility Inspection and Maintenance Program

The Phase II Permit requires annual inspections and appropriate maintenance of all permanent stormwater BMPs/facilities that were constructed on private properties since 2007 and discharge to the MS4. The Phase II Permit assigns responsibility for the enforcement of proper maintenance activity to the City.

During the investigation of Utility O&M programs, Utility staff identified the need to change the Private Facility Inspection and Maintenance Program because of changes in rate credits and an anticipated increase in private facilities. Staff made the recommendation to transition the program from relying only on enforcement code for maintenance to include a private facility owner self-certification program similar to what is implemented by King County. The City Council requested additional information on the recommended approach before approval.

Two policy alternatives and their pros and cons were considered, as described in Table 6-7.

Table 6-7. Private Facility Inspection and Maintenance Enforcement Policy Alternatives and Pros/Cons

Policy Alternative	Pros	Cons
Alternative 1: Status quo: use current inspection, notification, and enforcement mechanisms Continue to use SMC authority to oversee required Utility private drainage system inspection and enforcement activities	• Does not require creation of new municipal code for surface water maintenance enforcement • Generally accepted municipal business practice	Process may take longer than the allowed time for repairs as specified by the Phase II Permit and may result in an NPDES violation
Alternative 2: Establish a self-certification process Create a program for new systems and establish a process for property owners to conduct inspect and self-certify that the stormwater system is maintained and operating correctly	• Anticipated to result in less staff time for inspection, verifying maintenance actions, and code enforcement • Provides public education opportunities	• Requires new code to establish self-certification • Relies on property owners and their agents to assess proper functioning of stormwater systems • Requires incentive for existing systems to join • Could increase risk of permit noncompliance and/or third-party lawsuits

The City Council directed Utility staff to provide more information on Alternative 2: Establish a Self-Certification Process including more details on the participation and cost implications, and to report back to the City Council with findings. To gather more information on the recommended approach, Staff will embark on a pilot program offering the private properties the option to participate in the self-certification program with the use of qualified personnel as defined in the Phase II Permit. The Utility estimated an operating budget for the Utility staff to develop the self-certification process over the next 6 years. Details on the Private Facility Inspection and Maintenance Program are presented in Section 7.1.9.

The addition of a self-certification process to the existing private facility inspection and maintenance program promotes costs savings by reducing Utility staff time for inspections (see LOS 3, Equitable Service, in Table 2-1).

Section 7

Utility Programs

Utility programs are coordinated and planned activities with goals designed to help the Utility meet levels of service and address regulatory requirements. Programs involve various work activities including Utility administration, system operation and maintenance, and public involvement and outreach. Programs entail long-term or ongoing work activities that are supported by Utility staff and funded through operations budget. Short-term work activities that are funded through the City's CIP are generally referred to as projects, rather than programs[6]. Project recommendations are discussed in later sections.

The Utility currently runs 18 programs falling into one of three categories:

- **Operational programs** help the Utility meet regulatory requirements, collect and analyze water quality data and asset information, perform routine inspections, and support overall Utility staff and resource management
- **Maintenance programs** include preventive and corrective maintenance including cleaning, repair, rehabilitation, and replacement of damaged or deteriorated Utility assets
- **Public involvement programs** educate and engage Shoreline's residents and ratepayers in surface water management and improving surface water quality

One of the major goals for the development of this Master Plan was to perform a thorough review of current programs and operational activities and their benefit to levels of service (see Section 2), needs identified in the basin plans, anticipated growth, and evolving regulations, and to develop detailed recommendations for improvements. The Utility evaluated the status of each existing program (as of 2017) and compared the program outcomes with level-of-service targets and upcoming regulatory requirements. Each of the evaluations resulted in one of three possible outcomes: (1) maintain the existing program, (2) enhance the existing program, or (3) develop a new program to address potential needs. Nine of the 18 existing programs were identified for enhancements, while 9 new programs were considered for recommendation.

Table 7-1 lists the 27 programs considered for recommendation and implementation. Prior to recommendation, programs were prioritized and, based on this prioritization, were grouped according to three alternative management strategies (see Section 2 for level-of-service discussion). Ultimately one management strategy is recommended for implementation in the Master Plan. As a result, not all programs are recommended for implementation in the Master Plan. Additional details for all considered programs, including staffing needs and estimated implementation costs, are provided in Appendix D-1. Prioritization and selection of programs for implementation is described in Section 8.

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[6] Some ongoing programs, such as Pipe Repair and Replacement, are funded as capital improvements; but generally, programs are funded through operations and projects are funded through the CIP.

Table 7-1. Summary of Considered[a] Improvements for Utility Programs			
Program Category	Existing Programs		New Programs
	Maintain	Enhance	
Operation	• Administration and Management • Floodplain Management	• NPDES Compliance • Drainage Assessment • Water Quality Monitoring • Asset Management • System Inspection • Condition Assessment • Private Facility Inspection and Maintenance	• Stormwater Permit
Maintenance	• Street Sweeping • System Maintenance • Small Repairs	• Stormwater Pipe Repair and Replacement[b] • Surface Water Small Projects[b]	• Catch Basin Repair and Replacement • LID Maintenance • Pump Station Maintenance • Utility Crossing Removal • Improper Connection Repair
Public Involvement	• Soak It Up Rebate • Adopt-a-Drain • Local Source Control • Water Quality Public Outreach		• Business Inspection Source Control • Thornton Creek Stewardship • Aquatic Habitat Improvement

a. *Programs listed here were considered for inclusion in management strategies. Ultimately, not all considered programs were recommended for implementation; see Section 8 for the list of recommended programs and Section 10 for the selected management strategy.*

b. *These programs are funded as R&R capital projects in the City's annual budget.*

7.1 Operational Programs

Operational programs cover a broad range of work activities that administer surface water management practices, comply with regulatory requirements, sustainably manage assets, and support overall Utility staff and resource management.

7.1.1 Administration and Management (Existing)

Administration and management activities include workload management, budgeting, and policy development by Utility staff. These efforts also require coordination with, and support from, other City departments and their divisions, including the following:

- **Administrative services:** budget and financial administration, administrative support, accounting, purchasing, and GIS
- **Planning and Community Development:** development review and inspection, code enforcement
- **Engineering Division of Public Works Department:** engineering services
- **Operations and Streets Division of Public Works Department:** vehicle and equipment maintenance

Administration and management of the Utility is recommended to continue with the same basic responsibilities and administrative practices, though some activities may expand to accommodate additional staff and internal resources. This program helps the Utility meet all four levels of service (see levels of service defined in Table 2-1) by providing for the general management of the Utility and administration of the other programs described in this Section.

7.1.2 Floodplain Management (Existing)

The Utility manages the City's participation in FEMA's NFIP. FEMA NFIP regulatory compliance includes implementation of SMC Chapter 134.12, "Floodplain Management," which includes administration of floodplain development permits and review. Enforcing floodplain regulations helps the City meet the minimum requirements for a Community to participate in the NFIP (relates to LOS 4, Regulatory Compliance, see Table 2-1); see Section 5.2.3 for more details on the regulatory requirements for floodplain management and the NFIP. Sound floodplain management also more generally helps the City reduce the potential impacts of flooding events (relates to LOS 1, Surface Water Impacts, in Table 2-1). There are no recommendations for this program. The Utility should continue to work to keep the City in compliance with requirements for participation in the NFIP.

7.1.3 NPDES Compliance (Enhanced)

Public Works is the lead organization responsible for administration and interdepartmental coordination of the Phase II Permit compliance. While all City staff are responsible for response and reporting related to IDDE and spill response, Utility staff perform administrative duties to remain compliant including coordinating Phase II Permit-required training, preparing the annual report, tracking permit requirements, and communicating Phase II Permit needs to other City departments and with Ecology and neighboring jurisdictions (relates to LOS 4, Regulatory Compliance, see Table 2-1). The Utility addresses other NPDES requirements (e.g., public outreach and involvement, pollution prevention with O&M, and water quality monitoring) through other Utility programs described below. The NPDES requirement to control runoff from development is managed through the Department of Planning and Community Development.

The current NPDES Compliance Program is recommended for enhancement to address the anticipated new requirements of the next Phase II Permit, which Ecology plans to issue in 2019. Ecology has indicated that the 2019 Phase II Permit will include a new Business Inspection Source Control Program, updated water quality monitoring and reporting, IDDE tracking and reporting, and new watershed-scale planning. See Section 5.2.1 for more details about the Phase II Permit.

7.1.4 Drainage Assessment (Enhanced)

Utility staff investigate, evaluate, and prioritize drainage issues identified through basin planning, customer service requests, and staff field observations. This work identifies capacity deficiencies, addresses public safety hazards, and reduces risk of erosion and water quality impairment (relates to LOS 1, Surface Water Impacts, see Table 2-1). Prior to 2017, the Utility had an informal Drainage Assessment Program and because of limited resources a backlog of unaddressed drainage complaints has accumulated. Funding secured in 2017 allowed the Utility to begin to address the backlog of about 75 drainage assessment requests. Continued funding is needed to address the approximately 20 new drainage assessment requests that arise in a typical year.

The Drainage Assessment program is recommended for enhancement as an ongoing program to complete drainage assessments to address the backlog and maintain levels of service. As the drainage assessment work is completed and construction-based solutions are identified in an ongoing program, the additional resources will be allocated for the maintenance, repair, and replacement programs such as the Surface Water Small Projects Program; see Section 7.2.5. This enhanced program supports the Utility's Asset Management program, O&M of existing and planned assets, and Utility financial planning (relates to LOS 2, Equitable Service, see Table 2-1).

7.1.5 Water Quality Monitoring (Enhanced)

The Utility conducts a Water Quality Monitoring Program to fulfill several objectives, including the following:

- Support the City's *Vision 2029* goals for conserving and protecting environmental and natural resources
- Beach sampling at Echo Lake and Hidden Lake to protect human health as part of the King County Swimming Beach Monitoring Program
- Lake sampling as a part of the King County Lake Stewardship Program
- Water quality level-of-service goals of the 2011 and 2018 Master Plan

Under this program, staff collect water quality samples from six streams and two lakes within the city. The monitoring, which began in 2002, helps the Utility monitor the condition of the city's surface waters (relates to LOS 1, Surface Water Impacts, see Table 2-1). The results are documented in two water quality assessment summary reports (City 2010; City 2017d). The reports evaluate water quality relative to the applicable State water quality standards (WAC 173-201A). See section 4.3.3 for additional details about the water quality monitoring program and water body assessments.

The monitoring program is managed by full-time Utility staff, but relies on seasonal staff to assist with data collection and evaluation. Seasonal staff turnover rates are higher than permanent staff turnover rates, resulting in greater staff training needs and performance inefficiencies.

This program is recommended for enhancement to add staff resources to improve program efficiencies for sampling, analysis, and reporting.

7.1.6 Asset Management (Enhanced)

The Utility's existing Asset Management Program was established following adoption of the Master Plan in December 2011. Since then, a substantial amount of asset information has become available through condition assessment and basin planning efforts. In 2013, the City implemented Azteca Cityworks (Cityworks), a GIS-integrated CMMS designed to improve asset condition tracking and continued maintenance of City infrastructure. Cityworks uses a geographic-based asset inventory to facilitate the work flow process, enabling the Utility to plan and manage required maintenance more efficiently. Implementation of the Cityworks software platform required a significant reconfiguration of the City's GIS data and additional data capture, inspections, and work orders. All service requests, work orders on assets, and inspections are now recorded in the Cityworks system.

A key objective of the Master Plan work is to advance the asset management program. The Utility performed a formal evaluation on its portion of the citywide asset management program with a Utility Business Management Evaluation (UBME). The UBME helped identify areas of improvement needed to meet the Utility's level of service and to be on par with the management practices of similar-sized utilities. The UBME results and recommended actions to enhance the asset management program are documented in an Asset Management Work Plan (AMWP), which included near- and long-term actions. The AMWP is included in Appendix H.

This program is recommended to enhance the existing asset management program with activities outlined in the AMWP. In addition to the actions outlined in the AMWP, BC and FCS Group developed the following three guidance documents to assist with the enhancement of the asset management program:

- **Asset plan template:** outlines key information to help manage the asset over the asset's life cycle including introduction and overview; description of assets covered by the plan, service levels, future demand, life-cycle management, and financial considerations; and action plan (see Appendix I)

- **Asset management process and framework:** describes the process and key elements of the asset management framework including Utility goals, levels of service, asset knowledge, people and processes, asset decisions, and risk mitigation (see Appendix J)
- ***Condition Assessment Management Plan* (CAMP):** provides an asset management-based condition assessment approach and condition assessment results for eight of the Utility's currently inspected infrastructure assets (see Appendix C)

The enhanced Asset Management program will help continue the cost-effective planning and management of Utility assets, sound financial planning, and efficient operations (relates to LOS 2, Equitable Service, see Table 2-1).

7.1.7 System Inspection (Enhanced)

The Utility inspection program provides information for cleaning, repairs, and condition assessment, and is the backbone program for City surface water asset maintenance and management. The Utility inspects stormwater assets and facilities through three inspection programs: system inspection, private (commercial) facility inspection, and pipe inspections. More details about all inspection programs are available in the City's *Surface Water O&M Manual* included in Appendix G.

The system inspection program consists of the following types of inspections:

- ROW inspections include catch basins, ditches, and ditch-adjacent pipe (driveway culverts) networks that transfer surface water from ROW pavement. Each catch basin is inspected on a 2-year cycle while each ditch is inspected every third year.
- Regional facility inspections involve visual checks of stormwater facilities, site access, and safety features associated with a regional site owned and operated by the City. Inspections are conducted annually.
- Residential facility inspections involve visual checks of stormwater infrastructure on a biennial cycle. Half of the facilities are inspected in even years and the other half are inspected in odd years.
- Park facility inspections involve annual inspection of stormwater quality and flow control facilities in City-owned parks. Parks that have water quality and/or flow control infrastructures are inspected annually.
- City facility inspections involve the inspection of stormwater facilities on City-owned and City-maintained properties outside of parks.

Enhancements recommended for the System Inspection Program are a result of 2013 Phase II Permit requirements. To remain compliant, the Utility is required to increase catch basin inspection frequency, from at least once by August 1, 2017, to once every 2 years starting in 2018. Also, as redevelopment occurs within the City ROW, the City will own and operate more water quality BMPs. To meet the increasing needs of catch basin inspection and maintenance, the Utility should allocate additional staffing, material, and equipment resources for the System Inspection Program.

The program reduces incidents of flooding, erosion, and water quality impairment through systematic and scheduled inspections (relates to LOS 1, Surface Water Impacts, see Table 2-1). The program helps meet LOS 2, Equitable Service, by supporting the Asset Management program's goal of cost-effective planning and management of Utility assets, sound financial planning, and efficient operations. The program addresses O&M regulatory requirements of the Phase II Permit, which helps to meet LOS 4, Regulatory Compliance.

7.1.8 Condition Assessment (Enhanced)

Condition assessment provides a standardized inspection and scoring system to evaluate assets for repair, replacement, or re-inspection. The Condition Assessment program provides information necessary for risk-based asset management decision making. The program also identifies conditions that, if left unaddressed, may contribute to flooding, erosion, or water quality impairment (relates to LOS 1, Surface Water Impacts, see Table 2-1). The program helps meet LOS 2, Equitable Service, by supporting the goals of the Asset Management program including system preservation, O&M activities, and efficient financial planning.

Pipe condition assessment includes the inspection of pipes through closed-circuit television (CCTV) and handheld recording devices on a basin-wide scale. The general inspection cycle for stormwater is on a 20-year frequency, which is within the range of industry best management practices. Pipe inspections and condition assessments were performed between 2012 and 2016 as part of basin plan development. About two-thirds of the pipes have been inspected within the basin planning areas with a completed condition assessment. The remaining one-third of those pipes either have an incomplete inspection or were not inspected because of debris or structural blockage. Pipes with a condition assessment score were evaluated and prioritized in the SWPRRP (relates to Section 7.2.4).

In 2017, a condition assessment project began in the Thornton Creek basin. This project will complete the system-wide evaluations recommended in the 2011 Master Plan. Section 4.1 provides details about the pipe condition assessment evaluation for pipes inspected prior to 2017.

The enhancement for the Condition Assessment program is that it become an annually funded program. An ongoing program will help the Utility meet the recommended 20-year inspection frequency and complete the inspection of pipes whose inspections were incomplete or that were not inspected because of debris or blockages.

7.1.9 Private Facility Inspection and Maintenance (Enhanced)

The NPDES Permit requires annual inspections and maintenance, if needed, of all permanent stormwater BMPs/facilities constructed on private properties. The permit further assigns responsibility for enforcement of proper maintenance activity to the City. Privately owned stormwater assets are maintained by the owner. Until January 1, 2017, the Utility offered a Surface Water Management fee discount for any parcel that maintained its stormwater facilities.

With the anticipated growth in the City, the majority of new development and redevelopment projects will have to construct permanent stormwater BMPs/facilities. Over time, virtually all properties will have the potential to come under the inspection requirement. In July 2015, the City's planning-level redevelopment rate was estimated at 1.5 to 2.5 percent, suggesting that within a 50-year planning horizon, virtually all properties within the City of Shoreline could require annual drainage inspections.

The anticipated increase in the number of inspections and associated enforcement actions will be supported by the enhanced private inspection and maintenance enforcement program. This program is recommended to hold property owners accountable for their storm drainage system. Staff also recommends creating a process in which property owners conduct inspections and "self-certify" that the surface water system is maintained and operating correctly. The self-certification process would limit inspections to spot checks, properties where inspection is required, and those facilities that have repeatedly failed inspections.

The program provides the Utility opportunities for public outreach helping to meet the goals of LOS 3, Communication and Outreach (see Table 2-1). By documenting the inspection and maintenance of private facilities, the program helps meet the goals of LOS 4, Regulatory Compliance.

7.1.10 Stormwater Permit (New)

The City Council approved a Utility staff recommendation to develop a City stormwater permit for private development (see Section 6.3.2 for issue discussion with City Council). The new City stormwater permit will provide a mechanism for Utility staff to review proposed stormwater infrastructure designs, collect hard surface area information, manage and record maintenance covenants, update GIS, and inspect surface water infrastructure (relates to LOS 2, Equitable Service, see Table 2-1). In conjunction with the EDM and existing development permits, the stormwater permit will serve as the City's standard framework for regulating and tracking onsite stormwater systems and connections to the MS4.

Like other City development-related permits, the stormwater permit may gather surface water management chargeable area, defined as impervious surface until 2017 and now defined as hard surface. Hard surface areas are used to estimate sizing for surface water infrastructure and are also used to develop surface water management fees according to SMC 3.01.400. A 2017 evaluation of the existing Utility billing, permit review and tracking process revealed gaps in the City's methods for updating and tracking the surface water management chargeable area (see Appendix K for Utility billing evaluation). The evaluation recommended that chargeable area be collected on one permit and that the permit differentiate hard surface data (used for Utility billing) and hardscape data (used for land use code).

7.2 Maintenance Programs

Maintenance programs are routine maintenance activities including cleaning, repair, rehabilitation, and replacement of Utility assets.

7.2.1 Street Sweeping (Existing)

The Street Sweeping program, which is performed by Street Operations staff, includes sweeping arterial and residential streets, bike lanes, and some municipally owned parking lots to reduce the pollutant load from sediments and debris from entering the MS4 as roadway runoff. Pollutant removal helps the Utility maintain O&M-related compliance with the Phase II Permit (relates to LOS 4, Regulatory Compliance, see Table 2-1). Routine street sweeping is performed year-round with higher traffic volume streets being swept as often as monthly and lower volume streets and municipal parking lots swept twice per year. The program also provides seasonal and emergency sweeping services. In addition to providing water quality benefits, street sweeping maintains public safety and reduces airborne pollutants by removing fine particulate matter (relates to LOS 1, Surface Water Impacts, see Table 2-1). The Public Works Department prepared the *Street Sweeping Plan* to communicate to its citizens about the means, methods, frequency, and schedule of the program (City 2016). The Utility should continue to maintain city streets according to the *Street Sweeping Plan*.

7.2.2 System Maintenance (Existing)

System maintenance includes cleaning and minor repair of surface water assets and facilities. LID vegetation maintenance, catch basin cleaning, ditch maintenance, and other stormwater system maintenance are performed by Public Works operation staff and private contractors. Private contractors provide seasonal workforce resources and specialized equipment such as vactor trucks and high-pressure cleaners for collecting and removing sediment from catch basins, jetting and rodding equipment for cleaning and clearing pipe, and truck-mounted augers for ditch cleaning.

The City currently uses goats to help control blackberries and other weedy plants at selected surface water facilities. A goat herder is on site full-time for larger sites and part-time in fully fenced smaller areas.

The Utility should maintain its current efforts for the system maintenance program except where noted below for enhanced and new maintenance programs.

The System Maintenance program addresses problems in system capacity due to the accumulation of sediment and debris and also eliminates potential water quality problems (relates to LOS 1, Surface Water Impacts, see Table 2-1). The program also helps LOS 4, Regulatory Compliance, by addressing the O&M regulatory requirements of the NPDES Permit.

7.2.3 Small Repairs (Existing)

The Small Repairs program addresses minor repairs for assets not included in other repair programs, small projects, or CIP projects. This includes berms, road or shoulder work to resolve a drainage issue, and other small infrastructure repairs or installations typically made by O&M staff or private contractors on an as-needed basis. The Utility should maintain its current efforts for small repairs. The Small Repairs program helps meet LOS 1, Surface Water Impacts (see Table 2-1) by addressing system deficiencies and reducing potential public safety hazards and impairment of water quality and aquatic habitat. The program also helps meet LOS 2, Regulatory Compliance, by supporting the goals of the Asset Management Program.

7.2.4 Stormwater Pipe Repair and Replacement Program (Enhanced)

The City owns and maintains approximately 134 miles of stormwater pipes, and most of those pipes have exceeded their typical service lifespans. Pipes are evaluated in the Condition Assessment Program (Section 7.1.8) and prioritized for repair or replacement in the SWPRRP. The preferred repair method is to install a robust pipe liner (to date the City has used primarily cured-in-place pipe [CIPP] lining for repairs). Open-cut trench pipe replacement is used for pipes that are too deteriorated to repair with CIPP lining. These methods provide optimal value by extending the lifespan of the City's existing stormwater infrastructure.

The existing SWPRRP began following implementation of the system-wide Condition Assessment program. Because of limited resources, the program has resulted in the repair or replacement of only a small percentage of the failing pipes. At the current rate, completing the identified pipe repairs and replacements would take more than 20 years. An expansion of the program to finish repairs within a 20-year period is recommended to align with the City's 20-year inspection cycle. The recommended enhanced SWPRRP will proactively protect public safety, reduce flooding, decrease maintenance demands, and protect critical infrastructure and other public and private property (relates to LOS 1, Surface Water Impacts, and LOS 2, Equitable Service, see Table 2-1).

7.2.5 Surface Water Small Projects Program (Enhanced)

The Surface Water Small Projects (Small Projects) program implements small projects to address localized drainage problems and other small-scale surface-water-related issues. Drainage issues are generally identified through either the City's customer request system or City staff field observations and are evaluated in the Drainage Assessment Program (see Section 7.1.4).

With more surface water small project needs evaluated and identified in the enhanced Drainage Assessment program, the need for additional small drainage construction projects is estimated to double over the 6-year planning period. The Utility should allocate additional resources to the Small Projects program to construct the additional projects and help meet updated levels of service.

The enhanced Small Projects program helps meet LOS 1, Surface Water Impacts, by addressing system deficiencies and reducing potential public safety hazards. The program helps meet LOS 2, Equitable Service, directly by supporting the goals of the Asset Management program including cost-effective planning and management.

7.2.6 Catch Basin Repair and Replacement (New)

The Phase II Permit requires the Utility to perform maintenance on catch basins that do not meet the maintenance standard. The catch basins must be maintained within 6 months of inspection (relates to LOS 4, Regulatory Compliance, see Table 2-1). During the last 3 years, the number of catch basins needing repair or replacement was greater than the Utility resources available to perform the work. In addition, the number of catch basins requiring R&R is anticipated to increase as the Utility increases the frequency of catch basin inspections to remain compliant with the 2013 Phase II Permit O&M requirements. The recommended new catch basin R&R program will help the Utility remain in compliance with the Phase II Permit maintenance requirement.

7.2.7 Low Impact Development Maintenance (New)

The Utility has historically inspected its LID facilities and performed only vegetation maintenance for bioretention and swales. Other maintenance activities such as structural repair, soil replacement, and permeable pavement cleaning have been deferred until required by the Phase II Permit. To remain complaint with the Phase II Permit in 2018, the Utility should maintain all surface water assets to an established maintenance standard as based on inspection results (relates to LOS 4, Regulatory Compliance, see Table 2-1). The recommended LID maintenance program provides the resources necessary to perform cleaning, structural repair, and replacement efforts to achieve the facilities' adopted maintenance standard.

7.2.8 Pump Station Maintenance (New)

The Utility performs nearly weekly checks on the Utility's eight pump stations during the rainy season as part of the Hot Spot inspection program, and monthly in the dry summer months. While the spot inspections confirm that the pump stations are operating during the time of inspection, they do not provide routine or preventive maintenance or provide an overall condition assessment. This recommended program would provide routine maintenance of pump station equipment (e.g., hydraulic, mechanical, and electrical), structure, and facility access.

The new Pump Station Maintenance program will identify potential capacity deficiencies, which will help meet LOS 1, Surface Water Impacts (see Table 2-1) and help meet the cost efficiency goals of the Asset Management program LOS 2, Equitable Service.

7.2.9 Utility Crossing Removal (New)

The pipe inspection and condition assessment effort associated with the basin planning work revealed numerous instances throughout the city where other utility lines and unidentified conduits crossed storm drain pipes. Utility crossings can damage storm drain pipes, reduce flow capacity of pipes, cause obstructions in water flow from debris blockages, and make pipe inspection difficult. This recommended program involves City staff time to coordinate with other utilities to remove their lines and repair the storm drains that have been damaged because of improper crossings. The program would also include inspecting the removal work when complete.

The new Utility Crossing Removal program will identify potential capacity deficiencies caused by utility crossings, which will help meet LOS 1, Surface Water Impacts (see Table 2-1). The program will also help meet the cost efficiency goals of the Asset Management program LOS 2, Equitable Service.

7.2.10 Improper Connection Repair (New)

The pipe inspection and condition assessment effort associated with the Basin Planning work revealed numerous instances throughout the city where storm drains are improperly connected. Improperly installed storm drain connections can lead to separated pipe joints, leaks, erosion, and possibly damage to nearby structures. This recommended program involves fixing non-standard or improperly installed stormwater drains by adding a properly designed structure such as a catch basin or prefabricated tee to connect pipes. The recommended installations represented in this program would be those not included in other CIP projects.

The new Utility Connection Repair program addresses potential capacity deficiencies caused by improperly installed storm drain connections. This program helps meet LOS 1, Surface Water Impacts (see Table 2-1) by removing these deficiencies.

7.3 Public Involvement Programs

The Utility's Public Involvement programs are intended to educate, involve, and engage Shoreline ratepayers regarding surface water issues such as water quality, flood reduction, and expected levels of service. Current and recommended programs are described below.

7.3.1 Soak It Up Low Impact Development Rebate (Existing)

The Soak It Up rebate program helps property owners manage rainwater on their property with rain gardens or native vegetation conservation landscaping. Incentives are provided to qualified applicants as rebates. The program supports the Utility's Phase II Permit public outreach and education requirements. The Utility should continue promoting and growing participation in this rebate program.

The Soak It Up Low Impact Development Rebate program provides opportunities, education, and outreach for LID principles. This program helps meet the LOS 3, Communication and Outreach, and LOS 4, Regulatory Compliance (see Table 2-1).

7.3.2 Adopt-A-Drain (Existing)

This storm drain monitoring program increases awareness of localized flooding, efforts needed to protect fish and habitat from pollutants, and maintenance needs of the City's storm drains. The Adopt-A-Drain program volunteer participants keep drains clear of debris and monitor drains for potential contaminants such as paint, motor oil, or soapy water. Through program participation and promotion, information is also provided to encourage proper disposal of household hazardous waste to avoid surface water contamination. The Utility should continue promoting and growing participation in this volunteer program.

The Adopt-A-Drain program promotes public participation in activities that can reduce capacity deficiencies and erosion problems with low-cost volunteer efforts. The program helps meet LOS 1, Surface Water Impacts, and LOS 3, Communication and Outreach in Table 2-1.

7.3.3 Local Source Control (Existing)

The Local Source Control/Small Business Pollution Prevention program helps business owners develop practical methods to reduce or eliminate non-stormwater pollutant discharges through proper material storage, hazardous waste disposal, spill plans, and other BMPs. Upon completion of a spill plan, a business is eligible for a free spill kit. Training for staff is also provided through this program. This program supports NPDES regulatory compliance and includes targeted inspection and outreach to businesses (relates to LOS 3, Communication and Outreach, and LOS 4, Regulatory

Compliance in Table 2-1). The Utility should continue participating in this program and, where possible, combine efforts with the proposed Business Inspection Source Control Program.

7.3.4 Water Quality Public Outreach (Existing)

This program supports Phase II Permit compliance for community outreach and includes participation in Earth Day events, community and neighborhood events, and a car wash event program. The program also promotes water quality campaigns provided by the Utility and outside water quality organizations. The programs include materials and Web pages reporting spills, car washing, auto leaks, pet waste, and yard care. The Utility should continue performing outreach activities that promote public education, outreach, involvement, and participation requirements of the Phase II Permit (relates to LOS 3, Communication and Outreach, and LOS 4, Regulatory Compliance in Table 2-1).

7.3.5 Business Inspection Source Control (New)

This new program is anticipated to be a separate but complementary program to the Local Source Control program. The program, an anticipated requirement of the 2019 Phase II Permit, will require the Utility to inspect 20 percent of businesses annually to detect potential pollution sources and institute corrective actions as needed. The goal of the program is to reduce illicit discharges and build on existing public outreach and education efforts (relates to LOS 3, Communication and Outreach, and LOS 4, Regulatory Compliance, see Table 2-1). The recommended program is similar to what is currently required of Phase I Permit holders (e.g., City of Seattle, King County) and will require updates to the SMC.

7.3.6 Thornton Creek Stewardship (New)

Thornton Creek is the city's most degraded waterway and could benefit from a watershed-based public involvement and stewardship program. The recommended program would consist of a series of targeted behaviors to improve water quality such as a watershed-specific pet waste program. Through this type of program, City staff would conduct outreach on pet waste and provide an incentive for pet owners to change behavior. The program would survey constituents periodically to track behavior change. Other program elements might include habitat education and volunteer restoration activities.

The Thornton Creek Stewardship program will help meet LOS 1, Surface Water Impacts, and LOS 3, Communication and Outreach (see Table 2-1) by public education and outreach for the water quality needs of Thornton Creek.

7.3.7 Aquatic Habitat Improvement (New)

Riparian zones play a key role in combating adverse water quality impacts associated with nonpoint source pollution and offset the need for costly stormwater and flood protection facilities. This recommended program would conduct vegetation surveys and streamside plantings to improve overall habitat near freshwater systems. Other program activities include removing invasive plant species and replacing plantings with native species to improve functionality of the stream.

The Aquatic Habitat Improvement program will help meet LOS 1, Surface Water Impacts, and LOS 3, Communication and Outreach (see Table 2-1) by providing opportunities for public involvement, outreach, and education with projects that protect or restore aquatic habitat of city water bodies.

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Section 8

Management Strategies

As described in previous sections, recommendations for improving the Utility include new and enhanced programs and capital improvement projects. Programs and projects have considerable cost implications and must be prioritized for implementation over time and to ensure adequate funding. This section summarizes the recommended improvements and describes a detailed prioritization process that is based on meeting levels of service and complying with regulatory requirements. The results of the prioritization, in combination with estimated costs, were used to select and assemble projects and programs into solution sets, or *management strategies*. A financial analysis of each of the management strategies is presented in Section 9.

8.1 Prioritization Process

One of the key objectives of this Master Plan is to prioritize recommended programs and capital improvement projects, and to develop comprehensive management strategies based on those priorities. A systematic process was developed, including a spreadsheet tool that applies a consistent set of criteria and procedures for scoring. Figure 8-1 illustrates the prioritization and management strategy development process.

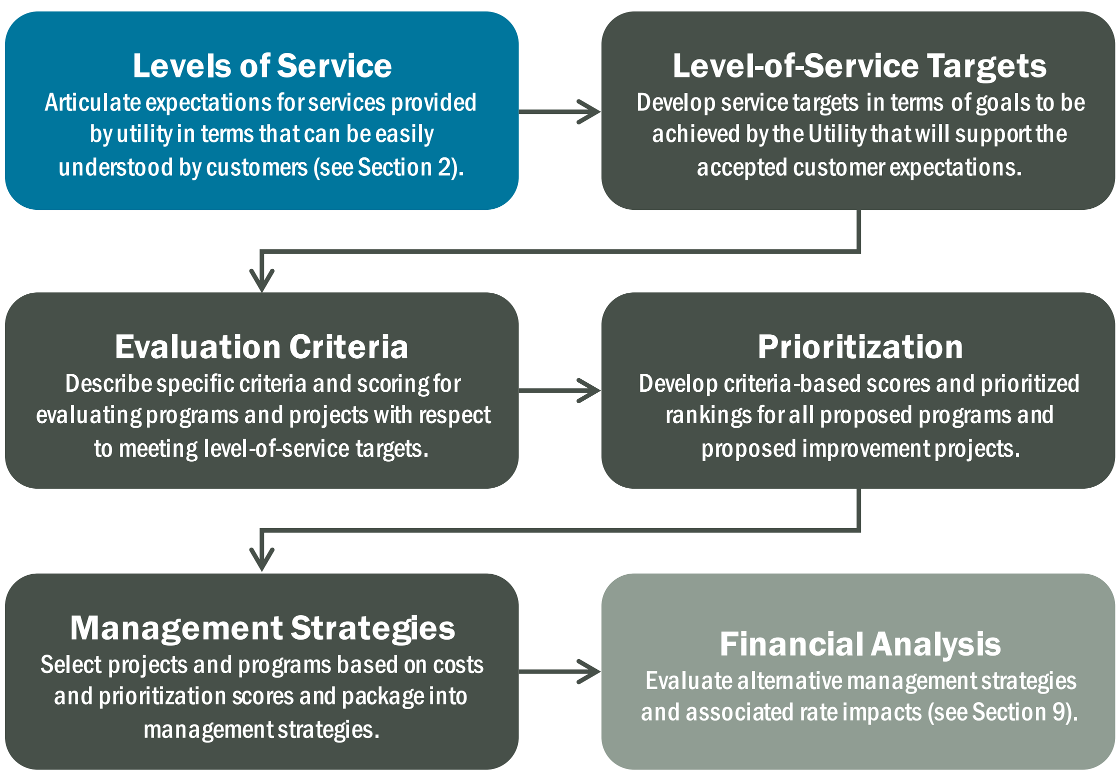

Figure 8-1. Prioritization process for developing management strategies

Levels of service (see Section 2) and associated level-of-service targets are the basis for articulating customer expectations for the services provided by the Utility. Level-of-service targets were refined to reflect key goals relating to flooding and erosion, water quality, aquatic habitat, responsible stewardship of assets, customer service and communications, and regulatory compliance (see Table 8-1). These targets were then carried forward to support project and program prioritization, as well as monitoring/tracking of operational activities.

Table 8-1. Level-of-Service Targets for Program and Project Evaluation

Level of Service	Level-of-Service Targets
1. Manage public health, safety, and environmental risks from impaired water quality, flooding, and failed infrastructure	A. Flooding and Erosion: No verifiable health and safety issues or environmental damage caused by flooding or erosion outside of an accepted risk tolerance B. Water Quality: Improve the quality of stormwater discharged to impaired receiving waters to mitigate environmental damage C. Habitat: Protect aquatic habitat by reducing impacts to ecosystem health and biotic diversity in lakes, streams, and wetlands
2. Provide consistent, equitable standards of service to the citizens of Shoreline at a reasonable cost, within rates and budget	D. Responsible Stewardship: Provide equitable services through cost-effective planning and management of utility assets, sound fiscal planning, and efficient operations
3. Engage in transparent communication through public education and outreach	E. Customer Service and Communications: Provide effective communication, public education, and outreach
4. Comply with regulatory requirements for the urban drainage system	F. Regulatory Compliance: Meet state and federal regulatory requirements for stormwater utilities

Level-of-service targets were further refined into specific evaluation criteria; these differed slightly between programs and projects. Table 8-2 provides an example of the program and project evaluation criteria for Level of Service Target “A. Flooding and Erosion” from above.

Table 8-2. Evaluation Criteria for Flooding and Erosion

Program Evaluation Criteria	Project Evaluation Criteria	
	Measure	Question
A.1 System Capacity Program addresses capacity deficiencies	The capacity of the drainage system to capture, convey, store, and discharge (or infiltrate) runoff should be sufficient to prevent flooding more often than the standard risk tolerance for the affected properties.	a. Does the project improve the capacity of the drainage system? b. What is the scale of the problem addressed by the improvement?
A.2 Hazard Reduction Program addresses an apparent public safety hazard	Urban drainage conditions that cause observed and recurring public safety hazards should be eliminated.	Does the project address an apparent public safety hazard such as severe flooding of inhabited structures or flooding that affects critical facilities?
A.3 Erosion Control Program addresses erosion problems related to public stormwater conveyance	Water conveyed through public infrastructure and/or within the public ROW (i.e., ditches and streams) should not cause erosion that threatens property or infrastructure.	Does the project address an erosion problem due to public stormwater conveyance?

As programs and projects are scored, each criterion receives a score of 0, 1, or 2. Guidance on scoring is provided for each evaluation criterion; in general, a 0 is assigned when there is not relevant benefit, a 1 when there is moderate relevant benefit, and a 2 when there is substantial relevant benefit. The scores are then multiplied by a pre-specified weighting factor. The weighted scores are then summed to obtain a single prioritization score for each program and project. Details on the evaluation criteria, scores, and weighting factors are provided in Appendix D-2.

After scoring was completed, the programs and projects were ranked from highest to lowest by their total scores and tabulated with other key information such as estimated cost, type, location, and the primary issue addressed (described below). This information was used to select programs and projects and align them with defined management strategies (see Section 8.2).

8.1.1 Program Prioritization and Cost Estimates

As described in Section 7, a total of 27 programs were considered for addressing current and future needs of the Utility, nine of which are a continuation of existing programs, nine are enhanced programs (existing programs with added enhancements), and nine are new programs.

Program costs were developed for all enhanced and new programs. For enhanced programs, the cost estimate consisted of costs only for the enhanced activities within the program. For new programs, costs were based on expenses of similar activities or programs at the Utility. In cases where a similar program did not exist, Utility staff referenced programs from other agency programs or developed estimates based on experience. Costs were also developed for new infrastructure per management strategy to provide anticipated planning-level costs for O&M in the 6-year planning period. Key elements for program costs included Utility staff labor, professional contracts, equipment, and materials. Details on these elements are as follows:

- Utility staff cost and FTE estimates:
  - Staff availability (hr/yr/FTE): 1,768
  - Percent of total program FTE for management, supervision, and administration: 15 percent
  - Program/project management: 1 hr/$1,000 contract
  - Staff loaded rate: $80/hr
- Professional services contracts:
  - Contractor rate: $130/hr
  - Program study: $30,000–$50,000
  - Maintenance work: Varies—based on existing contracts and program
- Equipment:
  - Estimates from Ecology documents and previous studies
  - Included in professional service contracts
- Materials:
  - Estimates from existing operation budget
  - Estimates from professional service contracts and project costs estimates

Table 8-3 lists the 27 programs, general program categories, prioritization scores, and capital cost estimates.

Table 8-3. Program Prioritization Scoring and Cost Summary			
Program	Category	Prioritization Score [c]	Estimated Annual Program Cost [d]
System Inspection (Enhanced)	Operation	1,280	$47,021
Business Inspection Source Control (New)	Public involvement	1,020	$86,780
Street Sweeping (Existing)	Maintenance	975	-[a]
Water Quality Public Outreach (Existing)	Public involvement	950	-[a]
Adopt-a-Drain (Existing)	Public involvement	855	-[a]
System Maintenance (Existing)	Maintenance	825	-[a]
Soak-It-Up Rebate (Existing)	Public involvement	815	-[a]
Local Source Control (Existing)	Public involvement	785	-[a]
Administration and Management (Existing)	Operation	740	-[a]
Catch Basin Repair and Replacement (New)	Maintenance	720	$354,100
Private Facility Inspection/Maintenance (Enhanced)	Operation	580	$62,192
NPDES Compliance (Enhanced)	Operation	560	$32,480
Stormwater Permit (New)	Operation	555	$47,840
Small Repairs (Existing)	Maintenance	525	-[a]
LID Maintenance (New)	Maintenance	525	$53,732
Condition Assessment (Enhanced)	Operation	480	$160,340
SW Pipe Repair and Replacement (Enhanced)	Maintenance	480	$953,600[b]
Surface Water Small Projects (Enhanced)	Maintenance	480	$500,000[b]
Drainage Assessment (Enhanced)	Operation	460	$175,640
Floodplain Management (Existing)	Operation	445	-[a]
Asset Management (Enhanced)	Operation	400	$69,200
Water Quality Monitoring (Enhanced)	Operation	325	$85,470
Utility Crossing Removal (New)	Maintenance	320	$18,400
Pump Station Maintenance (New)	Maintenance	260	$63,600
Improper Connection Repair (New)	Maintenance	220	$60,520
Thornton Creek Stewardship (New)	Public involvement	170	$19,900
Aquatic Habitat Improvement (New)	Public involvement	155	$54,600

a. *Costs for existing programs were not estimated; assumed to be included within existing operation costs.*

b. *Costs of pipe replacement and small projects can be scaled depending on the amount of work to be accomplished each year.*

c. *Maximum score 1,480.*

d. *2017 dollars.*

8.1.2 Project Prioritization and Cost Estimates

Since the completion of the basin plans, the Utility has compiled 116 recommended projects with a combined estimated cost of $50 million. One of the tasks of the Master Plan was to assess these projects within the context of the levels of service and consistent priorities for the Utility. A series of three workshops were conducted with staff to screen the projects and develop a transparent and repeatable prioritization process. These workshops are summarized below:

- **Workshop 1:** Staff worked to remove projects that have already been completed or are no longer relevant. Projects that can be addressed programmatically were removed from the list or added to an existing or new program. Project entries that address the same problem were combined.
- **Workshop 2:** Staff worked to develop a formal prioritization process based on the City's level of service, as well as regulatory and operational considerations. During this second workshop, Utility staff established a set of evaluation criteria and project scoring definitions. Following the workshop, BC developed a prioritization tool to implement the prioritization process and performed an initial round of project scoring.
- **Workshop 3:** Staff reviewed the results of the initial scoring and discussed ways to improve and refine the results. Following the workshop, staff worked to revise and refine the scoring and developed a final list of projects for consideration.

The project screening, workshops, and prioritization process resulted in a list of the 40 prioritized projects. Appendix D-6 presents the project prioritization evaluation criteria. The Utility prepared project summaries and planning-level cost estimates for each of the projects, which are provided in Appendix D-5. Quantities and line-item costs were based on information contained in the basin plans. Unit costs were updated to 2017 dollars based on the *Engineering News-Record* costs index. Other key cost assumptions include the following:

- An estimating and construction contingency of 50 percent was applied to the construction subtotal
- An additional 13 percent was added to the construction cost to account for contractor overhead, profit, and mobilization
- Washington State sales tax of 10 percent was applied to the construction subtotal
- An additional 15 percent was included to account for City staff time to support the project
- If a predesign feasibility study was needed to refine the design of the project, an addition cost ranging from 1.5 to 10.0 percent of the project cost was applied
- An additional 20 to 45 percent was applied to the subtotal cost of the above items to account for administration, engineering design, and permitting; the amount varied depending on the size and complexity of the project

Preliminary life-cycle cost estimates were also developed for the projects to assist with estimates of increasing O&M costs due to commissioning of new projects. Where possible, the life-cycle cost estimates include renewal and disposal costs, in addition to annual O&M costs. Cost information was obtained from national and local sources. Where available, estimates from the Utility budget breakdown were used exclusively or given higher weighting when combined with other estimates. Assumptions for life-cycle costs that vary per project type include:

- **Design life:** Life in years as specified in Washington State Department Highway Runoff Manual.
- **Operating, maintenance, and renewal activities:** Operating costs are estimated for pump stations as these are the only surface water assets that are operated. The costs include electricity estimates from the 2016 Utility operating budget summary.
- **Maintenance costs:** Based on regional and national estimates with regional estimates weighted more heavily.
- **Renewal costs:** Based on value for renewal costs per facility.
- **Disposal costs:** For many projects, disposal costs were estimated as an excavation cost based on the estimated dimensions of the project.

Table 8-4 lists the 40 projects, general project categories, prioritization scores, and capital cost estimates.

Table 8-4. Project Prioritization Scoring and Cost Summary				
	Project Name	Category[a]	Prioritization Score	Estimated Cost [b]
1	25th Ave. NE Flood Reduction and NE 195th St. Culvert Replacement	FM	620	$8,226,000
2	Master Plan Update	Study	620	$500,000
3	Springdale Ct. NW and Ridgefield Rd. Drainage Improvements	FM	560	$2,058,000
4	10th Ave. NE Stormwater Improvements	FM	515	$1,788,000
5	Heron Creek Culvert Crossing at Springdale Ct. NW	AM	485	$855,000
6	Hidden Lake Dam Removal	FM	480	$2,097,000
7	25th Ave. NE Ditch Improvements between NE 177th St. and 178th St.	EC	480	$2,538,000
8	Pump Station 26	AM	420	$891,000
9	Pump Station 30 Upgrades	AM	420	$339,000
10	6th Ave. NE and NE 200th St. Flood Reduction Project	FM	360	$384,000
11	Pump Station Improvements: Linden, Palatine, Pan Terra, 25, Ronald Bog, Serpentine	AM	360	$732,000
12	NE 148th St. Infiltration Facilities	FM	355	$393,000
13	Boeing Creek Regional Stormwater Facility	EC	315	$9,440,000
14	Stormwater Upgrades NW 196th St.	AM	310	$146,000
15	System Capacity Modeling Study	Study	300	$300,000
16	NW 195th Pl, and Richmond Beach Dr. Flooding	FM	280	$747,000
17	Stabilize NW 16th Pl. Storm Drainage in Reserve M	EC	260	$500,000
18	Storm Creek Erosion Management Study	EC	250	$80,000
19	Flood Reduction in Linden Avenue Neighborhood	FM	245	$803,000
20	Climate Impacts and Resiliency Study	Study	220	$80,000
21	Culvert Improvements near 14849 12th Ave. NE	FM	205	$347,000
22	Convert Stormwater Conveyance Ditches to Bio-infiltration Facilities	WQ	190	$1,178,000
23	Boeing Creek Restoration	AH	180	$7,630,000
24	NW 196th Pl. and 21st Ave. NW Infrastructure Improvements	FM	175	$313,000
25	Echo Lake Biofiltration Swale	WQ	160	$905,000
26	18th Ave. NW and NW 204th St. Drainage System Connection	FM	150	$261,000
27	NW 197th Pl. and 15th Ave. NW Flooding	FM	150	$119,000
28	Lack of System and Ponding on 20th Ave. NW	FM	150	$1,458,000
29	12th Ave. NE Infiltration Pond Retrofits	FM	140	$677,000
30	NE 177th St. Drainage Improvements	FM	130	$152,000
31	26th Ave. NE Flooding and Lack of System Study	FM	110	$64,000
32	NW 180th St. and 8th Ave. NW Ditch with Unknown Connection	FM	80	$68,000
33	NE 192nd St. Ditch Modifications	EC	60	$202,000
34	Bioretention at N 199th St. and Wallingford Ave. NE	WQ	50	$524,000
35	Bioretention at NE 192nd St. and Burke Ave. NE	WQ	50	$320,000
36	Hamlin Creek Daylighting	AH	50	$1,611,000
37	Thornton Creek Coarse-Grained Sediment Improvements	AH	50	$55,000
38	Enhance Ronald Bog Wetland Fringe Areas	AH	50	$2,826,000
39	Westminster Triangle Bioinfiltration Facility	WQ	45	$163,000
40	NW 194th Pl. and 25th Ave. NW Ditch Erosion	EC	40	$150,000

a. Abbreviations for project categories as follows: AH = Aquatic Habitat Enhancement, AM = Asset Management, EC = Erosion Control, FM = Flood Mitigation, Study = non-structural study funded through capital budget, WQ = Water Quality Improvement

b. 2017 dollars.

8.2 Management Strategies

The Utility developed three alternative management strategies to comprise selected programs and projects. The three management strategies are defined as follows:

- **Minimum:** meet the minimum in terms of existing system needs and anticipated new regulatory requirements
- **Proactive:** minimum management strategy plus new high-priority projects and new/enhanced programs that address high-priority, long-term needs
- **Optimum:** proactive management strategy plus additional recommendations to enhance water quality and aquatic habitat

Program selections were based on prioritization scores, contributions toward meeting levels of service, and needs to address regulatory requirements. Selected programs are assumed to start within the next 6 years, while the remaining programs are deferred. Three programs were considered for inclusion in the 6-year Master Plan but were not included. The list of programs within each management strategy is provided in Appendix D-3.

Projects were selected based primarily on prioritization scores, but with review and consideration for capital costs, project status (some projects have already been initiated), equitable distribution of projects throughout the city, and addressing a variety of project categories. Note that project selection is mostly a reflection of near-term versus long-term scheduling. Projects that were selected for each management strategy are to be included in the 6-year CIP, with the remaining projects to be completed over a 20-year planning horizon. In some cases, projects are assumed to be initiated (e.g., planning, design, and permitting phases) during the 6-year planning; however, construction is assumed to be completed in subsequent years. Table 8-5 provides a summary of the number of projects and programs selected for the three management strategies, as well as a qualitative assessment of the benefits to the four levels of service.

The City Council approved the Utility's recommended proactive management strategy. As noted in Table 8-5, the proactive management strategy includes 24 programs and 26 projects. It will provide a medium benefit to surface water impact level of service and high benefits to equitable service, regulatory compliance, communication, and outreach. In addition to meeting the existing system needs and anticipated new regulatory requirements, the proactive management strategy includes new projects and new/enhanced programs that address high-priority, long-term needs.

Table 8-5. Management Strategy Summary with Cost and Levels of Service Impacts

Management Strategy	Number of Projects and Programs	Total Annual Program Cost, $ million [a]	Total 6-Year Project Cost, $ million [b]	Benefit to Levels of Service			
				Surface Water Impacts	Equitable Service	Communication and Outreach	Regulatory Compliance
Minimum	18 programs 6 projects	4.3	6.2	Low	Medium	Medium	Medium
Proactive [c]	24 programs 26 projects	6.0	11.1	Medium	High	High	High
Optimum	27 programs 30 projects	6.7	16.3	High	High	High	High

a. Includes $3.66 million of current program expenses.

b. Total 6-year project costs based on 2017 dollars.

c. City Council approved the Utility's recommended proactive management strategy based on financial analyses (see Section 9).

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Section 9

Financial Analysis

The purpose of this financial plan is to ensure the viability of the City's surface water management program. This section is a summary of a full report prepared by FCS Group (*Financial Analysis for 2018 Master Plan,* November 2017 [Financial Analysis Report]). The full report can be found in Appendix L.

The financial plan considers the historical financial condition, current and identified future financial and policy obligations, O&M needs, and capital projects as identified in this 2018 Master Plan.

The Utility is responsible for funding all program and capital costs. The primary source of funding is a surface water management (SWM) fee to all properties in the city. The fee is billed on King County's property tax statement. Nominal additional revenues are generated through interest earned on reserves and grants. The City controls the fees and the City Council has the authority to adjust the fees as needed to meet financial objectives.

The financial plan assessed total system costs (capital and non-capital) and assessed funding sources (both current and potential additional funding sources). The report used a 6-year planning period.

9.1 Available Capital Funding Assistance and Financing

Long-term capital funding strategies must be defined to ensure that adequate resources are available to fund the CIP identified in the 2018 Master Plan. In addition to City resources (Utility fees), capital needs may be met from outside sources such as grants, low-interest loans, and bond financing. The following summarizes internal and external resources available for meeting funding requirements.

9.1.1 City Resources

Resources appropriate and available to the City for funding capital needs are limited to rate revenues and accumulated cash (through rates and interest) beyond what is required by the minimum reserve requirements set forth in fiscal policies. The City does not maintain specific capital-related charges such as a General Facilities Charge (GFC) that would provide additional capital resources.

9.1.2 Outside Resources

Although the City does not have additional internal funding sources, grant, loan, and bond opportunities are available to fund the CIP identified and some programs. These potential sources are described in the following subsections.

9.1.2.1 Grants and Low-Cost Loans

Historically, federal and state grant programs assist local utilities with funding of capital projects. However, these assistance programs have been mostly eliminated, reduced, or replaced by loan programs. Remaining miscellaneous grant programs are generally lightly funded and heavily subscribed. Major funding sources are described below.

Department of Ecology Grants and Loans. Ecology administers an integrated funding program for projects that improve and protect water quality. The funding cycle generally begins on September 1, and applicants must submit the final application by the first week of November. Capital projects include stormwater control and treatment, nonpoint pollution abatement, and stream restoration activities. The amount of available grant and loan funding varies from year to year based on the State's budget appropriation process and the annual federal budget. The sources of funding for water quality projects include the following:

- Centennial Clean Water Fund State Grant Program
- Clean Water Act Section 319 Federal Grant Program
- Clean Water State Revolving Fund (CWSRF) Loan Program
- Stormwater Financial Assistance Program (SFAP)

The City has received SFAP funding in the past and anticipates further funds from this program in 2018.

King County Flood Reduction Grant. King County's Flood Reduction Grants assist cities with local flood reduction projects. Applications are generally due in May and there is no cap on the award amount. Total available funding for 2017 was slightly over $3 million (King County 2017).

Public Works Trust Fund (PWTF). Cities, counties, special-purpose districts, public utility districts, and quasi-municipal governments are eligible to receive loans from the PWTF. Eligible projects include repair, replacement, and construction of infrastructure for domestic water, sanitary sewer, stormwater, solid waste, road, and bridge projects that improve public health and safety, respond to environmental issues, promote economic development, or upgrade system performance. As of August 2017, the PWTF is not funded through 2019 and is not accepting funding requests.

9.1.2.2 Bond Financing

General Obligation (GO) Bonds. GO bonds are bonds secured by the full faith and credit of the issuing agency. With this high level of commitment, GO bonds have relatively low interest rates and few financial restrictions. However, the authority to issue GO bonds is restricted in terms of the amount and use of the funds, as defined by Washington constitution and statute. The amount of debt that can be issued is linked to assessed valuation.

Revenue Bonds. Revenue bonds are commonly used to fund utility capital improvements. The debt is secured by the revenues of the issuing utility. With this limited commitment, revenue bonds typically bear higher interest rates than GO bonds and also require security conditions related to the maintenance of dedicated reserves (a bond reserve) and financial performance (added bond debt service coverage). The City agrees to satisfy these requirements by resolution as a condition of bond sale.

Revenue bonds can be issued in Washington without a public vote. The current financial forecast anticipates issuing revenue bonds to help fund capital projects starting in 2018.

9.2 Financial Forecast

The financial forecast, or revenue requirement analysis, predicts the amount of annual revenue that is needed from user rates to meet the obligations of the Utility. The analysis incorporates operating revenues, O&M expenses, debt service payments, rate-funded capital needs, and any other identified revenues or expenses related to surface water management.

The objective of the financial forecast is to evaluate the sufficiency of the current level of rates to meet expected expenditures and comply with fiscal policies and financial goals of the City. The results determine the amount of revenue needed in a given year to meet that year's expected financial obligations. For this analysis, two revenue sufficiency tests were developed to reflect the financial goals and constraints of the City: cash needs and debt coverage. To operate successfully with respect to these goals, both tests of revenue sufficiency must be met.

Cash Flow Test. The cash flow test identifies all known cash requirements for the City in each year of the planning period. The requirements include O&M expenses, debt service payments, depreciation funding or directly funded capital outlays, and additions to specified reserve balances. The total annual cash needs of the City are then compared to projected cash revenues using the current rate structure. If revenue shortfalls are identified, the rate increases necessary to make up the shortfalls are established.

Coverage Test. The coverage test is based on a commitment made by the City when issuing revenue bonds or certain other forms of long-term debt. Debt service coverage is expressed as a multiplier of the annual revenue bond debt service payment. For example, a 1.25 coverage factor means revenue must be sufficient to pay O&M expenses, annual revenue bond debt service, plus an additional 25 percent of that annual revenue bond debt service. Targeting a higher coverage factor can help the City achieve a better credit rating and provide lower interest rates for future debt issues.

In determining the annual revenue requirement, both the cash and coverage sufficiency tests must be met and the test with the greatest deficiency drives the level of needed rate increase in any given year.

9.2.1 Current Financial Structure

The City maintains a fund structure and implements financial policies that target management of a financially viable and fiscally responsible stormwater system. The City's fiscal policies and financial assumptions are described below.

Operating Reserves. Operating reserves ensure that adequate cash working capital will be maintained to deal with cash balance fluctuations.

The City's current policy is to maintain a minimum balance of 20 percent of O&M expenses. This equates to 73 days of operating expenses.

We recommend, and the study reflects, an O&M reserve minimum balance of 120 days. This higher level of reserves is consistent with the risk maintained by the City from receiving surface water fees twice per year coinciding with the payment of property taxes. If the City were to move to a monthly billing system this reserve target could be reduced.

Capital Reserves. A capital contingency reserve is an amount of cash set aside in case the Utility must make an unexpected (emergency) capital investment. The reserve is also available for other unanticipated capital needs such as cost overruns. Capital reserves are usually calculated as a percentage of fixed asset cost with industry BMP set at 1 or 2 percent.

This forecast is based on maintaining a minimum balance of at least 2 percent of assets, or approximately $450,000.

System Reinvestment. System reinvestment funding promotes system integrity through reinvestment in the system. Target system reinvestment funding levels are commonly linked to annual depreciation expense as a measure of the decline in asset value associated with routine use of the system. The specific benchmark used to set system reinvestment funding targets is a policy that balances various objectives including managing rate impacts, keeping long-term costs down, and promoting "generational equity" (i.e., not excessively burdening current customers with paying for facilities that will serve a larger group of customers in the future).

Because of the levels of planned capital improvements over the next 6 years, this study does not separately consider the need for additional, dedicated, system reinvestment.

Capital Funding. The City uses a combination of debt proceeds and rate revenue to fund capital projects. The following funding resources are identified as part of the capital funding strategy:

- Accumulated cash reserves over minimum fund balances
- Annual cash from rates available for rate funded capital
- Interest earned from the available fund balance and other miscellaneous capital resources
- Revenue bond proceeds (as necessary)

Debt Management. This financial analysis models a minimum bonded debt coverage test of 1.5. The financial forecast is developed from 2017 and 2018 budget documents. This forecast is supported by key factors and assumptions used to develop a complete portrayal of the Utility's annual financial obligations. A list of the key revenue and expense factors and assumptions used to develop the baseline financial forecast can be found in the Financial Analysis Report (Section III) in Appendix L.

9.3 Management Matrix Analysis

The City considered three management strategies in the financial analysis: minimum, proactive, and optimum. Each management strategy reflects a different suite of programs and projects that allow the City to provide varying levels of service to its customers. These varying programs and projects impact the forecasted operating and capital costs and thus necessary rate increases.

It is important to note that these three strategies are a change from the Utility's current operating scenario. The three management strategies all account for additional operational and capital expenditures that help better align the Utility to its levels of service.

Using management strategies in the financial analysis allows the City to determine the rate impacts of different service levels. Through discussion with the City Council, City staff, and community residents, the proactive strategy was chosen as the recommended management strategy. See a description of the proactive management strategy in Section 8.2.

Management strategies differ on two levels:

- **Programs** are O&M activities that enhance or maintain surface water services. The minimum strategy uses the fewest number of programs and the optimum strategy uses the most. Each strategy builds on the next so there are no programs in the minimum strategy that are not also in the proactive strategy and there are no programs in the proactive strategy missing from the optimum strategy.
- **Projects** are capital investments designed to enhance or maintain surface water services. The three management strategies differ in the number of projects that are assumed to take place in the 6-year planning horizon. Projects not planned in the 6-year planning period are assumed to occur in the next 20 years, between 2024 and 2036.

Minimum. The minimum management strategy is a combination of projects and programs meant to meet the minimum in existing system needs and anticipated new regulatory requirements.

Proactive. The proactive management strategy adds new projects and enhanced programs that address high-priority, long-term needs as well as anticipated new regulatory requirements.

Optimum. The optimum management strategy adds additional priority projects and programs that focus on enhancements to water quality and aquatic habitat.

9.3.1 Management Strategy Results and Summary

Table 9-1 summarizes the annual revenue requirements based on the forecast of revenues, expenditures, fund balances, and fiscal policies that would be needed for each management strategy.

Table 9-1. Management Strategy Financial Analysis Summary

Management Strategy Rate Impact Summary	2017	Year 1 2018	Year 2 2019	Year 3 2020	Year 4 2021	Year 4 2022	Year 5 2023
Minimum							
Proposed increase	N/A	20%	5%	5%	4%	3%	3%
Resulting revenue	$4,488,372	$ 5,391,433	$ 5,666,666	$ 5,955,949	$ 6,200,381	$ 6,392,779	$ 6,591,147
Proactive							
Proposed increase	N/A	27%	15%	10%	10%	5%	5%
Resulting revenue	$4,488,372	$ 5,705,933	$ 6,568,385	$ 7,232,449	$ 7,963,649	$ 8,370,193	$ 8,797,492
Optimum							
Proposed increase	N/A	42%	20%	10%	8%	5%	5%
Resulting revenue	$4,488,372	$ 6,379,862	$ 7,663,490	$ 8,438,269	$ 9,122,444	$ 9,588,145	$ 10,077,620

Source: Table IV-1, City of Shoreline Surface Water Utility; Financial Analysis for 2017 Master Plan, FCS Group (November 2017), Appendix L.

With the greatest number of programs and projects, the optimum strategy has the highest annual revenue requirements and thus the largest rate adjustment of the three scenarios. However, all scenarios require increases in annual revenue to meet new, required expenses as they relate to regulatory requirements and appropriately managing the system.

In all three scenarios, an initial, larger, revenue increase is required in 2018 followed by subsequent smaller increases over the next 5 years. This is due to increases in O&M expenses to meet regulatory and basic management requirements for operating the Utility.

These expenses cannot be funded through debt and thus the rate impact cannot be spread out over time. Efforts were made to spread costs and delay projects where possible to mitigate initial rate impacts.

The Utility staff recommends the proactive management strategy. This strategy allows the City to not only be compliant with permit requirements but also attend to desired levels of service and pressing investment needs. Section 10.5 details the recommended funding plan for the proactive strategy.

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Section 10

Implementation

Utility staff presented the management strategies and the results of the financial analysis to the City Council in August 2017, recommending implementation of the proactive management strategy. The recommendation for the proactive management strategy is based on the expected level of service provided for the associated cost and impact on surface water management fees. The proactive management strategy provides the following:

- Programs that meet current O&M needs and regulatory requirements
- Programs to meet anticipated new regulatory requirements
- High-priority projects and programs that most directly help meet the four levels of service
- Equitable Utility services across the city's drainage basins

The City Council directed Utility staff to proceed with the proactive management strategy for preparing costs and financial information for the 2018–2023 CIP and 2018 City budget. The following sections summarize the policy recommendations, programs, and projects associated with implementation of the proactive management strategy.

10.1 Policy Recommendations

As described in Section 4.3, Utility staff have already conducted policy issue discussions with the City Council on four key policy issues. The following bullets summarize the recommended course of action based on the guidance provided by the City Council:

- **Use of Utility funds outside of the ROW:** The Utility will continue the practice of not expending Utility funds on private property unless City staff determine that the facilities in question are the responsibility of the City or public infrastructure is threatened. Utility staff will follow a "decision requirements" flow chart, shown previously in Figure 6-2. This flow chart shows the criteria Utility staff and the City Attorney will use to identify situations where it is appropriate to use Utility funds outside the ROW.
- **Stormwater Permit:** The Utility will establish a Stormwater Permit that consolidates all the onsite and ROW stormwater review activity into a single permit process covering all ongoing inspections, operations, maintenance, and enforcement of maintenance standards for private drainage systems as required by the Phase II Permit. The Stormwater Permit Program is intended to provide operating budget and staff resources for implementing this recommendation.
- **Surface water management fee-chargeable area:** The Utility will change the chargeable area for surface water fees to be based on hard surfaces. The chargeable area was updated in the surface water management rate table (SMC 3.01.400) when the City Council approved the 2018 budget.
- **Private facility inspection and maintenance:** The Utility will continue with the current inspection and maintenance program but will embark on a pilot program offering private properties the option to participate in a self-certification program. The Utility estimated an operating budget for the Utility staff to develop the self-certification process over the next 6 years.

The Utility is expected to proceed as described above on each policy issue. Actions required by the Utility have been incorporated into program recommendations where applicable.

10.2 Programs

The proactive management strategy includes 24 programs: 9 existing programs, 9 enhanced programs, and 6 new programs. These programs have been developed to meet current and anticipated NPDES requirements, implement Utility BMPs, and reduce the backlog of existing programs. Table 10-1 presents a summary of the proactive management strategy by program category with additional annual operation costs and estimated staffing. Staffing needs were developed by identifying program activities and workload estimates for enhanced and new programs. Staffing needs are included in program costs estimates in Appendix D-1.

Table 10-1. Implemented Program Summary

Category	Program	Status	Planned Start Year	Operating Cost (Additional to Existing)	Additional Staffing (FTE)
Operation	NPDES Compliance	Enhanced	2020[a]	$32,480	0.13
	Floodplain Management	Existing	Ongoing	-[c]	-[d]
	Administration and Management	Existing	Ongoing	-[c]	-[d]
	Drainage Assessment	Enhanced	2018	$175,640	0.20
	Water Quality Monitoring	Enhanced	2020[a]	$85,470	0.25
	System Inspection	Enhanced	2018	$47,021	0.25
	Condition Assessment	Enhanced	2018	$160,340	0.34
	Private System Inspection	Enhanced	2019[b]	$62,192	0.40
	Stormwater Permit	New	2019[b]	$47,840	0.33
	Asset Management	Enhanced	2018	$69,200	0.25
Maintenance	Street Sweeping	Existing	Ongoing	-[c]	-[d]
	System Maintenance	Existing	Ongoing	-[c]	-[d]
	Small Repairs	Existing	Ongoing	-[c]	-
	SW Pipe Replacement	Enhanced	2019[b]	$651,520	0.52
	Surface Water Small Projects	Enhanced	2018	$400,000	0.16
	Catch Basin R&R	New	2018	$354,100	0.20
	LID Maintenance	New	2018	$53,732	0.10
	Pump Station Maintenance	New	2018	$63,600	0.10
	Utility Crossing Removal	New	2018	$18,400	0.15
Public involvement	Soak-It-Up Rebate	Existing	Ongoing	-[c]	-[d]
	Adopt-a-Drain	Existing	Ongoing	-[c]	-[d]
	Local Source Control	Existing	Ongoing	-[c]	-[d]
	Water Quality Public Outreach	Existing	Ongoing	-[c]	-[d]
	Business Inspection Source Control	New	2020[a]	$86,780	0.10
Average annual O&M effort for infrastructure associated with proactive management strategy				$33,867	0.02
			Total	**$2,342,182**	**3.50**

a. Existing program to continue until enhanced program begins in noted year.

b. Program development begins in 2018; program implementation begins in noted year.

c. Costs for existing programs assumed to be included within existing operation costs.

d. Staffing for existing programs assumed to be covered by existing staff.

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Three programs were only included in the optimum management strategy and therefore not included in the recommended management strategy. These programs included a group of projects or programmatic work that were considered good candidates for alternate funding such from a grant or as a component of a separate but related capital project. The programs and discussion for funding are as follows:

- **Improper Connection Removal Program:** Identified in the condition assessment efforts of the basin plan work. Improper connections can be addressed when identified as a surface water small project or as part of a separate but related capital project.
- **Thornton Creek Stewardship Program:** Identified in the Thornton Creek Basin Plan because of the creek's poor water quality. The stewardship opportunities identified for this basin can be applied to all basins. Grant funding from Ecology or the Puget Sound Partnership may be available for this public outreach, involvement, and education program.
- **Aquatic Habitat Improvement Program:** Identified in basin planning efforts as a citywide need. Aquatic habitat improvements identified in this program can be addressed when identified as a part of a separate but related capital project. Portions of this program related to public outreach and involvement may be funded through Ecology grants.

10.2.1 Staffing Needs

The Utility staff estimated additional staff resources during the development of proactive management strategy program costs and the annual City budget process. The need for 3.5 additional FTE was identified in the enhancement of Utility programs. These FTE include 1.00 FTE (Public Works Senior Maintenance Worker), 1.00 FTE (Engineering Technician), 1.00 FTE (Engineer I), and 0.2 FTE (Maintenance Worker). The remaining 0.3 FTE to be allocated to the Utility programs was obtained through the redistribution of existing FTE within the Public Works Department. Redistribution of FTE occurs during the annual budget review process, but can also occur as needed. From the development of the 2018 budget, a notable redistribution of the FTE consisted of the addition the development review and construction inspection staff. These staff will help with new Stormwater Permit program.

Figure 10-1 shows an organizational chart for Utility personnel with FTE allocations for 2018.

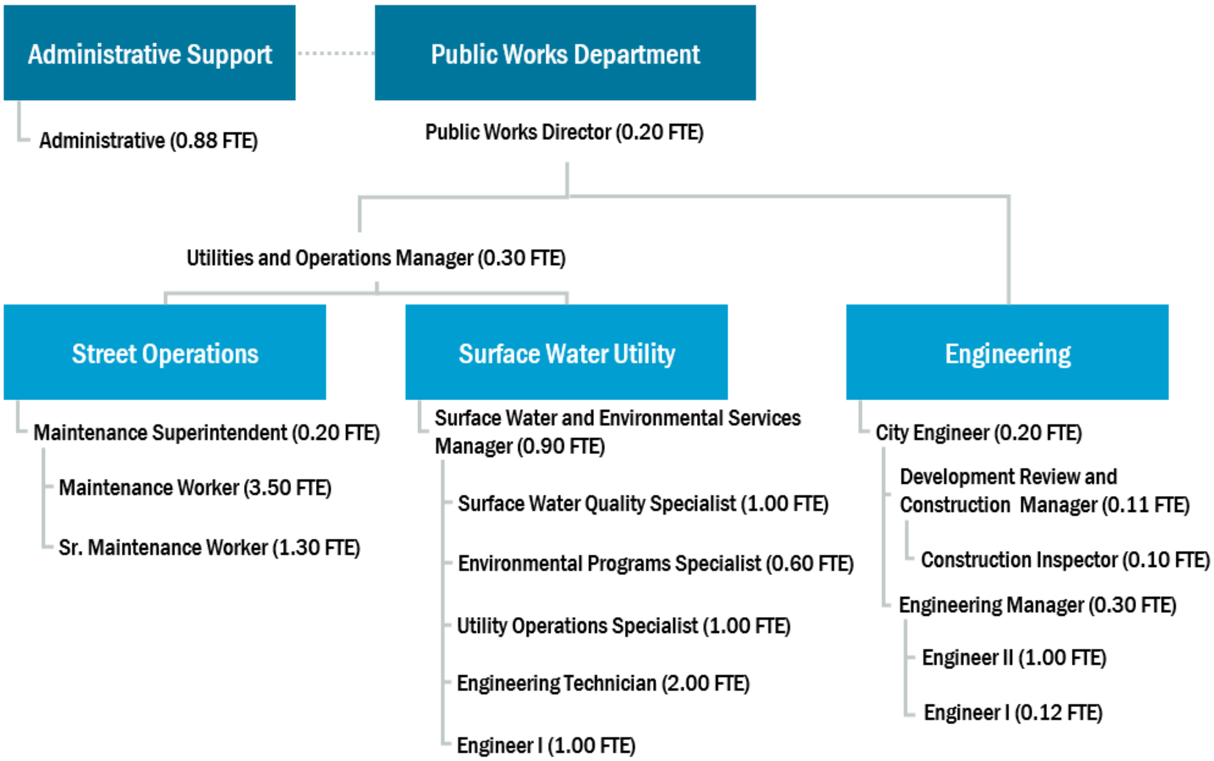

Figure 10-1. Organization of personnel contributing to Utility with FTE allocations for 2018

10.2.2 Monitoring Performance

As the Utility moves forward with implementing the programs included in the proactive management strategy, staff will collect data and monitor the performance of these programs over time. The Utility has assessed each of the programs and described the characteristics of a successful program. Staff identified quantitative performance measures related to the successful implementation of each program. These performance measures were then narrowed down to one per program, and thresholds for success were set according to three possible levels or ratings (see Table 10-2).

Table 10-2. Performance Ratings for Programs

Performance Rating	Definition
Meets expectations	Program meets expectations and is consistent with meeting level-of-service targets.
Needs improvement	Program is active and is being implemented by staff, but still needs improvement to meet expectations of customers or stakeholders.
Below expectations	Program either does not exist or falls short of meeting expectations of customers or stakeholders.

Appendix D-4 provides a comprehensive list of the programs to be implemented for the proactive management strategy along with a description of the performance measure identified for each. An overall assessment of levels of service can be made by combining the ratings of all related programs for a particular level of service. For example, if there are 11 programs that greatly impact level of service 1 (manage public health, safety, and environmental risks from impaired water quality, flooding, and failed infrastructure), we can assess the status of each program and then determine an average rating (see Table 10-3).

Table 10-3. Combined Assessment of Programs Supporting LOS 1, Surface Water Impacts

Relevant Program	2017 Program Status	Combined Status
Drainage Assessment [a]	Needs improvement	Below Expectations
Water Quality Monitoring [a]	Meets expectations	
Street Sweeping	Meets expectations	
System Maintenance	Needs improvement	
Pipe Condition Assessment Program [a]	Below expectations	
SW Pipe Replacement Program [a]	Below expectations	
System Inspection [a]	Meets expectations	
Catch Basin Repair and Replacement [a]	Below expectations	
LID Maintenance [a]	Below expectations	
Pump Station Maintenance [a]	Below expectations	
Utility Crossing Removal [a]	Below expectations	

a. *Programs that are new or enhanced for the proactive management strategy; these programs may have gaps or may not exist currently, which would lead to a "below expectations" rating in 2017.*

Appendix D-4 provides a complete list of the programs with 2017 program status ratings. Appendix D-4 also shows the anticipated ratings for 2018, once additional programs become active and additional Utility staff are available to ramp up those activities. In addition, Appendix D-4 shows the long-term goals for each program as anticipated for 2023. Table 10-4 shows the overall ratings and planned improvements for how the programs will support the levels of service.

Table 10-4. Levels of Service and Level-of-Service Targets for the Surface Water Utility

Level of Service		Level-of-Service Target	2017	2018	2023
LOS 1: Surface Water Impacts	Manage public health, safety, and environmental risks from impaired water quality, flooding, and failed infrastructure	No verifiable health and safety issues or environmental damage caused by the stormwater services outside of risk tolerance	Below expectations	Needs improvement	Meets expectations
LOS 2: Equitable Service	Provide consistent, equitable standards of service to the citizens of Shoreline at a reasonable cost, within rates and budget	Meet the levels of service as measured by customer satisfaction and rate and revenue projections	Needs improvement	Meets expectations	Meets expectations
LOS 3: Communication and Outreach	Engage in transparent communication through public education and outreach	Maintain a communication plan to inform the community on utility goals and progress	Meets expectations	Meets expectations	Meets expectations
LOS 4: Regulatory Compliance	Comply with regulatory requirements for the urban drainage system	Meet or exceed regulatory requirements for NPDES Phase II and federal, state, and local regulations affecting surface water management	Below expectations	Meets expectations	Meets expectations

Meets expectations (green) Needs improvement (yellow) Below expectations (red)

10.3 Projects

The City Council approved staff's recommendation for the implementation of the proactive management strategy, which includes 25 projects, 21 of which are construction projects and 4 of which are studies or plans. The proactive projects include high-priority construction projects and studies that help meet the level-of-service targets. Projects selected for the 6-year CIP were then examined in closer detail with respect to implementation. Several projects were divided into phases where predesign/feasibility studies were needed or engineering and planning must be done well in advance of construction. Table 10-5 lists the proactive management strategy projects in order of priority with costs in 2017 dollars.

Table 10-5. Proactive Management Strategy Project Summary

6-year CIP status[a]	Project Name	6-Year CIP Cost [b]	Capital Cost [b]
DC	25th Ave. NE Flood Reduction and NE 195th St. Culvert Replacement	$2,674,000	$8,226,000
P	Master Plan Update	$500,000	$500,000
PD	Springdale Ct. NW and Ridgefield Rd. Drainage Improvements	$545,000	$2,058,000
PDC	10th Ave. NE Stormwater Improvements	$1,788,000	$1,788,000
PD	Heron Creek Culvert Crossing at Springdale Ct. NW	$226,000	$855,000
DC	Hidden Lake Dam Removal	$2,097,000	$2,097,000
P	25th Ave. NE Ditch Improvements between NE 177th St. and 178th St.	$141,000	$2,538,000
PD	Pump Station 26	$320,000	$891,000
PD	Pump Station 30 Upgrades	$90,000	$339,000
P	6th Ave. NE and NE 200th St. Flood Reduction Project	$22,000	$384,000
PDC	Pump Station Misc. Improvements (Linden, Palatine, Pan Terra, 25, Ronald Bog, Serpentine)	$732,000	$732,000
C	NE 148th St. Infiltration Facilities	$393,000	$393,000
P	Boeing Creek Regional Stormwater Facility	$83,000	$9,440,000
P	System Capacity Modeling Study	$300,000	$300,000
PDC	NW 195th Pl. and Richmond Beach Dr. Flooding	$747,000	$747,000
P	Stabilize NW 16th Pl. Storm Drainage in Reserve M	$28,000	$500,000
P	Storm Creek Erosion Management Study	$80,000	$80,000
P	Climate Impacts and Resiliency Study	$80,000	$80,000
P	Boeing Creek Restoration	$50,000	$7,630,000
PD	NW 196th Pl. and 21st Ave. NW Infrastructure Improvements	$83,000	$313,000
P	18th Ave. NW and NW 204th St. Drainage System Connection	$15,000	$261,000
P	NW 197th Pl. and 15th Ave. NW Flooding	$7,000	$119,000
P	Lack of System and Ponding on 20th Ave. NW	$81,000	$1,458,000
P	12th Ave. NE Infiltration Pond Retrofits	$38,000	$677,000
P	NE 177th St. Drainage Improvements	$9,000	$152,000
		$11,129,000	$51,920,000

a. Implementation status key: P = planning/predesign/study, D = design/permitting, C = construction

b. 2017 dollars. O&M and other life-cycle costs included in financial planning analysis.

10.4 Recommended Funding Plan

The proactive management strategy includes project (capital) and program (non-capital) investments to meet regulatory requirements and address high-priority, long-term needs of the Utility.

Capital. There are more than $22.3 million in identified capital project costs over the 6-year planning horizon assuming a 3 percent annual escalation rate. The specific projects and costs are identified the Financial Analysis Report (see Appendix L).

O&M Program. The proactive strategy O&M expenses (including programs not in the 2017 O&M program) were identified in Table V-3 in the Financial Analysis Report. Annual (escalated) expenses ranged from approximately $4.78 million (2018) to $5.69 million (2023).

10.5 Current and Projected Rates

Surface water management fee rates are approved annually when the City's annual budget is approved. The rate increases required for the proactive management strategy are implemented for the 6-year planning period through the budget approval. The financial analysis was prepared for capital projects and O&M programs for a 20-year period (2017–2036) and therefore includes financial planning beyond the 6-year period. This section describes the rate increases for the 2018–2023 projected rates and the 2024–2036 revenue requirements.

10.5.1 2018–2023 Projected Rates

The Financial Analysis Report accounts for the "proactive level" of capital and O&M program costs over the 6-year planning period. The report also accounts for the associated costs for the debt servicing, reserve funds, and meeting the policy requirements over the planning period. The report then projects the rate increases necessary to support this level of programming. Table 10-6 below (Table VI-1 in the Financial Analysis Report—see Appendix L) provides the results of the projected rate analysis by year.

Table 10-6. Projected Percentage Rate Increases to Meet Proactive Level Program Expenditures

Rate Increase Summary	2017	2018	2019	2020	2021	2022	2023
Annual rate increases	NA	27.0%	15.0%	10.0%	10.0%	5.0%	5.0%
Single-family annual bill	$ 168.81	$ 214.38	$246.54	$ 271.19	$ 298.31	$ 322.18	$ 328.89
Increase over prior year	NA	$ 45.58	$ 32.16	$ 24.65	$ 27.12	$ 14.92	$ 15.66

Source: Table VI-1; City of Shoreline Surface Water Utility; Financial Analysis for 2017 Master Plan, FCS Group (November 2017) (Appendix L)

The analysis shows the need for the rate's highest increase in 2018 with gradually smaller increases in later years. For single-family residences, this reflects an increase in the annual surface water charge from $168.81 in 2017 to $328.89 by 2023. The same percentage increase would apply for every customer type. The current customer rates were adopted on November 20, 2017, when the City Council approved the 2018 budget; these are located in the SMC 3.01.400 Surface Water Management rate table.

Figure 10-2 compares the 2018 Shoreline monthly surface water management fee with 2018 monthly fees of other surface water agencies. The Shoreline monthly fee is considerably lower than that of Seattle and similar to that of other local agencies.

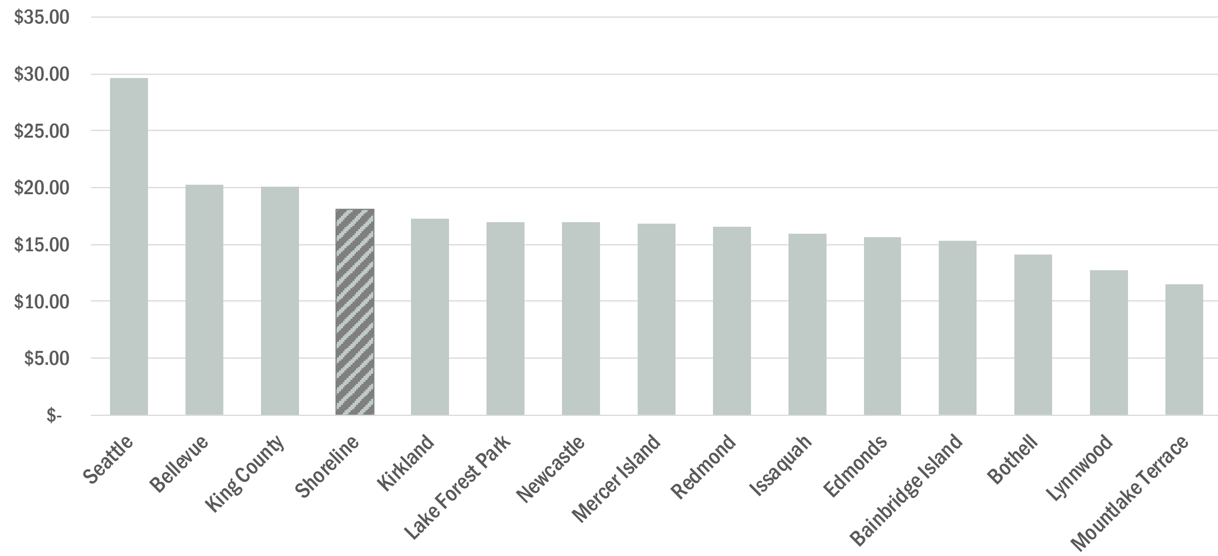

Figure 10-2. Comparison of Shoreline 2018 monthly surface water management fees with other 2018 surface water agencies

10.5.2 2024–2036 Revenue Requirement Discussion

Capital improvement estimates show a sustained increase in capital investments from 2024 through 2036. This increase currently results in an average of more than $3 million annually in additional capital expenditures as compared to the current 6-year spending average. Because of sustained above-inflation increases through 2023, current financial forecasts show that the City will require slightly lower rate increases starting in 2024 (of 7 percent) that reduce toward inflationary increases over time despite the higher projected capital expenditures. These forecasts are dependent on the City maintaining its current capital schedule and cost estimates.

10.6 Conclusion

The City examined three management strategies in the financial analysis. Each analysis considered all funding resource options, the Utility's financial policies and targets, and current operating needs. All strategies were developed such that they, at a minimum, meet Phase II Permit obligations. All management strategies require rate increases. The 2018 rate increase is the most substantial, followed by smaller increases through 2023. These increases are related to higher O&M obligations of new programs.

The proactive strategy adds new, high-priority projects and programs and is the recommended management strategy. The proactive management strategy is recommended because it meets Phase II Permit obligations and funds many high-priority needs but does not require the same level of investment (and rate increases) as the optimum strategy.

It is important that the City revisit the identified rates annually to ensure that the rate projections developed remain adequate. Any significant changes should be incorporated into the financial plan and future rates should be adjusted as needed.

The City should take extra consideration of improved capital cost estimates and scheduling in the 2024–2036 planning period. While the current rate forecast plans for an increase in capital expenditures through this period, changes to costs and schedules will be important to incorporate.

Other financial planning recommendations include the following:

- Adopt rate structure presented for the proactive management strategy
- Revise City “CIP model” to include updated reserve requirements including:
  - 120 days of O&M expenses minimum operating reserve balance
  - 2 percent of assets minimum capital reserve balance
- Review rates and current operational and capital needs annually
- Conduct new financial analysis in 5 years to ensure that projected rates are in line with Utility expenses

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Section 11

Limitations

This document was prepared solely for the City of Shoreline in accordance with professional standards at the time the services were performed and in accordance with the contract between the City of Shoreline and Brown and Caldwell dated July 14, 2016. This document is governed by the specific scope of work authorized by the City of Shoreline; it is not intended to be relied upon by any other party except for regulatory authorities contemplated by the scope of work. We have relied on information or instructions provided by the City of Shoreline and other parties and, unless otherwise expressly indicated, have made no independent investigation as to the validity, completeness, or accuracy of such information.

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Section 12

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Appendix A: Public Survey Results

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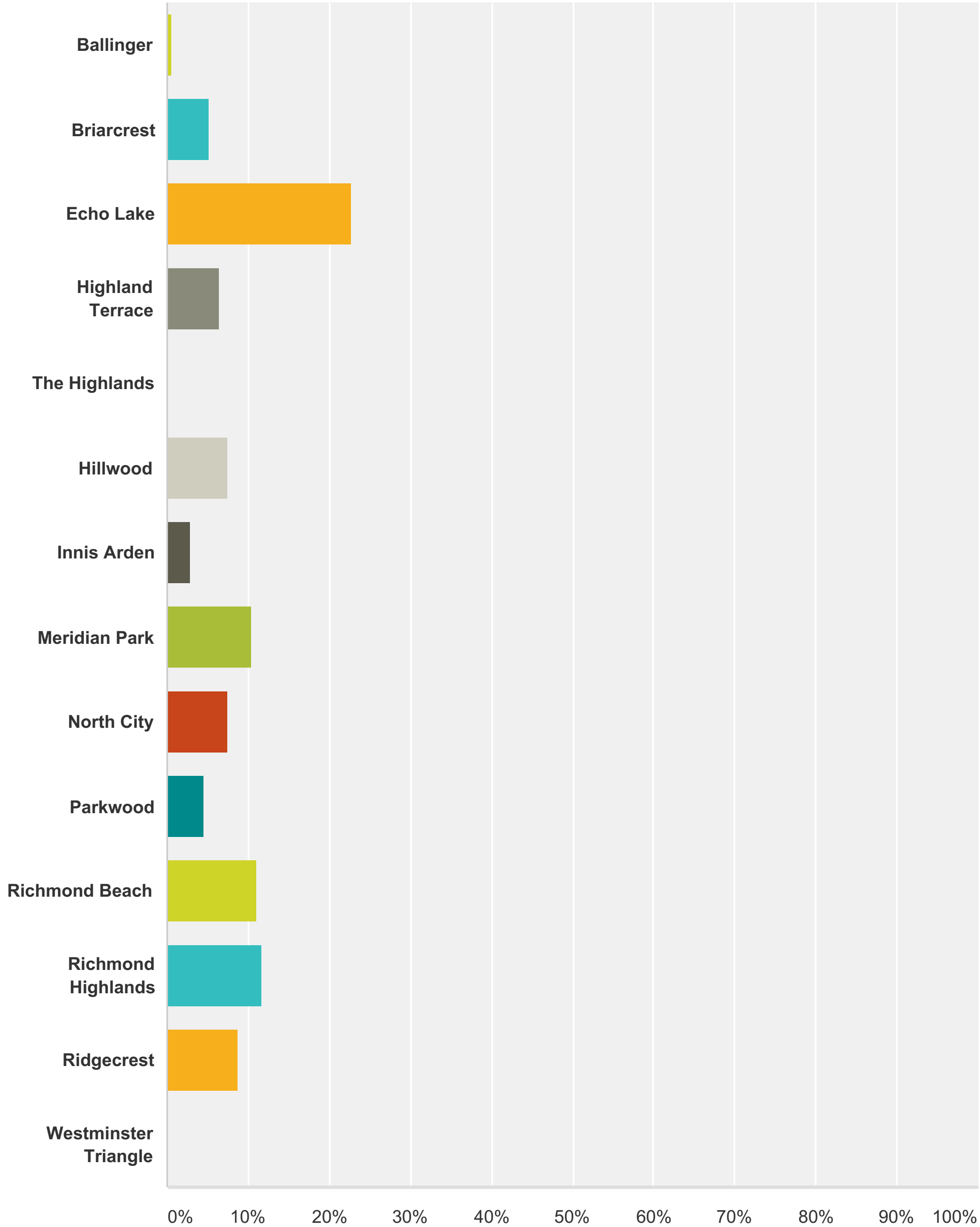
Public Survey:
Proposed levels of service
September 2-16, 2016

Q1 What neighborhood do you live in?

Answered: 171 Skipped: 0

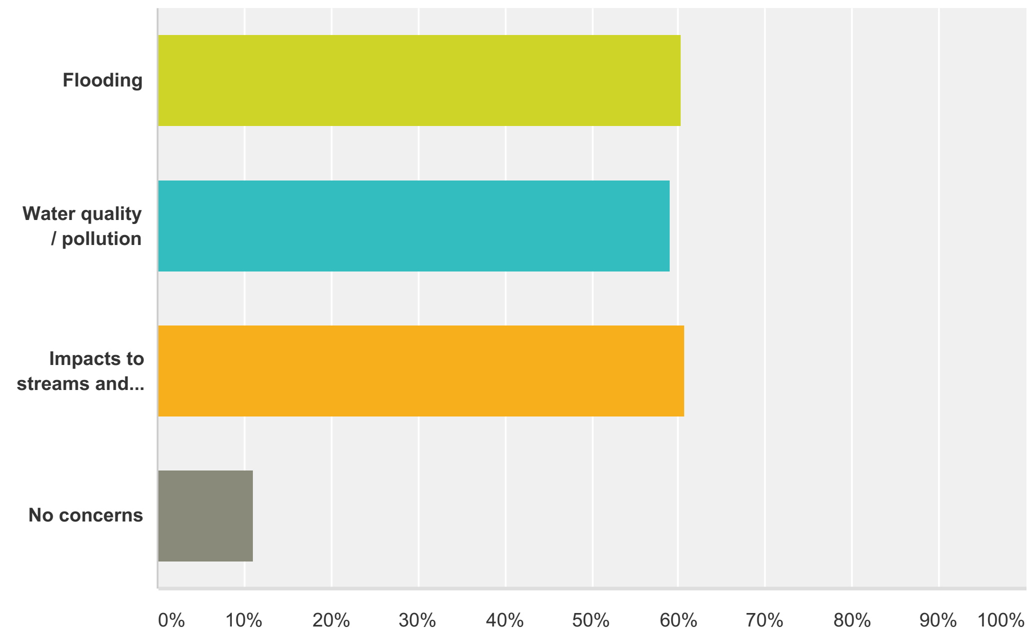


Answer Choices	Responses	
Ballinger	**0.58%**	1
Briarcrest	**5.26%**	9
Echo Lake	**22.81%**	39
Highland Terrace	**6.43%**	11
The Highlands	**0.00%**	0

Hillwood	**7.60%**	13
Innis Arden	**2.92%**	5
Meridian Park	**10.53%**	18
North City	**7.60%**	13
Parkwood	**4.68%**	8
Richmond Beach	**11.11%**	19
Richmond Highlands	**11.70%**	20
Ridgecrest	**8.77%**	15
Westminster Triangle	**0.00%**	0
Total		**171**

Q2 What are your concerns with stormwater? Check all that apply.

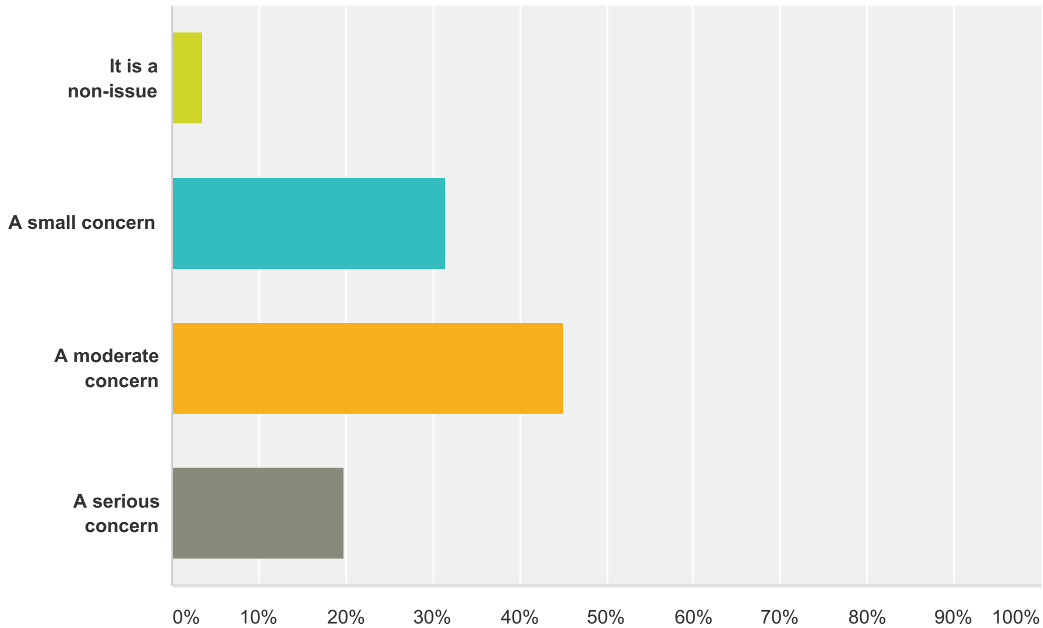
Answered: 171 Skipped: 0



Answer Choices	Responses	
Flooding	**60.23%**	103
Water quality / pollution	**59.06%**	101
Impacts to streams and wetlands	**60.82%**	104
No concerns	**11.11%**	19
Total Respondents: 171		

Q3 How would you rate stormwater issues in Shoreline, as a whole?

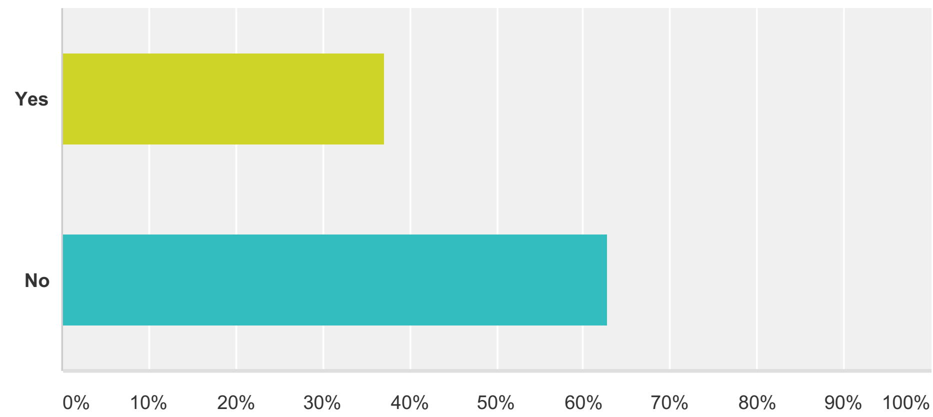
Answered: 171 Skipped: 0



Answer Choices	Responses	
It is a non-issue	**3.51%**	6
A small concern	**31.58%**	54
A moderate concern	**45.03%**	77
A serious concern	**19.88%**	34
Total		**171**

Q4 Are you familiar with the Surface Water Utility and what it does?

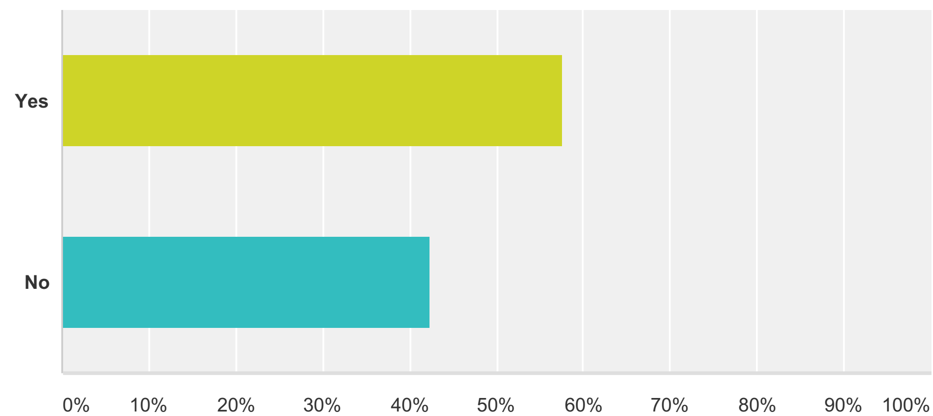
Answered: 170 Skipped: 1



Answer Choices	Responses	
Yes	**37.06%**	63
No	**62.94%**	107
Total		**170**

Q5 Do you have any concerns with stormwater services, such as drains, ditches or outfalls, being properly maintained in your area?

Answered: 170 Skipped: 1



Answer Choices	Responses	
Yes	**57.65%**	98
No	**42.35%**	72
Total		**170**

Q6 You answered "yes" to having concerns with stormwater services such as drains, ditches or outfalls, being properly maintained in your area. Please describe your concern below:

Answered: 78 Skipped: 93

#	Responses	Date
1	Specifically the on and off ramps for I-5 and 175th. There has been flooding here multiple times in the last year, coming close to swamping lower-clearance cars.	9/15/2016 3:17 PM
2	Cromwell Park is an eyesore and now we have Mosquitos that we did not have before the retention pond.	9/15/2016 10:36 AM
3	We had an 8' deep sink hole develop right next to our house a few years ago. There is a large storm drain that runs there. A 1963 pipe failed during a big November rain. It runs down a steep hill from there. If a pipe up top failed, I worry about the condition of the rest of the line.	9/14/2016 11:07 PM
4	Keeping drains clear, and making sure ditches are clear of debri	9/14/2016 8:49 PM
5	Flooding usually near the corner of 1st and 179th after a rainfall.	9/14/2016 4:01 PM
6	The city has told me it only maintains the ditch once every two years. Neighbor blows needles and other debris into the ditch (though he denies it), which can cause clogging.	9/14/2016 3:23 PM
7	When there is a heavy downpour, part of my street floods. Additionally, there is always debris clogging the drains on Fremont, causing standing water during heavy rains	9/13/2016 8:35 PM
8	Overflowing storm drains flood our property. The city has done little to manage their water on our property. This storm drain is not prepared for major weather events.	9/13/2016 8:29 PM
9	Drains--so far so good, and I'd like to be able to continue saying that.	9/11/2016 11:47 PM
10	The drains are never cleaned or cleared on our street. We do it ourselves	9/10/2016 3:40 PM
11	The ditches and culverts in front of our house and other houses along Greenwood Ave N should be inspected, it appears some are clogged up so the water may not move south-north.	9/10/2016 9:51 AM
12	I have no idea what if anything you will do. I never heard of you before.	9/9/2016 6:22 PM
13	Drain is not level with road- road needs resurfacing	9/9/2016 4:02 PM
14	The area along the street in front of my property that is county property that I have to maintain is very wet and muddy especially when some one drives on it and makes a large rut which makes it hard for me to mow.	9/9/2016 1:28 PM
15	Concerned about Echo Lake water levels and water quality, particularly since Aurora Corridor project. Seems that it's worse, and not 'as good or better.'	9/9/2016 11:08 AM
16	We have runoff from the QFC shopping center coming through our property. very year when the leaves come down we worry about the neighbor yard being flooded? We have to be vigilant to make certain the leaves are removed to avoid flooding	9/9/2016 11:06 AM
17	Streets are ok but concerned about where it is going. Sensitive areas like echo lake has drainage issues. Not solved - auroras done now. Harmful Vegetation has grown in	9/9/2016 10:58 AM
18	Water draining into echo lake	9/9/2016 10:55 AM
19	Regulations are complete and precise enough to be applied to actual conditions reliably.	9/9/2016 10:54 AM
20	High water table, new structures make increased standing water. Getting worse.	9/8/2016 7:30 PM
21	Storm water being directed thru culver behind the ymca is loaded with oils and sediment from aurora. Their is inadequate filtration and holding tanks for the volume of water entering Echo Lake during a moderate storm.	9/8/2016 1:25 PM
22	This has been a concern since I bought property 35 yrs ago. Everybody passed the problem around. Street always floods, drains slow and we keep leaves etc our	9/8/2016 12:41 AM

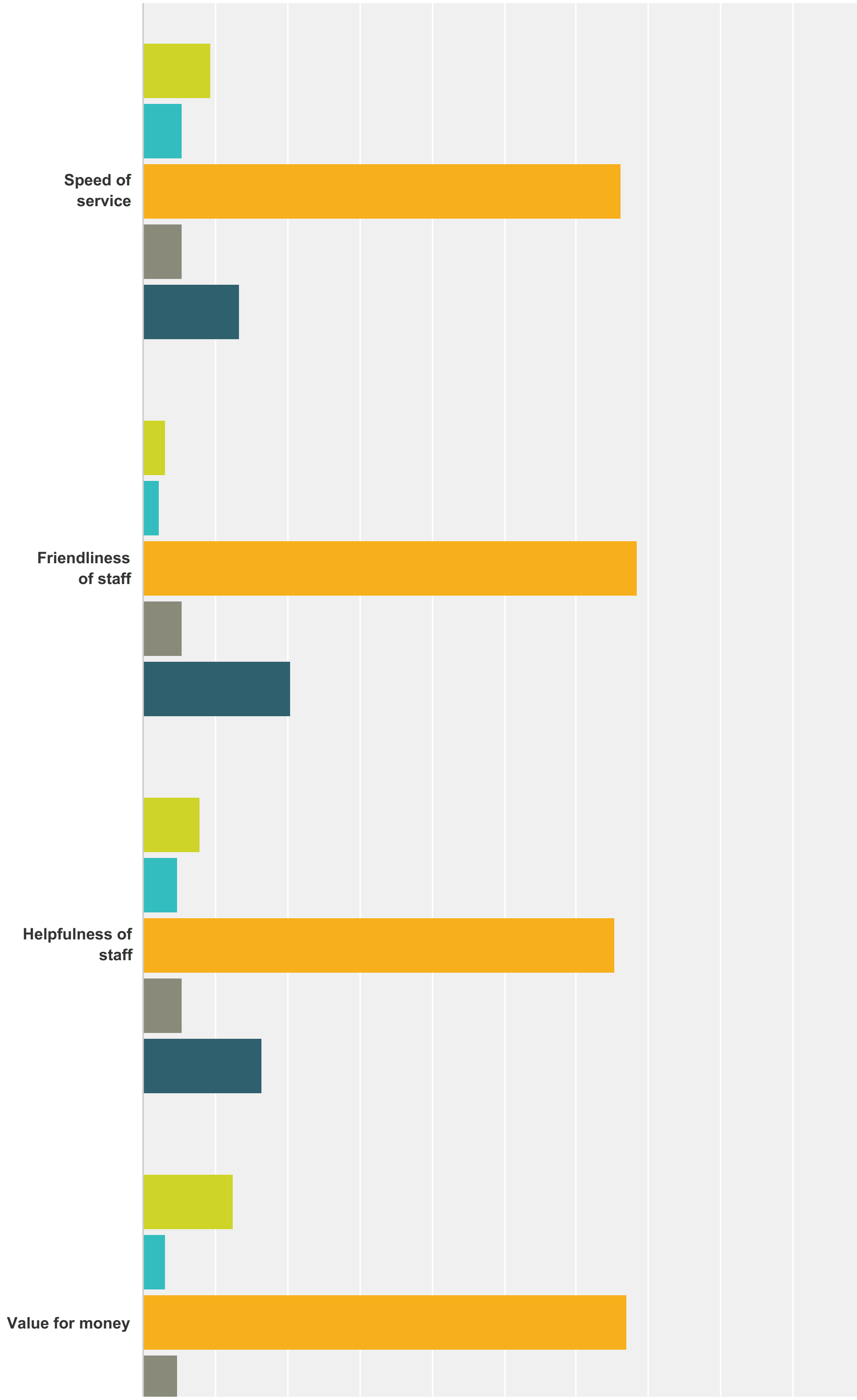
23	I live on Echo Lake. And there have been times the drain at the north end of the lake gets clogged, the water level rises, and is frightening. Once it got within 18 inches of the door. If it had not been for a volunteer who knew where the drain was and cleared it, we would have had real problems.	9/7/2016 9:50 PM
24	The city right of ways - alleys especially are not being addressed. New construction down hill from our property was put in and they were allowed to raise the alley. Thus, the flow from all the houses upstream from us dumps into our backyard and we have had major damage due to this. After several phone calls and visits to us and our neighbors from the city, no one is responding or taken any responsibility. We will need to spend thousands of dollars to take care of this water that is not coming from our property.	9/7/2016 9:38 PM
25	I am not sure if my culvert has been inspected along with the with pipes that feed it. There also doesn't seem to be a concerted effort to notify homeowners that the stormwater covers/grates should be kept clear of debris.	9/7/2016 7:19 PM
26	When the sidewalk was installed in front of my home, several years ago, it wasn't level and there is a dip where rain water pools. It's gotten worse over time. I reached out to the Shoreline Public Works supervisor continuously, for 2 years. He finally replied, just last month, to say that it wouldn't be repaired (but on one or two occasions over those 2 years, had led me to believe they would).	9/7/2016 6:35 PM
27	I live right n N 185th St. The leaves clog the drains unless someone pulls them out. Street cleaners don't go by often enough. Perhaps the crew in orange jumpsuits can be put to work pulling leaves out of the grates on a regular basis during the Fall & Winter.	9/7/2016 4:44 PM
28	alleys that are considered city R.O.W. but that are not maintained by the city and allow water migration off of and then allows excess water to drain onto properties which causes flooding to residences.	9/7/2016 4:32 PM
29	We live in a slope and our basement has flooded in the past. I want to make sure storm water drains are maintained so the runoff doesn't end up in our basement.	9/7/2016 4:20 PM
30	Water from surrounding properties and from the street flows onto our property, causing flooding of crawl spaces, necessitating a sump pump that runs most of the winter. Each individual property (and the city) should be required to manage their own stormwater and prevent runoff onto surrounding properties.	9/7/2016 4:07 PM
31	drain between homes gets clogged and drain by bus stop backs up	9/7/2016 4:00 PM
32	I often see clogged drains due to leaves, etc. on the arterials in our neighborhood. I'm especially concerned with standing water in front of Meridian Park elementary school. This is a hazard to drivers, students, and other pedestrians.	9/7/2016 3:56 PM
33	Needs more maintenance	9/7/2016 3:47 PM
34	Excess surface rain water runs down Densmore N. near 155th. Small berm seems only a temporary solution.	9/7/2016 3:42 PM
35	Standing water at corner of 183rd Street and Meridian Ave N. Homes that have asphalt covering entire area from property to street causing more run off downhill.	9/7/2016 1:08 PM
36	There is a ditch at the bottom of my property next to the street. I honestly don't know if it's my responsibility or the city's to maintain that area, so I do it - clean up dead leaves and debris. I also clear out debris from the large drainage pipe that runs from the ditch under my driveway. The city never cuts the weeds/grass here, although I see it being done in other areas. So I do it to the best of my ability.	9/7/2016 11:14 AM
37	Drains are plugged which causes rainwater to flood the street. Pollution enters through the open system. Outfalls create erosion of soils.	9/7/2016 11:01 AM
38	My concerns are: - Road construction is impacting stormwater drainage. When the 175th Ave was redone 10/15 years ago, water started backing up in backyards. - Additional development of buildings that will cover more of the soil and end up with more runoff water. The extreme flooding that happen this year in the south of the country happened to places that are not subject to floods but the heavy construction created a dangerous path for water flooding.	9/7/2016 10:18 AM
39	Maintenance and cleaning of storm drain catch basins on private property such as Condominiums and Homeowner Associations.	9/7/2016 10:06 AM
40	My basement was destroyed by flooding. I spent $30K to repair it and to put in a drainage system. Makes me wonder what the city is doing.	9/7/2016 9:59 AM
41	have never seen any work being done on the ditches and drainage in our area	9/7/2016 9:52 AM
42	My garage at 17327 1st Ave NW is the default drainage for the neighborhood, dependent on one storm drain, which gets clogged with leaves etc. from upper sections of the street.	9/7/2016 9:35 AM
43	Some drains get clogged with leaves and debris. We try to watch out for it, but it tends to happen in the winter, when we are rarely home during daylight hours.	9/7/2016 8:30 AM

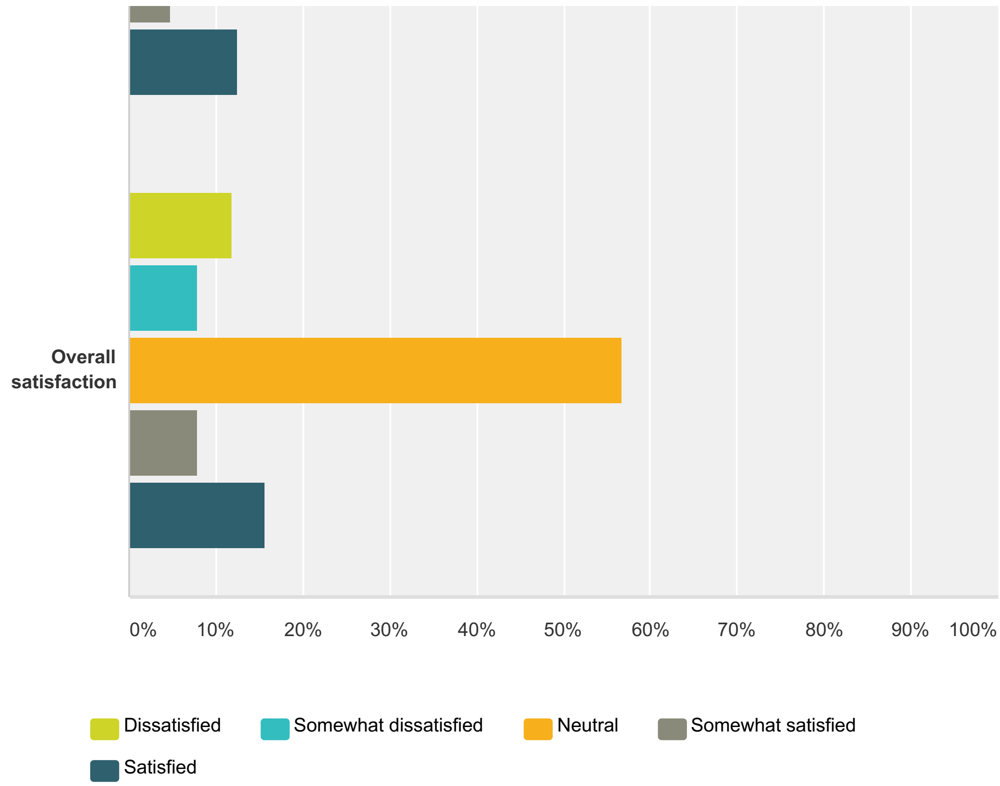
44	Our ditches are over grown and almost completely filled in. There is no place for the water to go. Neighors over the years have filled in the ditches for parking.	9/7/2016 8:20 AM
45	-	9/7/2016 8:12 AM
46	That neighbors and homeowners continue to keep street drains clear by their driveways, especially during the fall and winter months.	9/7/2016 7:56 AM
47	Blocked drains, Old or unknown drainage systems on private property diverting water in unexpected ways. High Groundwater flooding basement during wet season.	9/7/2016 7:56 AM
48	Rainwater accumulates in areas where the street has slumped, so it pools instead of flowing to drains.	9/7/2016 7:52 AM
49	Drains are often clogged with tree debris in the Fall. Storm drain locations are inadequate to capture water runoff flowing down streets and into driveways.	9/7/2016 7:51 AM
50	when it rains I have water from my neighbor's back yard I have to have sand bags along fence also installed sump pump in front yard my house is the only one that floods in my cul de sac, my back yard has been sinking in one corner before my house was built this land was a lake full of water then filled to build a house I have contacted seattle water, ronald waste water many times & no response if I sell my house I have to disclose this so Iam not happy with city of shoreline	9/7/2016 7:25 AM
51	there is no storm sewer on my block - water won't run uphill to the nearest outlet, so it has to evaporate in the street, and might be making the adjacent ground soft	9/7/2016 7:15 AM
52	My parking strip floods during heavy rains making any visitor parking extremely inconvenient. (I am not familiar with your agency, thus my answers in #7).	9/7/2016 7:12 AM
53	There are spots on Ashworth Ave N where water collects when it rains.	9/7/2016 7:05 AM
54	Surface water structures not connected to the City system in areas where high density residential has been proposed. Steep slopes in areas of high density rezone.	9/7/2016 6:16 AM
55	Flooding in our back yard and in front of our house because neighbors drain into street	9/7/2016 12:09 AM
56	Ever since my road was slurried, water pours down my driveway, overcomes the drain I have and present a real problem of flooding the basement thru a below grade window. The street needs to be leveled so water id channeled into the drain system that is there.	9/6/2016 11:22 PM
57	I really don't think people are aware that the drains need to be kept clear and debris in front of their house will wind up floating down with the rain. Educational letters might help? In the past 2 years there have been more pine needles and plant debris due to the drought conditions and it has caused issues on my block with water flow.	9/6/2016 10:27 PM
58	Open ditches can fill and overflow. Shrubs growing in open ditches, plants/shrubs/weeds/ivy/trees drink water but also impede flow of water.	9/6/2016 6:49 PM
59	There are a series of ditches along 5th NE that need work and maintenance as well as the runoff from the road that runs in front of my house. I think the project along Ashworth should be modeled for this street. The ditches fill with debris and garbage and that gets washed into the drainage system. I also think more could be done to enlist residents to help make sure street drains are clear to receive runoff.	9/6/2016 6:10 PM
60	Our condo area is flooded by properties north of here.	9/6/2016 4:32 PM
61	Surface water management in Innis Arden and much of Richmond Beach is non-existent or inadequate with roadside flooding or water coursing down and/or across roadsides in many areas during significant rains. Some areas have no ditches or catch basins and many catch basins are at an elevation above the pavement so that water does not flow into them, creating huge puddles or channeling the run-off into other areas. Shoreline has authorized massive tree-cutting of significant trees without requiring planning and mitigation for the additional run-off generated as a result of tree removal.	9/6/2016 4:24 PM
62	Primarily centered around drain at NW corner of 178th and Wayne. Heavy rainfall or during winter it doesn't drain so water accumulates. I have gone out with a rake to clear it when the puddle forms.	9/6/2016 4:07 PM
63	Current infrastructure doesn't seem to be capable of handling existing runoff. The recent rezone will only make matters worse. Also jurisdiction is an issue. The Shoreline community Center storm drains aren't under the managing entity.	9/6/2016 3:27 PM
64	Neighbors mow lawn, blows into the street...then the rain takes it into the storm drains and plugs them.....chemicals in lawns etc.	9/6/2016 3:15 PM
65	Surface drains need to be cleared of clougs	9/6/2016 3:00 PM
66	The infrastructure is a problem throughout America. Fortunately, Shoreline's sewer is newer than most. RE: the next set of questions - how would I know?	9/6/2016 2:42 PM

67	Ditches in our neighborhood, not tied in to storm water sewers	9/6/2016 2:40 PM
68	Boeing Creek washed out banks and trails is concerning. Also not excited about the plan to breach Lost Lake dam but understand the prohibited costs of dredge. Wish there was a cost effective way to keep the lake without the need to dredge.	9/6/2016 1:32 PM
69	We had a mainline burst in front of our property.	9/6/2016 12:53 PM
70	There are too many 'ditches' which do not allow people to walk without going into the street and traffic. The city should address this.	9/6/2016 12:42 PM
71	Failing culverts under private driveways, ditch maintenance, inventory of drainage pipes not correct or classified properly.	9/6/2016 12:41 PM
72	They hardly seem to be maintained at all. When something was done the result was so bad the neighbors filled the ditch back it.	9/6/2016 11:58 AM
73	Some drains have been built higher than the street and are useless. An example of this is on the corner of Richmond Beach Road and 3rd NW. There are also drains placed within 2 feet of each other--total waste. There are many open ditches in our neighborhood that do not flow with water, even during heavy rainstorms. These should be filled in and covered with sidewalks to make walking along streets more safe.	9/6/2016 11:48 AM
74	I hae concerns of flood events and it's impact on water quality on Echo Lake. I also have concerns on maintainenanc of open ditches along streetsides..as they become deposits for litter and invasive weeds.	9/6/2016 11:42 AM
75	When the lake is high and the rain is falling hard and fast our yard starts to flood and comes closer and closer to my patio	9/6/2016 11:37 AM
76	Clear the ditches and drains	9/6/2016 11:37 AM
77	As a pedestrian I often notice pools of water on the side streets that do not drain - an example is on 183rd and Meridian. When there is a lot of rain or a downpour this can be a safety issue having so much water in the street or path.	9/6/2016 11:34 AM
78	The ditches are dangerous for people and cars. They become a litter bin - and cannot be casually cleaned. The grass grows so high that in some places you cannot see over it, or you cannot see there is a ditch there. The Echo Lake exit is not well maintained. It gets clogged with debris - a neighbor used to maintain it in storms but he has moved.	9/5/2016 11:23 PM

Q7 How satisfied are you with the following aspects of our stormwater services?

Answered: 127 Skipped: 44

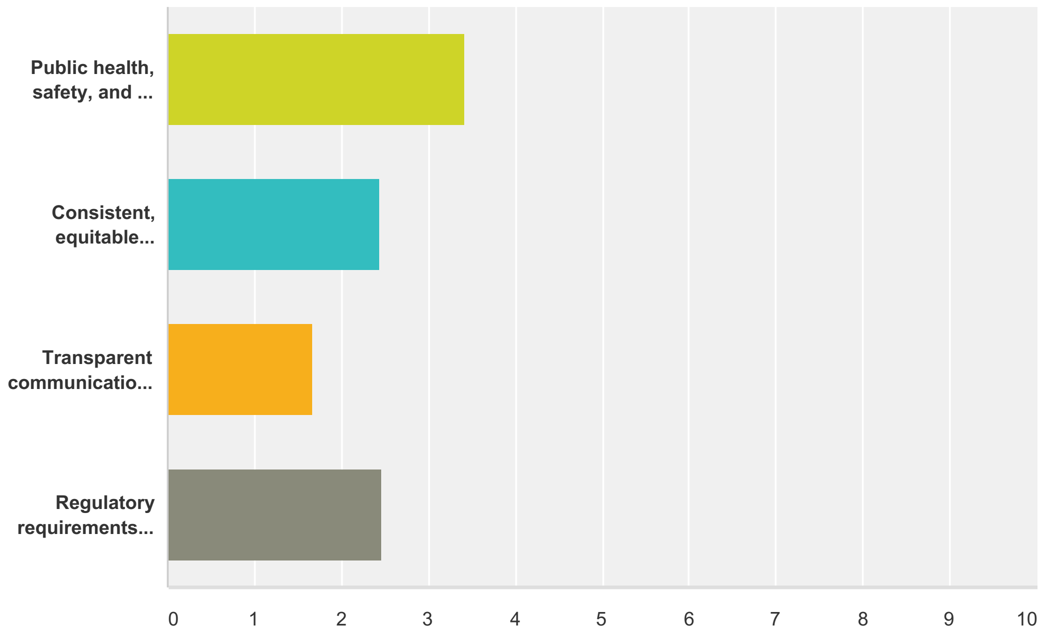




	Dissatisfied	Somewhat dissatisfied	Neutral	Somewhat satisfied	Satisfied	Total
Speed of service	**9.45%** 12	**5.51%** 7	**66.14%** 84	**5.51%** 7	**13.39%** 17	127
Friendliness of staff	**3.15%** 4	**2.36%** 3	**68.50%** 87	**5.51%** 7	**20.47%** 26	127
Helpfulness of staff	**7.87%** 10	**4.72%** 6	**65.35%** 83	**5.51%** 7	**16.54%** 21	127
Value for money	**12.60%** 16	**3.15%** 4	**66.93%** 85	**4.72%** 6	**12.60%** 16	127
Overall satisfaction	**11.81%** 15	**7.87%** 10	**56.69%** 72	**7.87%** 10	**15.75%** 20	127

Q8 *Please rank the following Levels of Service in the order of most importance to least importance (using 1 for most important and 4 for least important).

Answered: 127 Skipped: 44



	1	2	3	4	Total	Score
Public health, safety, and the environmentManage public health, safety and environmental risks from impaired water quality, flooding, and failed infrastructure.	**61.42%** 78	**25.20%** 32	**7.09%** 9	**6.30%** 8	127	3.42
Consistent, equitable standards of serviceProvide consistent, equitable standards of service to the citizens of Shoreline at a reasonable cost, within rates and budget.	**14.96%** 19	**28.35%** 36	**43.31%** 55	**13.39%** 17	127	2.45
Transparent communication and educationEngage in transparent communication through public education and outreach.	**3.94%** 5	**15.75%** 20	**22.83%** 29	**57.48%** 73	127	1.66
Regulatory requirements complianceComply with regulatory requirements for the urban drainage system.	**19.69%** 25	**30.71%** 39	**26.77%** 34	**22.83%** 29	127	2.47

Q9 Do you have any additional stormwater service concerns or suggestions?

Answered: 53 Skipped: 118

#	Responses	Date
1	Thanks for asking.	9/14/2016 11:07 PM
2	A storm water outlet near the NE corner of the Dale Turner YMCA is about 4 to 5 feet across and during heavy rain discharges over 1 million gallons of water within a 24 hr. period several times a year which goes into Echo Lake. How can this possibly be filtered properly before it enters the lake? My calculations made from data taken from King Co records.	9/13/2016 3:37 PM
3	this is the first time I heard of Surface Water Utility	9/11/2016 11:47 PM
4	It would be great to have community education on residential and commercial pollutants, so people are using environmentally friendly or no chemicals on their lawns, gardens, and rooftops.	9/10/2016 9:51 AM
5	No. This is all new to me.	9/9/2016 6:22 PM
6	Not at this time.	9/9/2016 4:13 PM
7	I am concerned that the report on the Lake quality will take too long.	9/9/2016 11:08 AM
8	Put cisterns at the QFC Rite Aid parking lots to end the water coming through my private property.	9/9/2016 11:06 AM
9	Concerns about echo lake. Encourage ymca to help	9/9/2016 10:58 AM
10	Concerned goals and regulations will be ignored by developers and no effective action will be taken.	9/9/2016 10:54 AM
11	New buildings need to address their impact and not make it worse.	9/8/2016 7:30 PM
12	Pump the culver behind the ymca 4x a year of sludge, street sweep aurora at night to cut oils and heavy metals. Cut the envasive weeds at the s end of Echo lake and get rid of the drug users living in the bushes and replant with native plants and make a bird santuary. Re due the ditch between Echo Lake and the culver; it is loaded with sluge.	9/8/2016 1:25 PM
13	In general I'm concerned about the water quality of Echo Lake, but am unsure of the root cause of deteriorating water quality.	9/8/2016 12:59 PM
14	Fix the flooding problem on our streets 167th and Linden	9/8/2016 12:41 AM
15	I don't really know much about it; sorry. I do appreciate the concern about wetlands.	9/7/2016 9:50 PM
16	Please contact me with a solution for the major water run off from the alley that lands on my property in Richmond Beach. Thank you, Diane Schultz 206-542-4928	9/7/2016 9:38 PM
17	As a homeowner, perhaps a "homeowners stormwater guide" with helpful tips and basic steps showing what we all can all be doing also to improve storm water quality on our properties.	9/7/2016 8:10 PM
18	No	9/7/2016 7:19 PM
19	Since I'm not sure what the Surface Water team provides, I couldn't answer #7. If they are the Public Works group, my answers would be "dissatisifed".	9/7/2016 6:35 PM
20	Several neighbors on my street spent a good amount of time discussing water issues that have been problematic for MANY years with a gentleman from the city (I would have to research on another computer to find the email communications and I will when necessary). I was actually shocked at how fast they came by to check it out and just as fast to discuss what could be done. Well, that was a couple of years ago and have not heard a word since. I would be happy to get into more details. gruwellfam@comcast.net	9/7/2016 4:53 PM
21	The zoning to allow more buildings along N 185th St. area & bring in a larger population is absolutely insane. We have standing water, underground streams, swampy yards and yet the City Council thinks it's a great idea to build, build, build. More people = more waste water & pollution. Stop the growth. If we wanted to live in the "city" we'd be in downtown Seattle among all the concrete!	9/7/2016 4:44 PM
22	Keep up the good work!	9/7/2016 2:31 PM
23	What are the bright green areas inside the different neighborhoods.	9/7/2016 1:43 PM

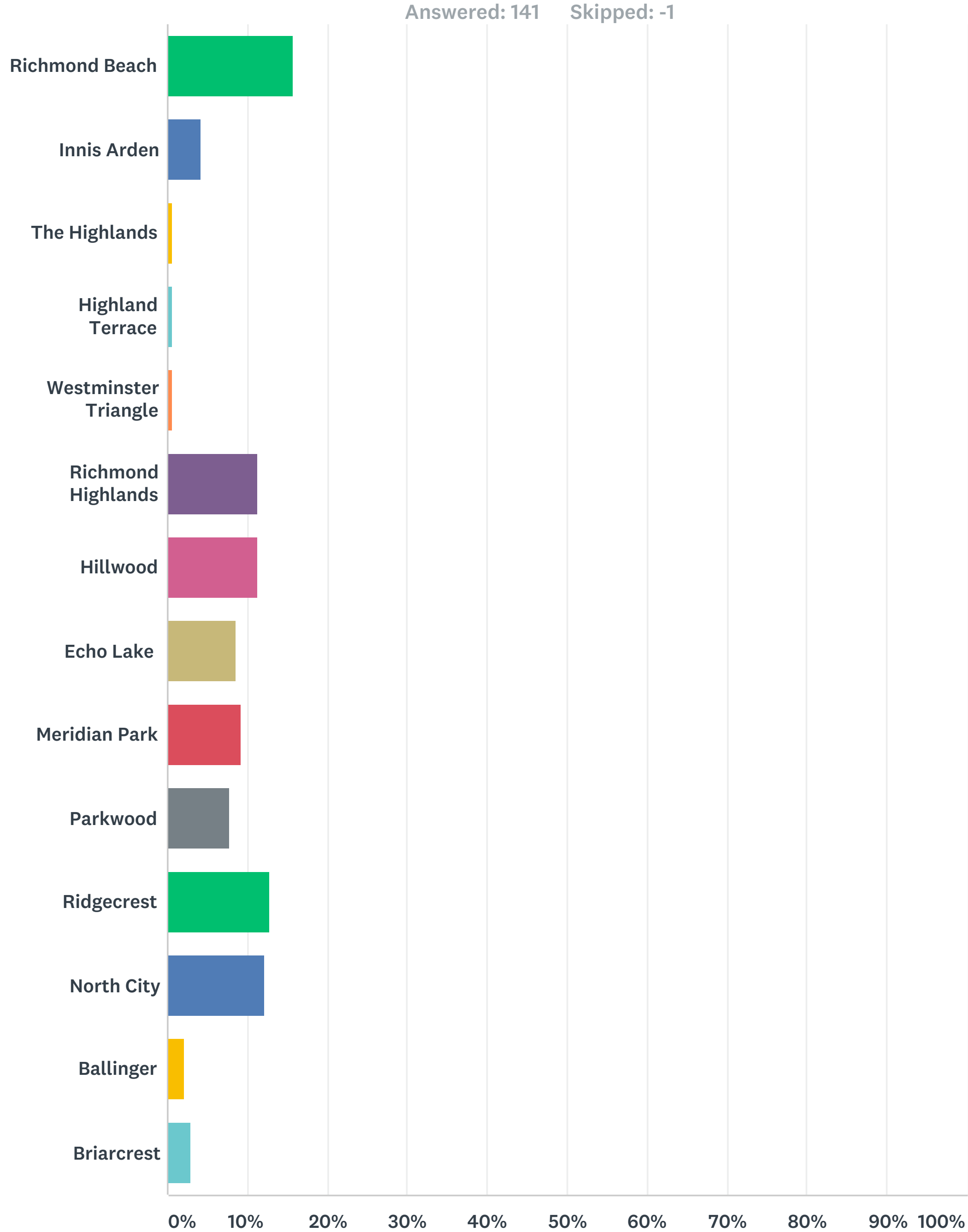
24	All of us are remiss in not making the natural environment a top priority. But ultimately, accomodating nature's ways is a critical goal.	9/7/2016 11:44 AM
25	Proposed construction of townhouses at 18339 Wallingford Ave N will increase flooding of homes just south of that address (including our home!).	9/7/2016 11:01 AM
26	too expensive, city regularly doesn't protect wetlands	9/7/2016 8:12 AM
27	Any power generation possibilities? Turbine at outfall?	9/7/2016 7:56 AM
28	Needs better outreach with public.	9/7/2016 7:56 AM
29	Storm water flowing down hills is not captured by drains and diverts down our driveway, causing pooling of water in front of our garage and occasional flooding into our garage.	9/7/2016 7:51 AM
30	answer my questions that I addressed in survey	9/7/2016 7:25 AM
31	This survey doesn't really address actual concerns of me as a resident, but asks me to rate an agency I know little about, since Shoreline's "customer svc" rep I dealt with goes out of his way to disappoint and find excuses for not providing service for my neighborhood.	9/7/2016 7:15 AM
32	Would love to see sidewalks, curbs, and proper drains on Ashworth!	9/7/2016 7:05 AM
33	I have seen hard working Shoreline employees clearing drains! Keep up the great work!	9/7/2016 6:35 AM
34	City needs to work with private residents to get a better understanding of where the system is broken or absent. Complete assessment of each lot in any up zone areas with moratorium on any permits until this is done.	9/7/2016 6:16 AM
35	See the above pertaining to Greenwood Pl N	9/6/2016 11:22 PM
36	I do and am currently in contact with Shoreline Public Works department regarding the issues on 26th Ave. I believe home to home education on prevention and possibly additional drain(s) would help the issues my neighbors and I have been experiencing. Please note that my answers for # 7 are neutral, as I am not familiar yet with the storm water services, but would like and now plan to be. Thank you for asking! :)	9/6/2016 10:27 PM
37	Cover or enclose ditches to prevent overflow. Upgrade to larger stormwater runoff pipes. With all of the new construction in our area, there is more cement, fewer trees and shrubs to absorb the water so the entire system needs to be enlarged to handle the increased flow that does not absorb into the ground. Water retention and detention systems in new developments should be a requirement and the developers should pay for them as well as for upgrades to the surrounding communities/neighbors/and down stream stormwater systems.	9/6/2016 6:49 PM
38	Question 7 is difficult to answer as I have had no personal experience or interaction with the stormwater services. Question 8 is problematic in that some of the responses rank equally and are not necessarily more important than the other. I would rank them all fairly high and would assume that they go hand in hand.	9/6/2016 6:10 PM
39	No	9/6/2016 3:27 PM
40	Have neighborhoods take responsibility for their storm drains	9/6/2016 3:00 PM
41	My heavens, you have gone too far with questions 7 & 8.	9/6/2016 2:42 PM
42	No	9/6/2016 2:40 PM
43	Bury all the open ditches and cover drain pipes with sidewalks.	9/6/2016 1:32 PM
44	How does under ground water effect storm water especially with new construction digging foundation walls that block under ground water paths. Is this what is creating the water table to rise?	9/6/2016 12:47 PM
45	If there is an issue on my street again I will never talk to city about it in fear that crews will come and destroy property while making things worse.	9/6/2016 11:58 AM
46	Someone should survey drainage ditches during rainstorms. If the ditch is not in use (i.e., no water flowing through it) then the ditch should be covered for pedestrian safety.	9/6/2016 11:48 AM
47	Not the biggest issues the city faces. drug use, homeless, crime are much more of a concern than a little water a few times of the year. If folks get off their ass and clean up the drains and such already in place, much of this can be eliminated.	9/6/2016 11:38 AM
48	Don't raise property taxes to cover more city expenses. You're impacting property owners in Shoreline. Please keep it affordable to live and work here.	9/6/2016 11:38 AM
49	plans for lowering lake levels when necessary	9/6/2016 11:37 AM
50	Stay within the budget, and keep the drains clear.	9/6/2016 11:37 AM

51	Don't make all of your survey questions required. As someone who is new to Shoreline, I cannot accurately answer #6 yet. When you make every survey question required, you get more bad data.	9/6/2016 11:34 AM
52	A huge concern is the cost for infrastructure in Shoreline.	9/6/2016 11:34 AM
53	We need to be responsible for areas downstream from us - Lake Forest Park and North Seattle and not contribute to their surface water problems.	9/5/2016 11:23 PM

Public Survey:
Proposed management strategies
July 5-16, 2017

Q1 What neighborhood do you live in?

Answered: 141 Skipped: -1

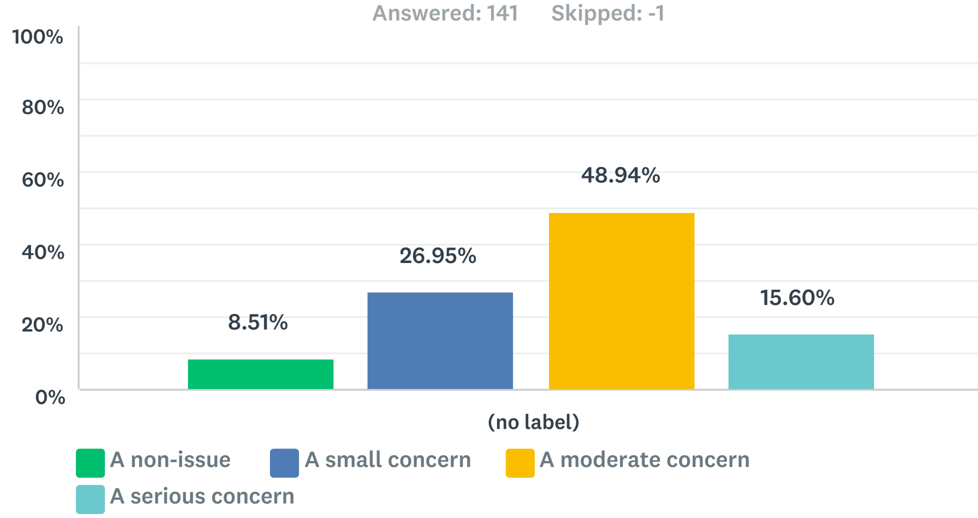


Answer Choices	Responses	
Richmond Beach	15.60%	22
Innis Arden	4.26%	6
The Highlands	0.71%	1
Highland Terrace	0.71%	1
Westminster Triangle	0.71%	1
Richmond Highlands	11.35%	16

Hillwood	11.35%	16
Echo Lake	8.51%	12
Meridian Park	9.22%	13
Parkwood	7.80%	11
Ridgecrest	12.77%	18
North City	12.06%	17
Ballinger	2.13%	3
Briarcrest	2.84%	4
Total		141

Q2 How would you rate stormwater issues in the City of Shoreline as a whole?

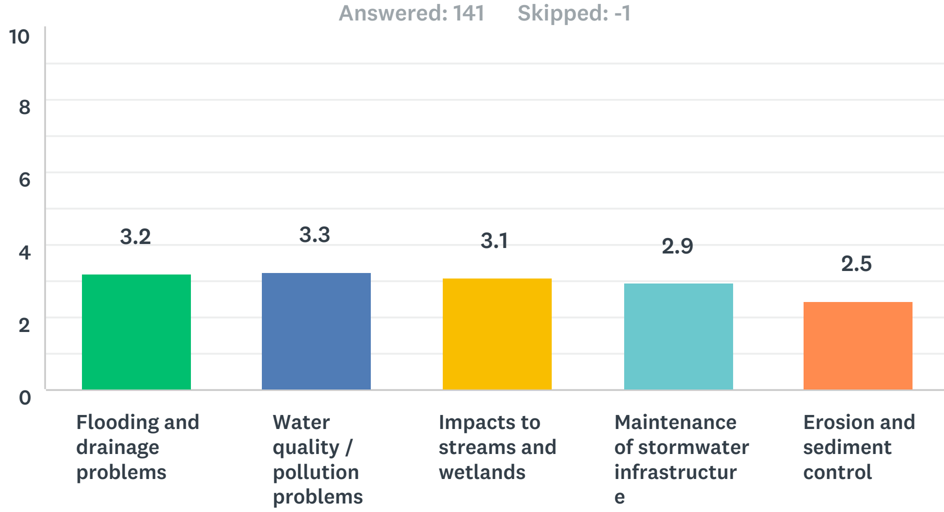
Answered: 141 Skipped: -1



	A non-issue	A small concern	A moderate concern	A serious concern	Total	Weighted Average
(no label)	**8.51%** 12	**26.95%** 38	**48.94%** 69	**15.60%** 22	141	2.72

Q3 Please rank your concerns regarding stormwater management. (Using 1 for most important and 5 for least important)

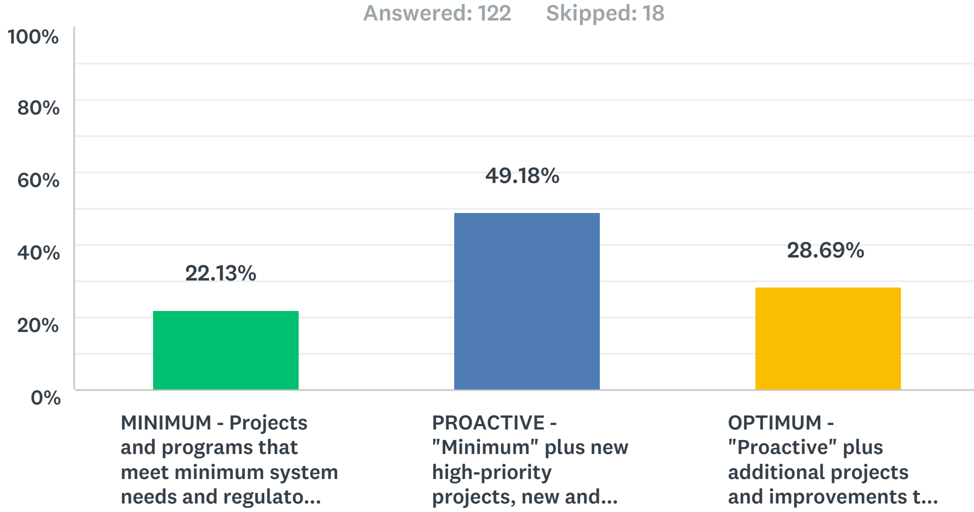
Answered: 141 Skipped: -1



	1	2	3	4	5	Total	Score
Flooding and drainage problems	**31.21%** 44	**19.15%** 27	**11.35%** 16	**15.60%** 22	**22.70%** 32	141	3.21
Water quality / pollution problems	**20.57%** 29	**27.66%** 39	**22.70%** 32	**16.31%** 23	**12.77%** 18	141	3.27
Impacts to streams and wetlands	**20.57%** 29	**21.28%** 30	**21.99%** 31	**21.28%** 30	**14.89%** 21	141	3.11
Maintenance of stormwater infrastructure	**17.02%** 24	**12.06%** 17	**32.62%** 46	**24.82%** 35	**13.48%** 19	141	2.94
Erosion and sediment control	**10.64%** 15	**19.86%** 28	**11.35%** 16	**21.99%** 31	**36.17%** 51	141	2.47

Q4 A key objective of the Master Plan is to identify improvements that will help the Utility meet levels of service that reflect the expectations of customers and that are appropriately in line with stormwater fees. What management level would you recommend for the stormwater strategy is you area?

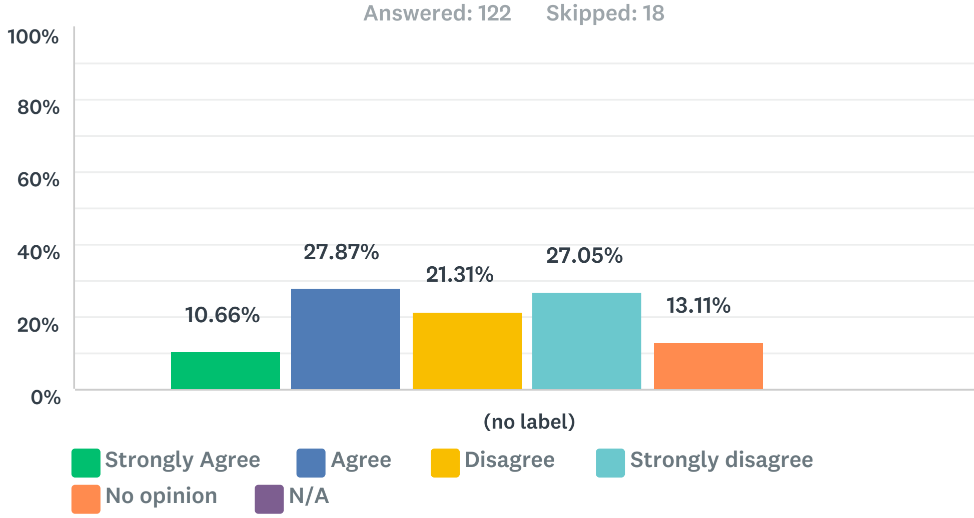
Answered: 122 Skipped: 18



Answer Choices	Responses	
MINIMUM - Projects and programs that meet minimum system needs and regulatory requirements	22.13%	27
PROACTIVE - "Minimum" plus new high-priority projects, new and enhanced on-going programs that address high priority long-term needs and anticipated regulatory requirements	49.18%	60
OPTIMUM - "Proactive" plus additional projects and improvements to address water quality and aquatic enhancement	28.69%	35
Total		122

Q5 To implement improvements of the City's stormwater management, the City should increase the existing stormwater fees to assist in the funding of the services provided.

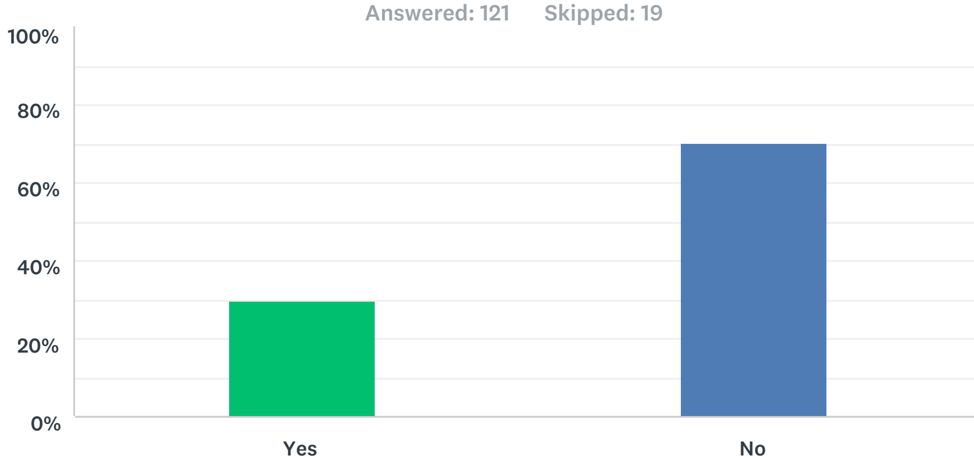
Answered: 122 Skipped: 18



	Strongly Agree	Agree	Disagree	Strongly disagree	No opinion	N/A	Total	Weighted Average
(no label)	10.66% 13	27.87% 34	21.31% 26	27.05% 33	13.11% 16	0.00% 0	122	2.39

Q6 Are you interested in volunteering or participating in any of the City of Shoreline stormwater management programs or activities?

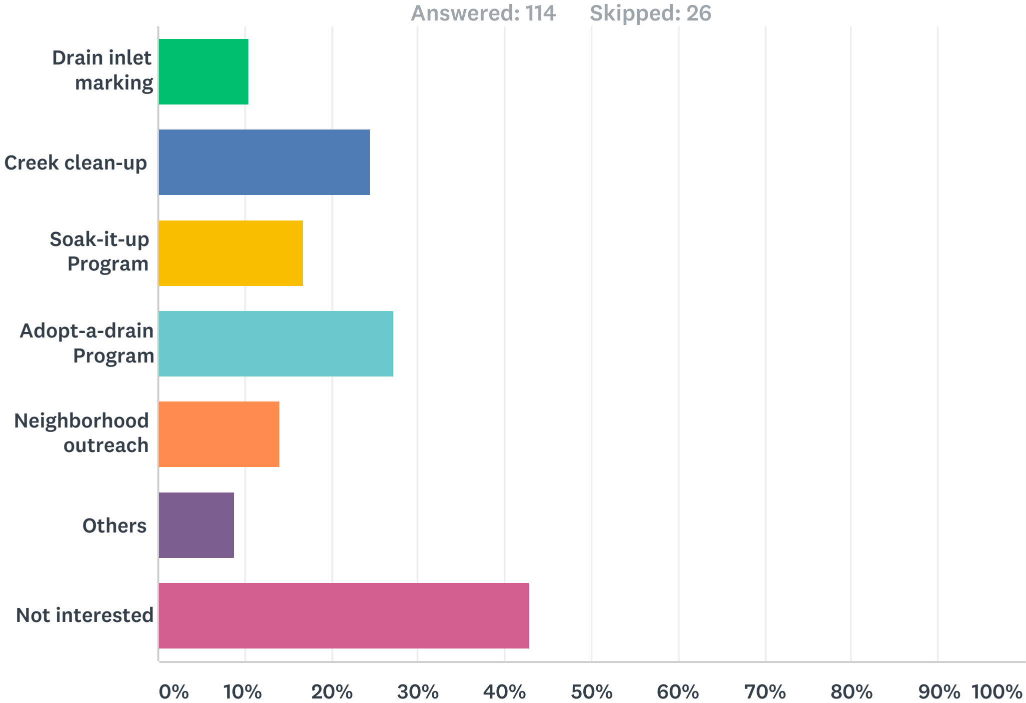
Answered: 121 Skipped: 19



Answer Choices	Responses	
Yes	29.75%	36
No	70.25%	85
Total		121

Q7 What kinds of programs are you interested in?

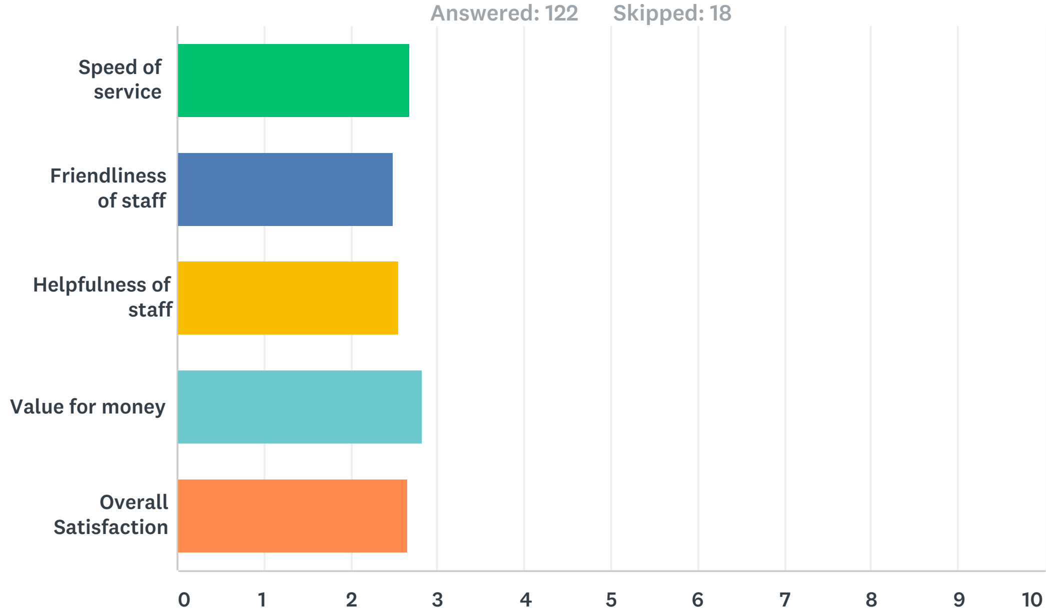
Answered: 114 Skipped: 26



Answer Choices	Responses	
Drain inlet marking	10.53%	12
Creek clean-up	24.56%	28
Soak-it-up Program	16.67%	19
Adopt-a-drain Program	27.19%	31
Neighborhood outreach	14.04%	16
Others	8.77%	10
Not interested	42.98%	49
Total Respondents: 114		

Q8 How satisfied are you with the following aspects of our stormwater services?

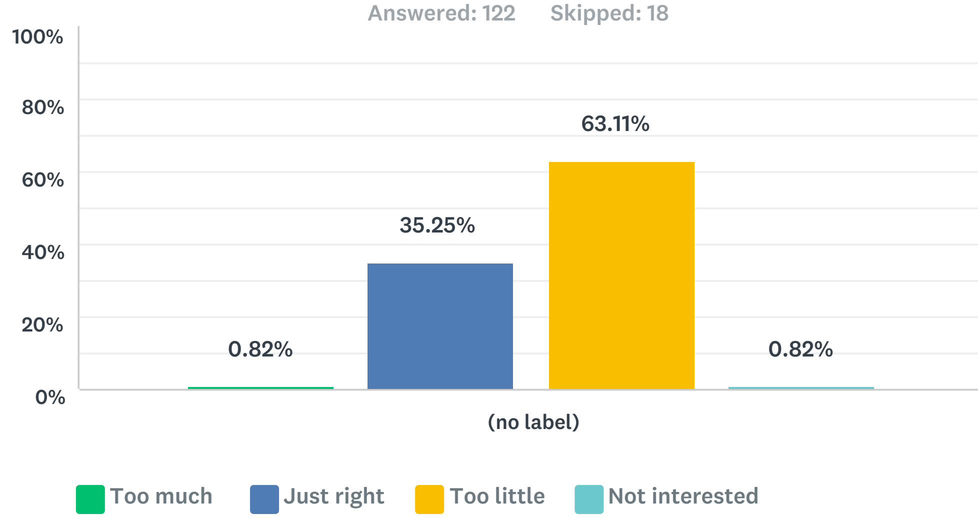
Answered: 122 Skipped: 18



	Very Satisfied	Somewhat Satisfied	Neither satisfied nor dissatisfied	Somewhat dissatisfied	Very Dissatisfied	Total	Weighted Average
Speed of service	19.01% 23	14.05% 17	53.72% 65	6.61% 8	6.61% 8	121	2.68
Friendliness of staff	25.21% 30	10.92% 13	56.30% 67	5.04% 6	2.52% 3	119	2.49
Helpfulness of staff	21.37% 25	13.68% 16	56.41% 66	5.98% 7	2.56% 3	117	2.55
Value for money	12.50% 15	17.50% 21	50.00% 60	15.00% 18	5.00% 6	120	2.83
Overall Satisfaction	13.93% 17	25.41% 31	46.72% 57	9.02% 11	4.92% 6	122	2.66

Q9 The amount of information I received about stormwater issues in the City of Shoreline is:

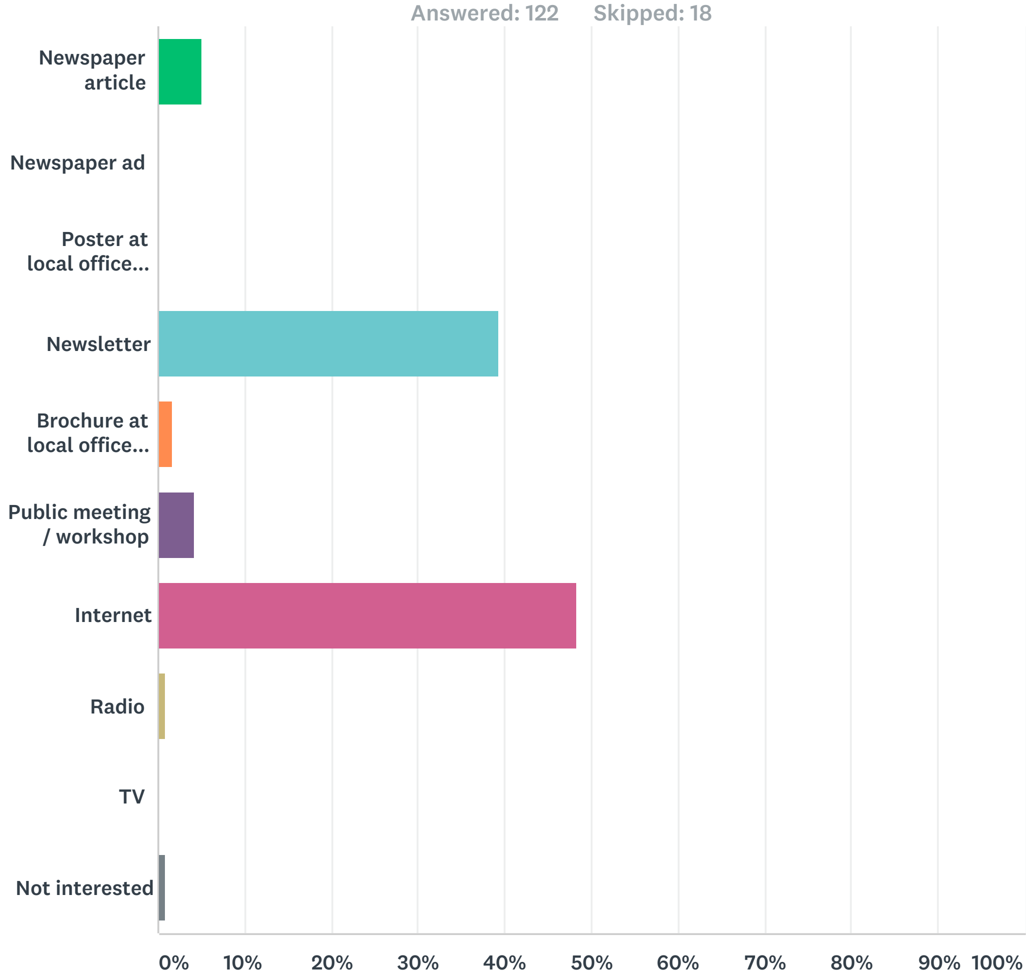
Answered: 122 Skipped: 18



	Too much	Just right	Too little	Not interested	Total	Weighted Average
(no label)	**0.82%** 1	**35.25%** 43	**63.11%** 77	**0.82%** 1	122	2.61

Q10 What is the best way to inform you about stormwater issues?

Answered: 122 Skipped: 18



Answer Choices	Responses	
Newspaper article	4.92%	6
Newspaper ad	0.00%	0
Poster at local offices or businesses	0.00%	0
Newsletter	39.34%	48
Brochure at local offices or businesses	1.64%	2
Public meeting / workshop	4.10%	5
Internet	48.36%	59
Radio	0.82%	1
TV	0.00%	0
Not interested	0.82%	1
Total		122

Q11 Do you have any additional stormwater service concerns or suggestions?

Answered: 43 Skipped: 97

#	Responses	Date
1	It does not appear that the City is implementing enough complete the streets projects that would offer opportunity to improve stormwater. In general, stormwater has the appearance of being a low priority of the City. Connecting it with transportation may be a way to get more support and complete more projects.	7/18/2017 11:39 AM
2	Our neighborhood smells of sewage several times a year. The City is worthless when contacted about flooding or drainage and does nothing to maintain the infrastructure. You make too many regulations, try and restrict property owners' use of their property, but you have neglected basic maintenance, like drains and grading of roads, that would solve the problem without stupid restrictions on how much of your land can be covered with something you consider permeable. Very unhappy with my City about this. And no taxing me more is not the answer. Do your jobs with the money already paid you.	7/15/2017 5:42 PM
3	The trees along Meridian Ave. N are contributing to blockage of drains every Fall as leaves clog things up. They are plainly and simply too large.	7/15/2017 12:02 PM
4	more public land needs to be converted into wetlands. Buy the Dargey property (former Denny triangle) and make that into a wetland to absorb all the runoff from the Sears-Central Market complex.	7/15/2017 11:54 AM
5	No	7/15/2017 11:24 AM
6	Stormwater should be filtered before reaching the sound.	7/15/2017 7:59 AM
7	Put a moratorium on building permits inside the two planned action rezones until you have done a lot by lot examination of the surface water infrastructure in those areas, made the necessary repairs to the system needed to support current use and determine the cost and who will pay for the upgrade needed to support the redevelopment under the new zoning. This must include notifications to the property owners and opportunities for the public in Shoreline to participate in a review of any redevelopment before the permit applications can be approved.	7/15/2017 7:53 AM
8	Create an educational program for elementary students	7/15/2017 7:36 AM
9	Yes, we have drains in the 155th to 160th and people don't keep them free of debree	7/15/2017 6:22 AM
10	We all pay the bill, but most people don't really know what you do or how it affects us. We don't see you around the neighborhood, just know where your office is.	7/15/2017 6:15 AM
11	City of Shoreline's monthly "Channels" newsletter is the best way to inform citizens of issues. I believe additional fees on new construction and subdivision of existing lots is the best way to obtain more funding. It is paving over additional ground that causes additional problems. This option was not given. I think this is a poor survey.	7/15/2017 5:33 AM
12	The outlet from Echo Lake gets clogged in storms. The water backs up in the lake and threatens lakeside condos. A neighbor used to clean the drain in storms but he moved. Now no one is maintaining it.	7/14/2017 11:57 PM
13	thanks	7/14/2017 11:20 PM
14	Not at this time.	7/14/2017 9:37 PM
15	It is important to remind people that stormwater drainage carries whatever toxins are in the environment into the lakes, streams and the Salish Sea. Also, and consequently, that we should all be very careful with our use of chemicals, motor oil, and other pollutants, and should avoid pesticides and herbicides whenever possible.	7/14/2017 9:06 PM
16	I feel badly that I am a poorly informed on these issues	7/14/2017 9:05 PM
17	Live on 25th border to Lake Forest Park - drain way below street level; paving driveways above has caused more runoff, drain way below street level in gravel driven on all the time	7/14/2017 8:53 PM
18	adopt & enforce low impact development	7/14/2017 8:26 PM

19	You made me spend nearly $100,000 to handle my own stormwater. I should get a break on fees as a result.	7/14/2017 8:15 PM
20	Not at this time.	7/14/2017 7:58 PM
21	Maintain what we have	7/14/2017 6:29 PM
22	The ranking of the 1-5 priorities is difficult because all of the choices should be number 1 with proper maintenance flooding is easier to control the water makes it through the treatment plan lessening the pollution but all the other choices are equally important with multiple points for each	7/14/2017 6:23 PM
23	The people who build homes in vulnerable locations are the ones who should pay for any infrastructure upgrades. There should be a fee for new home builds to pay for those impacts.	7/14/2017 5:45 PM
24	Cost is too high.	7/14/2017 5:01 PM
25	Don't dismiss the concerns of constituents.	7/14/2017 4:57 PM
26	No	7/14/2017 4:44 PM
27	There needs to be better maintenance of city built raingardens.	7/14/2017 4:42 PM
28	With new development on 8th Ave NW I have flooding in my back yard during heavy rain. I did not have this prior to the new homes on 8th	7/14/2017 4:36 PM
29	Did not realize we were having issues with this.	7/14/2017 4:21 PM
30	Several of the priorities you list above are inter-related not either/or concerns. If we have proper storm drain infrastructure, it lessens the impact of runoff in terms of flooding, landslides, pollution, etc. We know Point Wells, for example, is in a dangerous Osso-like slide area, and yet the City of Shoreline supports it. My basement has flooded twice in the last seven years (after no flooding since 1987) because of lax Shoreline policies. This shows great disregard and disrespect for Shoreline residents.	7/14/2017 4:20 PM
31	Monitor drainage with new/recent construction. Create buffers.	7/14/2017 4:19 PM
32	you need to be WAY more proactive in explaining what you do and why - not many people even know there is a stormwater utility at all...	7/14/2017 4:18 PM
33	The fees went up and I still have a flood zone in front of my house	7/14/2017 4:14 PM
34	No	7/13/2017 6:03 PM
35	people dumping stuff into protected creeks and storm drains	7/12/2017 11:23 AM
36	At the end of 197th Place off of Wallingford there is flooding every fall and winter. Wish we could correct this. There is a drain on the north side of the street and we keep it clear but it does not help.	7/9/2017 10:28 AM
37	Good Job. Don't let the city screw it up!	7/6/2017 9:26 PM
38	Let's not find a way to raise taxes or fees, please.	7/6/2017 8:47 AM
39	Concern: every new construction project increases stormwater issues in neighboring properties as there is little to no requirement for proper stormwater management.	7/5/2017 9:12 PM
40	I don't know what the issues are. Maybe when sending the survey you also send a link to inform is with more details so we can make informed decisions. I might appro e higher fees if I knew what it would be used for and why money is needed. Everyone's out for more money but can't articulate why.	7/5/2017 4:37 PM
41	I think a there should be more of a focus on perpetual problems (that are perhaps gray areas, as in ours or theirs?), for example, the constant clogged drain and resulting flood-puddle at 145th St and 1st on the Seattle Golf Club side of the road. Just fix it!	7/5/2017 1:54 PM
42	My neighbors are I would like to see ditches/ROW paved over with sidewalks on 12th Ave NE between NE 145th St and NE 155th St	7/5/2017 1:52 PM
43	The wonderful raingarden at the northeast corner of N. 188th and Linden Ave N is threatened by developement. It would be a waste of resources to remove this effective project. It could so easily connect to a garden pathway along Firlands Way.	7/5/2017 1:43 PM

Appendix B: SEPA Checklist [PLACEHOLDER]

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Appendix C: Condition Assessment Management Plan

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Surface Water Utility Asset Condition Assessment Management Plan

Prepared for

City of Shoreline, Washington

July 31, 2017

Surface Water Utility Asset Condition Assessment Management Plan

Prepared for

City of Shoreline, Washington

July 31, 2017

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List of Abbreviations

AMWP	Asset Management Work Plan
BC	Brown and Caldwell
ATR	alternative technology recommendations
CAMP	Condition Assessment Management Plan
CCTV	closed-circuit television
CIP	capital improvement program
CIPP	cured-in-place pipe
City	City of Shoreline
Consultant Team	Brown and Caldwell and FCS Group
CP Tool	Criticality and Prioritization Tool
DR	ditch recommendation
FCSG	FCS Group
ft	foot/feet
GIS	geographic information system
ID	identifier
in.	inch(es)
in.^{2}	square inch(es)
LFR	LID facility recommendation
LID	low-impact development
MACP	Manhole Assessment and Certification Program
Master Plan	Surface Water Master Plan
NASSCO	National Association of Sewer Service Companies
NPDES	National Pollutant Discharge Elimination System
O&M	operations and maintenance
OAR	other asset recommendation
OR	overall recommendations
PACP	Pipeline Assessment Certification Program
PLC	programmable logic controller
PR	pipe recommendation
PSR	pump station recommendation
QSR	quick score
R&R	rehabilitation and replacement
SCADA	supervisory control and data acquisition
SPR	rating score
SPRI	index score
SR	structure recommendation
Utility	Surface Water Utility
WSDOE	Washington State Department of Ecology

Section 1

Introduction

Brown and Caldwell (BC) and FCS Group (FCSG) (collectively referred to as the “Consultant Team”) are working with the City of Shoreline (City) to prepare an updated Surface Water Master Plan (Master Plan) for the Surface Water Utility (Utility) that will address drainage and water quality issues associated with growth, increasing regulations, and aging infrastructure. The Master Plan will guide Utility activities for the next 5 to 10 years, and will include recommendations for capital improvement projects, policies, capital improvement programs (CIPs), and a financial plan for long-term asset management.

1.1 Purpose

This Condition Assessment Management Plan (CAMP) will assist the Utility in developing its condition assessment program by reviewing data, approaches, and activities, and providing recommendations for asset management-based condition assessment. The recommended processes were developed in coordination with other Master Plan efforts including the Asset Management Work Plan (AMWP), Operations and Maintenance (O&M) Manual, and CIP development. As the Utility advances its asset management program, improvements to the condition assessment process will provide information that is key to Utility O&M and asset rehabilitation and replacement (R&R) planning. Asset maintenance (e.g., inspection and cleaning) and R&R programs keep surface water assets functioning as intended to comply with National Pollutant Discharge Elimination System (NPDES) Phase II permit requirements (WSDOE 2014), meet the ratepayer anticipated level of service, and contribute to cost savings associated with the City’s asset management program.

The CAMP provides a planning-level analysis of consequence and probability of failure by reviewing inspection records and geographic information system (GIS) data. The summary information is not meant to replace the day-to-day decisions the O&M staff make about cleaning, repair, and replacement work orders. The summary information is meant to give an estimate of effort for future work overall, track condition of assets over time for efficiency trends and systemic problems, and help allocate resources.

The approaches, processes, and recommendations presented in this CAMP build on the Utility’s existing efforts for inspection, condition assessment, and R&R program development.

1.2 Approach and Process

This CAMP outlines an asset management-based condition assessment approach including standardized condition assessment scoring, asset criticality development and scoring, and risk management decision matrices. The approach is applied to eight Utility asset classes: (1) pipe, (2) catch basin, (3) manhole, (4) ditch, (5) permeable pavement, (6) bioretention, (7) swale, and (8) pump station. The approach includes the components described below.

Condition Assessment Scoring. The Utility prepares condition assessments for many assets based on inspection information. The condition assessment varies in rigor and recording. Pipe condition assessment scoring is recorded in the City’s GIS and is used for ranking pipes in the R&R program. The ditch condition assessment, on the other hand, is done in the field and is not recorded in GIS, and is used immediately to generate maintenance work orders. The existing condition assessment process is reviewed for the eight asset classes. Gaps are identified and new or updated condition assessment methods are proposed. Following the recommendation of the AMWP, condition scoring will be based on a 1 to 5 scale, where 5 is the poorest condition. The condition scoring methodologies are programmed in Excel, Cityworks, or GIS, and use inspection information that the Utility collects and stores in Access, Excel, Cityworks, or GIS.

Criticality Criteria Development and Assignment. Asset criticality is based on consequences of failure, and is assessed based on the following indicators (Consultant Team 2017):

- Financial consequences of unplanned failure (both internal and community costs)
- Environmental consequences
- Health and safety consequences
- Other service-level consequences

Criticality scoring helps to more efficiently focus repair efforts and reduce high-impact failure events. For instance, a small pipe failing in a residential neighborhood would likely be easier to repair and have less impact to the system than a large pipe underneath a major roadway that serves a hospital.

The Utility has not formally assigned criticality to its assets, but has included criticality criteria in its existing pipe condition assessment and implicitly with its NPDES-required O&M for catch basins and low-impact development (LID) facilities. A set of criticality criteria was developed for each of the eight asset classes, and was applied to give each asset per class a criticality score.

Risk Management Matrix Development and Application. A risk management matrix describes the relationship between condition assessment and criticality and assigns or prioritizes each asset into a risk management strategy (e.g., action or program) such as inspection, maintenance, and R&R. The Utility is currently implementing risk management strategies for pipes, structures, and LID facilities. The process proposed here standardizes risk management strategies and can be integrated with the existing processes over time. The asset management program elements, such as condition and criticality scoring, are integrated into the City's GIS.

1.3 Accompanying Processing Tools and Revised GIS Files

Several GIS programming tools and shapefiles were developed to perform the revised condition assessment approach for pipe, catch basin and manhole asset classes. All assets considered in the analysis are identified in GIS as active, owned, and operated by the City. The tools and files developed for the analysis are listed by asset below. Details on the tools and their use are included in Appendix A: Criticality and Prioritization Tool:

- For the pipe asset class, files include the Pipe Criticality and Prioritization Tool (PipeCPTool.tbx) and a modified copy of the surface water pipe GIS file (swPipePriority.shp).
- For the manhole asset class, files include the Manhole Criticality and Prioritization Tool (ManholeCPTool.tbx) and a modified copy of the catch basin GIS file (swmanhole.shp).
- For the catch basin asset class, files include the Catch Basin Criticality and Prioritization Tool (CatchBasinCPTool.tbx) and a modified copy of the catch basin GIS file (swcatchbasin.shp).
- For the ditch, permeable-pavement, bioretention, and swale asset classes, files include a modified copy of the associated GIS file (swDitch.shp, swPermPave.shp, swBioretention.shp, and swSwale.shp). The condition and criticality scoring and risk management matrix assignment for these asset classes was completed manually with a combination of Excel and GIS. The process can be automated with a simple GIS-based tool for each asset.

Section 2

Condition Assessment Approach

This section presents the approach taken to develop the condition assessment of the City's pipes, structures (e.g., catch basins and manholes), ditches, LID facilities, and pump stations. For each asset, the existing condition assessment process is reviewed and a new or revised condition assessment is presented where a gap is noted. Criticality scoring and risk management programs or actions are also presented for each asset. All numbers for each asset type are based on GIS information from January 2017 (City 2017). The City continuously updates the GIS database and the number presented may not be the most up to date.

2.1 Pipe

This section presents the approach taken for the condition assessment of pipes, including a condition assessment review, gap analysis, and update; criticality analysis; and risk management.

2.1.1 Condition Assessment Review, Gap Analysis, and Update

The Utility owns and maintains nearly 134 miles of stormwater pipe. As a part of the Utility basin planning work outlined in the 2011 Master Plan, the Utility has inspected pipes in six of the seven major drainage basins: Storm Creek, Boeing Creek, McAleer Creek, Lyons Creek, Puget Sound drainages, and Lake Washington (SAIC 2011). The Thornton Creek basin plan was completed before the 2011 Master Plan and did not include pipe inspection. The Thornton Creek basin pipe inspection is planned in the current 6-year CIP to begin in 2017.

Based on GIS data sets as of January 2017, the City has inspected nearly 44 percent of the length of pipes it owns and has prepared a pipe R&R program based on inspection information. The Utility has identified other pipe needs from inspection information such as pipe relocation to the right-of-way, removal of utility crossing, and intensive pipe cleaning.

City staff analysis of the existing-condition assessment program estimates that 37 percent of the pipes within the City-owned right-of-way have been inspected. Of the remaining 63 percent to be inspected, approximately half are in the Thornton Creek basin. Pipes in this basin are scheduled for initial inspection in 2017 and 2018. The remaining half of uninspected pipes are located within other basins and were not inspected due to access constraints, or have an incomplete inspection.

Visual pipe inspection is accomplished by a variety of methods that include simply looking into the end of a pipe (e.g., candling for pipes less than 25 feet) using a pole-mounted zoom camera, or using a closed-circuit television (CCTV) inspection device. Regardless of the inspection methodology used, the standard industry practice is to use the National Association of Sewer Service Companies (NASSCO) Pipeline Assessment Certification Program (PACP) methodology to conduct pipeline condition assessments. PACP procedures are a repeatable inspection process that documents the condition of the pipe in a standard fashion to allow the assessment of degradation over time and comparison of assets against each other.

The PACP methodology was applied to all pipes inspected. The Utility used three scoring procedures to summarize and rank condition assessments based on inspection information—quick score (QSR) [1], rating score (SPR) [2], and index score (SPRI) [3]—with the quick score being used to generate the rating score and the index score. The pipe condition assessment for the Boeing, Storm, Lyon, and McAleer creeks basins used the index score. While the quick score was used to develop the index score for these four basins, it was not retained in the Utility's condition assessment database. The quick score and rating score methods were used to assess pipes within the Puget Sound drainages and Lake Washington basins.

Condition Assessment Gap. The Utility has the following gaps in its pipe condition assessment methodology. Recommendations to close the gaps are included in Section 3:

- Post-inspection processing of PACP scores has not been consistently applied or recorded for inspected pipes. The quick score procedure is preferred because it ranks pipes based on the most severe defect value, but quick score is not available within GIS data for pipes assessed prior to 2016; these pipes were primarily evaluated by rating score and index score, which are less useful for prioritization.
- A spot-check of video and PACP scores revealed error in some PACP score recordings. For example, pipes with poor structural condition were scored with a low value (i.e., good condition) and pipes in good condition were scored with a high value (i.e., poor condition).
- Pipe condition assessment scoring is not updated in GIS or Cityworks when a pipe has been repaired or replaced.

Updated Condition Assessment. The updated condition assessment method uses the PACP scores recorded in GIS to generate a 1 to 5 score with a GIS-based tool[4], where 5 is the poorest condition. Because the PACP scoring method varies between two methods, the tool uses index scores where quick scores are not available. While combining the index scores and the quick scores is not ideal, combining the scores is necessary to generate enough data to make useful system-level recommendations.

Tables 2-1 and 2-2 show the distribution of pipe in structural and maintenance condition categories for all inspected pipes, respectively. A total of 16 percent of the pipes inspected have a structural condition rating of 4 or greater. A total of 12 percent of the pipes inspected have a maintenance condition rating of 4 or greater.

---

[1] Quick score is a 4-digit composite number indicating the count of the most severe and second-most severe defect. For example, 4513 means that the worst defect is a class 4 defect on a scale of 0 to 5 and has a count of five defects in this severity class, and the second-worst defect is a 1 on a scale of 0 to 5 and a count of three defects in this severity class.

[2] Rating score is the sum product of the quick score pair. For example, the rating score of quick score = 4513 = [4 * 5] + [1 * 3] = 23.

[3] Index score is the normalization of the rating score by dividing it by the sum of the count of the most and second-most severe defects, and rounded. Continuing with the example, a quick score of 4513 (rating score of 23) has an index score of 23 ÷ 5 = 4.6.

[4] Pipe condition scoring algorithm is part of a pipe risk management and prioritization tool that uses condition score, criticality score, and risk relationship matrix to categorize asset management level. The tool is a GIS-based program developed specifically for use with the Utility's swPipe.shp. The tool is provided electronically. The program logic and instructions are included in Appendix A.

Table 2-1. Pipe Structural Condition Score Distribution

Condition	Number of Pipe(s)	Percent of Pipe Length	Length of Pipe (ft)
5	278	9	28,038
4	214	7	22,036
3	343	11	33,553
2	446	13	41,026
1	2,398	60	183,568
Total	3679	100	308,221

ft = feet.

Table 2-2. Pipe Maintenance Condition Score Distribution

Condition	Number of Pipe(s)	Percent of Pipe Length	Length of Pipe (ft)
5	246	6	17,506
4	233	6	19,066
3	642	17	50,911
2	1,018	31	94,510
1	1,540	41	126,227
Total	3679	100	308,221

2.1.2 Criticality

Previous condition assessment efforts varied in the application of criticality criteria. For example, inspected and scored pipes in the Boeing Creek and Storm Creek basins did not include a formal criticality evaluation. The gap in pipe criticality information exists because of how the criticality information is used in the asset management process. The current pipe scoring methodology adds criticality information on top of a condition score to generate an overall pipe score. The proposed methodology keeps the condition and criticality separate and uses criticality to prepare strategies for risk management.

The purpose of criticality scoring is to rank assets based upon the potential consequences of failure. Criticality categories and point values are based on staff recommendations. This method is like other asset management-based approaches that include economic, environmental, and social equity impacts (NASSCO 2016). Categories used to rank pipe criticality are listed below. The criticality score for each pipe is the sum of the points assigned from each of the four categories, with a maximum of 5 points for pipes with high criticality. These values are assigned in the pipe risk management and prioritization tool (Appendix A) and recorded for each pipe in GIS:

- **Arterial pipes:** 2 points were assigned to this category for pipes intersecting or along arterial streets as defined in the City's GIS layer "Street"
- **Street crossings:** 1 point was assigned to this category for pipes crossing a street
- **Large-diameter pipes:** 1 point was assigned to this category for pipes with diameters greater than 12 inches (in.)
- **Miscellanea:** 1 point (total) was assigned to this category for pipes with any of the following characteristics:

- Slope is greater than 23 percent (a value previously used by the City; this can be modified as necessary). Vertical information in GIS is extremely limited.
- Lies within a flood, slide, or erosion hazard area, as defined by King County GIS information.
- Conveys streamflow (as defined by the City's GIS information).
- Serves a critical infrastructure parcel. Critical infrastructure parcels are those that have been developed to contain hospitals, schools, fire stations, police stations, public health clinics, and solid waste facilities. Other critical infrastructure parcels that can be added include critical public facilities such as utility power stations, maintenance yards or operation centers, and existing areas of high-density and/or high-growth potential.

Table 2-3 shows the distribution of criticality scores for City-owned pipes. A total of 14 percent of the City-owned pipes have a criticality score of 4 or greater.

Table 2-3. Pipe Criticality Scores

Criticality	Number of Pipe(s)	Percent of Pipe Length	Length of Pipe (ft)
5	238	4	26,310
4	830	10	72,453
3	2,425	25	178,749
2	1,456	15	107,305
1	5,112	46	323,823

2.1.3 Risk Management

Pipes with a condition and criticality score are categorized and prioritized into five risk management programs (see Figure 2-1). A condition score of 4 distinguishes between pipes that will be considered for the R&R program and continued inspection.

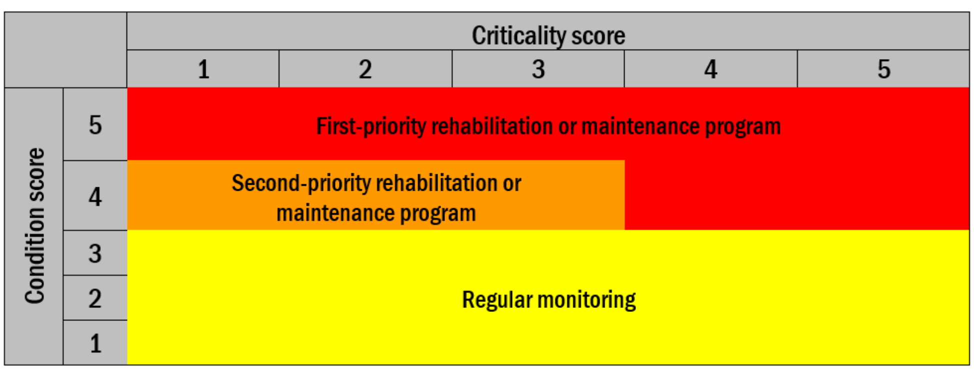

Figure 2-1. Pipe risk management matrix

The pipe risk management prioritization matrix is a part of the algorithms from the pipe prioritization tool (see Appendix A). These values are assigned in the pipe risk management and prioritization tool and recorded for each pipe in GIS. The tool may be used to reassess risk management and pipe priority once additional assets are inspected or repairs are completed.

The following are brief descriptions of the risk management levels and recommended actions:

- **First-priority rehabilitation or maintenance program:** Assets that receive a condition rating of 5 regardless of criticality, and assets that receive a condition rating of 4 and criticality rating of 4 and 5, are placed at the highest priority for the R&R program. These assets have a high probability of failure, present the potential for flooding, and could create a major disruption in service and detrimentally impact the environment and/or public if not rehabilitated in the near term.
- **Second-priority rehabilitation or maintenance program:** Assets that receive a condition rating of 4 and criticality rating of 1, 2, or 3 will be given second priority in the R&R program. These assets are likely to continue to deteriorate and require attention in the foreseeable future. These should be scheduled for rehabilitation as soon as the first-priority assets have been addressed.
- **Regular monitoring:** The assets in the regular monitoring category are typically in serviceable condition (condition rating of 3 or less). Regular monitoring periods vary per agency and flow type (e.g., sewer versus surface water); however, a typical inspection frequency for surface water infrastructure is 10 to 20 years. A 20-year inspection cycle is recommended for this Utility.

Table 2-4 presents the distribution of pipes per risk management category. A total of 16 percent of pipes are assigned to the first- or second-priority R&R program. The pipe segment risk management action shown in the "Action" column of Table 2-4 is included in the accompanying GIS shapefile (sw PipePriority.shp) in the "ConditionR" field. (A value of "A" in the "ConditionR" field represents "first-priority rehabilitation or maintenance program.")

Table 2-4. Pipe Risk Management Distribution

Action	Number of Pipe(s)	Percent of Pipe Length	Length of Pipe (ft)
First-priority rehabilitation or maintenance program	308	10	31,073
Second-priority rehabilitation or maintenance program	184	6	19,001
Regular monitoring	3,187	84	258,148

Because all pipes have a criticality value, pipes without inspection or with an incomplete inspection can be prioritized for inspection based on criticality and included in an inspection and monitoring program. Based on GIS data as of January 2017, 56 percent of pipes do not have inspection information. Approximately 33 percent are in the Thornton Creek basin, where the inspection program has not yet been implemented. The remaining 23 percent of pipes uninspected, or incomplete inspection pipes, are located within basins where the pipe inspection program has been implemented. The pipes were not inspected because of debris or structural blockage or access issues. These pipes will require maintenance and access resolution prior to inspection. Table 2-5 shows the criticality distribution of pipes that are 12 inches diameter or greater, and requiring maintenance and access resolution prior to inspection.

Table 2-5. Criticality Distribution of Uninspected/No Data Pipes, Excluding Thornton Creek

Criticality	Number of Pipe(s)	Percent of Pipe Length	Length of Pipe (ft)
5	52	4	5,123
4	160	8	10,510
3	503	24	29,715
2	415	21	25,883
1	1,030	43	52,710

2.2 Structures: Catch Basin

This section presents the approach taken to develop the condition assessment of catch basins, including a condition assessment review, gap analysis, and update; criticality analysis; and risk management.

2.2.1 Condition Assessment Review, Gap Analysis, and Update

The City owns and maintains 7,461 catch basins. The inspection and maintenance of catch basins and inlets is required by the Utility's Phase II NDPES permit. The Utility inspects its catch basins every other year and performs necessary maintenance within 6 months of inspection based on the exceedance of the maintenance standard. Condition assessment occurs during the inspection recording processes. Data are pulled from the inspection templates, and work orders for repair and replacement are created in batches based on failures and combinations of failures. As of January 2017, approximately 91 percent of the catch basins have inspection information stored in Cityworks from routine inspections. A modified Manhole Assessment and Certification Program (MACP)-based inspection for catch basins was developed and implemented during the preparation of the *Puget Sound and Lake Washington Drainage Plan* (AltaTerra 2015). While the inspections of the catch basin in these basins were recorded following MACP procedures, no MACP condition score was developed because the data could not be read by NASSCO MACP condition-rating software. Because most of the City's catch basins are inspected with the Cityworks inspection template method, this information was used to develop a condition assessment score.

Table 2-6 shows the Utility's condition rating methodology for catch basins. The scoring and weights are programmed directly into Cityworks and produce a 0 to 100 condition assessment score.

Table 2-6. Catch Basin Condition Assessment Rating Methodology

Criterion	Result	Explanation	Score	Weight
Frame/slab	Fail	Holes larger than 2 in.^{2} or cracks larger than 1/4 in.	2	2
	Concern	Holes between 1 and 2 in.^{2} or cracks greater than 1/8 in. and less than 1/4 in.	1	
	Pass	No holes larger than 1 in.^{2} and cracks larger than 1/8 in.	0	
Walls/bottom	Fail	Judgment that structure is unsound and needs immediate R&R; function of basin is severely compromised	2	4
	Concern	Judgment that there are structural issues but basin is functioning; may need minor repair	1	
	Pass	No structural issues; function of basin is sound	0	
Grout fillet (pipe–wall)	Fail	Crack greater than 1/2 in. and longer than 1 ft with evidence of sediment entering	2	3
	Concern	Cracks between 1/4 in. and 1/2 in. and length less than 1 ft with no evidence of sediment entering	1	
	Pass	Crack less than 1/4 in. and less than 1 ft length with no evidence of sediment entering	0	
Ladder	Fail	Missing rungs, rust, cracks, sharp edges	1	1
	Pass	No missing rungs, rust, cracks, sharp edges	0	
Grate/cover	Fail	Unable to open, missing, and/or broken	1	1
	Pass	Able to open, present, and intact	0	
	Pass	Can locate	0	

in.^{2} = square inches.

The condition score is the percent of the total score possible. In Table 2-6, the total points possible is (2*2) + (2*4) + (2*3) + (1*1) + (1*1) = 20. A catch basin with a score of 20 out of 20 possible points has a condition score of 20/20 or 100 percent, as simplified in Cityworks as a score of 100.

The current condition assessment system provides a 0 to 100 condition score instead of the recommended 1 to 5 scale, where 5 is the poorest condition. Maintenance-related items like sediment, debris blockages, trash, and debris are not used to calculate the condition score, as these items do not affect the structural condition of the catch basin. The City documents catch basins that require cleaning in a parallel process. The City does not currently inspect and clean catch basins at the same time.

In the current rating system (Cityworks), catch basins that have a null value have no recorded inspection information and catch basins that have been inspected and are in perfect condition have a condition score of zero. Transferring data between platforms and running programming scripts on null and zero values can process null and zero condition scores to the same value or null or zero. It is recommended that catch basins that have been found to be in perfect condition receive a condition score of 1 to distinguish these assets from the null value.

Once catch basins have been repaired, it is important to reset the condition score to 1 or other appropriate value based on the extent of the repairs and the original condition of the catch basin. Current high condition scores in the database may not be the actual number of catch basins that require repair. Many of the worst catch basins on the priority list have likely been repaired; however, the updated condition has not been documented to be reflected this in this analysis.

For evaluation and prioritization, the existing catch basin 0 to 100 scores were translated into a 1 to 5 score where 5 is the poorest condition to be consistent with other assets. The breakdown to develop the 1 to 5 score is shown in Table 2-7. In addition to the condition score, the City maintains a priority list of catch basins that—per NPDES permits—require immediate attention. These catch basins were assigned a condition score of 100 (i.e., 5).

Table 2-7. Catch Basin Condition Score Translation

0–100 Score Range	1–5 Score
0–19	1
20–39	2
40–59	3
60–79	4
80–100	5

The condition score of catch basins not inspected/with no data was set to zero to quickly identify catch basins that either have not been inspected, or for which no data were available. The results of the condition assessment are presented in Table 2-8.

Table 2-8. Catch Basin Condition Scores

Condition	Number of Catch Basins	Percent of Catch Basins
5	51	0.7
4	35	0.5
3	86	1.2
2	607	8.1
1	5,982	80.2
0	700	9.4
Total	7,461	100.0

2.2.2 Criticality and Risk Management

Catch basins are assigned criticality based on the highest-rated criticality of the connecting pipe. For example, if a catch basin has two connecting pipes and one has a criticality of 2 and the other has a criticality of 4, the catch basin is assigned a criticality of 4. Thus, the distribution of criticality for catch basins is like that of pipes. The distribution of results of the criticality assessment is presented in Table 2-9. A total of 14 percent of catch basins have a criticality score of 4 or greater.

Table 2-9. Catch Basin Criticality Scores

Criticality	Number of Catch Basins	Percent of Catch Basins
5	242	3
4	827	11
3	2,058	28
2	1,157	16
1	3,177	43

Catch basins with a condition and criticality score are categorized and prioritized into three risk management programs (see Figure 2-2). The results of the prioritization are shown in Table 2-10.

Based on the Utility's NPDES Phase II permit, regular monitoring means that catch basins are inspected every other year. The NPDES Phase II permit also requires that failing catch basins be repaired or replaced within 6 months of inspection. Catch basins with a condition score of 5 are those that require repair or replacement within 6 months to meet NPDES requirements. Catch basins with a condition score of 4 should also be scheduled for repair or replacement, but may not have to be repair or replace within 6 months. Ultimately the catch basin inspector evaluates the catch basin condition during the inspection and determines with the inspection form entries if the catch basin should be cleaned, repaired, or replaced within the 6 months.

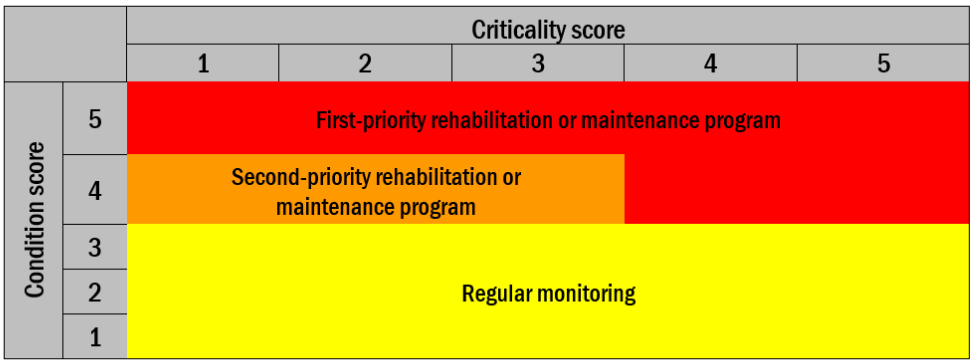

Figure 2-2. Catch basin risk management matrix

Table 2-10. Catch Basin Prioritization

Action	Number of Catch Basins	Percent of Catch Basins
First-priority rehabilitation or maintenance program	52	0.7
Second-priority rehabilitation or maintenance program	34	0.5
Regular monitoring	6,675	89.0
Not inspected/no data	700	9.0

Based on its NPDES requirement, the City must repair or maintain catch basins within 6 months of inspection. In a spot-check of several asset identifiers (IDs) for first-priority rehabilitation catch basins, the basins have all received maintenance per Cityworks. It is likely that many of the catch basins identified for repair as part of this analysis have already been corrected. The method identified here can be used moving forward. An important part of this process is to reset the condition score to 1 following corrective action.

2.3 Structures: Manhole

This section presents the approach taken to develop the condition assessment of manholes, including a condition assessment review, gap analysis, and update; criticality analysis; and risk management.

2.3.1 Condition Assessment Review, Gap Analysis, and Update

The City has 736 active manholes[5] in its GIS manhole asset feature class. Manholes are inspected if they are part of one of the Utility's annual commercial, park, or right-of-way inspection programs. The

[5] Some records in the City's manhole asset class are Type II catch basins.

City has an inspection form and algorithm to turn the inspection information into a 0 to 100 condition score. However, the condition algorithm has not been programmed or applied in Cityworks. At the time of the data gathering for this work (January 2017), no manholes had a condition assessment score associated with them in Cityworks/GIS. All accessible manholes within the Puget Sound drainages and Lake Washington basins were inspected as part of the Puget Sound Drainages Basin Plan project in 2016. In this effort, manholes were inspected with the MACP system.

While NASSCO has a condition assessment scoring system for manholes, the data collected in the Puget Sound drainages manhole and catch basin inspections were not recorded using a method that could be read by NASSCO MACP condition-rating software to develop a condition score. Because of this lack of information, no condition assessment was completed on manholes using the MACP-style inspection. A condition assessment was completed, similar to catch basins, using the inspection data stored in Cityworks and implementing the City's scoring methodology.

Table 2-11 shows the Utility's condition rating methodology for manholes. The scoring and weights are programmed directly into Cityworks and produce a 0 to 100 condition assessment score.

Table 2-11. Manhole Condition Assessment Rating Methodology

Criterion	Result	Explanation	Score	Weight
Frame/slab	Fail	Holes larger than 2 square inches or cracks larger than 1/4 inch	2	2
	Concern	Holes between 1 and 2 inches or cracks greater than 1/8 inch and less than a 1/4 inch	1	
	Pass	No holes larger than 1 square inches and cracks larger less than 1/8 inch	0	
Walls/Bottom	Fail	Judgment that structure is unsound and needs immediate repair or replacement; function of basin is severely compromised	2	4
	Concern	Judgement that there are structural issues but basin is functioning; may need minor repair	1	
	Pass	No structural issues; function of basin is sound	0	
Grout Fillet (Pipe to Wall)	Fail	Crack > 1/2inch and longer than 1 foot with evidence of sediment entering	2	3
	Concern	Cracks between 1/4 inch and 1/2 inch and length less than one foot with no evidence of sediment entering	1	
	Pass	Crack < 1/4inch and less than 1 ft length with NO evidence of sediment entering	0	
Ladder	Fail	Missing rungs, rust, cracks, sharp edges	1	1
	Pass	No missing rungs, rust, cracks, sharp edges	0	
Grate/Cover	Fail	Unable to open, missing, and/or broken	1	1
	Pass	Able to open, present, and intact	0	

The condition score is the percent of the total score possible. In Table 2-11, the total points possible are (2*2) + (2*4) + (2*3) + (1*1) + (1*1) = 20. A manhole with a score of 20 out of 20 possible points has a condition score of 20/20 or 100 percent, as simplified in Cityworks as a score of 100.

The current condition assessment system provides a 0 to 100 condition score instead of the recommended 1 to 5 scale, where 5 is the poorest condition. Maintenance-related items like sediment, debris blockages, trash, and debris are not used to calculate the condition score, as these items do not affect the structural condition of the manhole. The City documents manholes that require cleaning in a parallel process.

In the current rating system (in Cityworks), manholes that have no data (i.e., have not been inspected) and manholes that have been inspected and are in perfect condition both have a condition score of zero. It is recommended that inspected manholes receive a condition score of 1 to distinguish these assets.

Once manholes have been repaired, it is important to reset the condition score to 1 or other appropriate value based on the extent of the repairs and the original condition of the manhole. Current high condition scores in the database may not be the actual number of manholes that require repair. Many of the worst manholes on the priority list have likely been repaired; however, the updated condition has not been documented to be reflected this in this analysis.

For evaluation and prioritization, the existing manhole 0 to 100 scores were translated into a 1 to 5 score to be consistent with other assets, where 5 is the poorest condition. The breakdown to develop the 1 to 5 score is shown in Table 2-12.

Table 2-12. Manhole Condition Score Translation

0–100 Score Range	1–5 Score
0–19	1
20–39	2
40–59	3
60–79	4
80–100	5

The condition score of manholes not inspected/with no data was set to zero to identify manholes that either have not been inspected or for which no data were available. The results of the condition assessment are presented in Table 2-13.

Table 2-13. Manhole Condition Scores

Condition	Number of Catch Basins	Percent of Catch Basins
5	0	0
4	0	0
3	0	0
2	0	0
1	273	37
0	463	63
Total	736	100

2.3.2 Criticality and Risk Management

Manholes are assigned criticality based on the highest rated criticality of the connecting pipe. For example, if a manhole has two connecting pipes and one has a criticality of 2 and the other has a criticality of 4, the manhole is assigned a criticality of 4. Thus, the distribution of criticality for manholes is like that of pipes. The distribution of results of the criticality assessment is presented in Table 2-14. A total of 12 percent of manholes have a criticality score of 4 or greater.

Table 2-14. Manhole Criticality Scores

Criticality	Number of Catch Basins	Percent of Catch Basins
5	44	6
4	46	6
3	74	10
2	44	6
1	528	72

Manholes with a condition and criticality score are categorized and prioritized into three risk management programs (see Figure 2-3). The results of the prioritization are shown in Table 2-15.

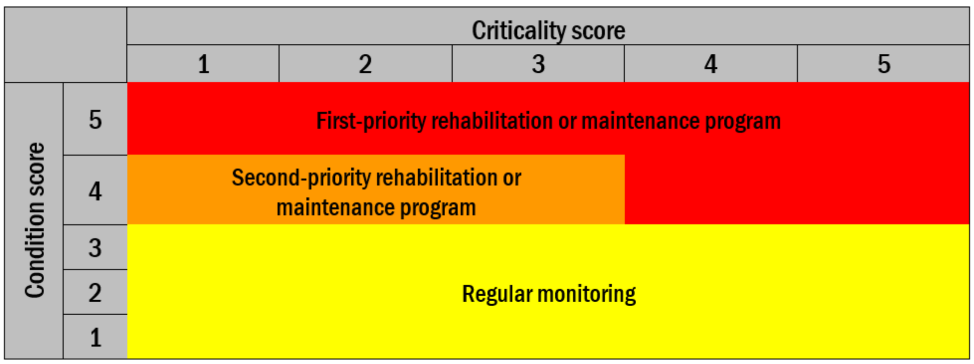

Figure 2-3. Manhole risk management matrix

Table 2-15. Manhole Prioritization

Action	Number of Catch Basins	Percent of Catch Basins
First-priority rehabilitation or maintenance program	0	0
Second-priority rehabilitation or maintenance program	0	0
Regular monitoring	273	37
Not inspected/no data	463	63

2.4 Ditch

This section presents the approach taken to develop the condition assessment of ditches, including a condition assessment review, gap analysis, and update; criticality analysis; and risk management.

2.4.1 Condition Assessment Review, Gap Analysis, and Update

The Utility completed a full circuit of ditch inspection and maintenance between 2008 and 2013. Beginning in 2014, ditches have been inspected and maintained every 3 years, with one third of the ditches inspected and maintained per year. Ditches are inspected in early summer and are typically maintained within 1 month of inspection. Approximately one quarter of the ditches inspected require maintenance. The inspection results are stored in Cityworks, but an overall condition assessment score is not recorded in Cityworks or GIS. The inspection results are used for the preparation of work orders for maintenance and repair by contract services.

A new condition rating methodology was developed from the Cityworks ditch inspection forms. The ditch asset has 10 pass/fail inspection criteria: (1) sediment, (2) vegetation, (3) contamination, (4) trash and debris, (5) inlet/outlet, (6) weir, (7) erosion, (8) cannot locate, (9) lateral connection, and (10) other. One gap in the inspection form is the observation for roadway drainage access to the ditch via the road shoulder. If vegetation or the shoulder slope prevent roadway runoff from entering the ditch, the ditch is not operating as intended and roadway flooding could occur at the road shoulder or low spot in the roadway down slope of the shoulder. It is recommended to include a pass/fail criterion based on the ability of water to travel from the adjacent road into the ditch. This additional category is added to the condition rating methodology.

In coordination with Utility staff, the five inspection criteria that directly relate to the functionality of the ditch include: (1) sediment, (2) vegetation, (3) inlet/outlet, (4) erosion, and (5) roadway drainage. In some instances, the comments provided in the "other" criterion contained information that indicated there was an impediment to water flow in the ditch. In these instances, the "other" field was used to assess the condition of the ditch. The condition rating methodology tracks the number failed items of the five key criteria. Table 2-16 shows the condition rating for the number of the five key failed criteria per inspection.

Table 2-16. Ditch Condition Rating Methodology

Number of Failed Criteria	Condition Rating
Not inspected/no data	0
0	1
1	4
2 or more	5
One of the following: erosion or roadway drainage	5

Ditches without inspection data were assigned a condition score of zero. The results of the criticality assessment are presented in Table 2-17. Approximately 28 percent of ditches have a condition score of 4 or greater.

Table 2-17. Ditch Condition Scores

Condition	Number of Ditches	Percent of Ditch Length	Length of Ditches (ft)
5	402	21	26,641
4	133	7	9,613
1	1,239	62	79,025
0	177	10	12,625
Total	1,951	100	127,904

2.4.2 Criticality and Risk Management

The ditch criticality assessment is similar to the assessment developed for pipes. Because ditch size is not provided in GIS, ditch criticality is not evaluated based on the quantity of flow conveyed. A future improvement could be to populate the ditch size in GIS, or use upstream pipe diameter as a proxy.

Categories used to rank ditch criticality include the following:

- **Arterial:** 2 points were assigned to this category for ditches intersecting or along (50-foot-wide buffer) arterial streets as defined in the City's GIS layer "Street."
- **Flood, slide, or erosion hazard area:** 1 point was assigned to this category for ditches intersecting flood, slide, or erosion hazard areas, as defined by King County GIS information.
- **Streamflow:** 1 point was assigned to ditches that intersect the City's "nfStreamBuffer" GIS layer.
- **Critical infrastructure parcel:** 1 point was assigned to ditches that are within 20 feet of critical infrastructure. Critical infrastructure parcels are those that have been developed to contain hospitals, schools, fire stations, police stations, public health clinics, and solid waste facilities.

The criticality score for each ditch is the sum of the points assigned from each of the four categories above, with a maximum of 5 points. The results of the criticality assessment are presented in Table 2-18. A total of 94 percent of ditches have a criticality score of 3 or less.

Table 2-18. Ditch Criticality Scores

Criticality	Number of Ditches	Percent of Total Ditch Length	Length of Ditch (ft)
5	2	0.2	300
4	33	5.8	7,405
3	103	8.0	10,430
2	326	20.0	25,357
1	1,487	66.0	84,412

Ditches with a condition and criticality score are categorized and prioritized into three risk management programs (see Figure 2-4). The results of the prioritization are shown in Table 2-19.

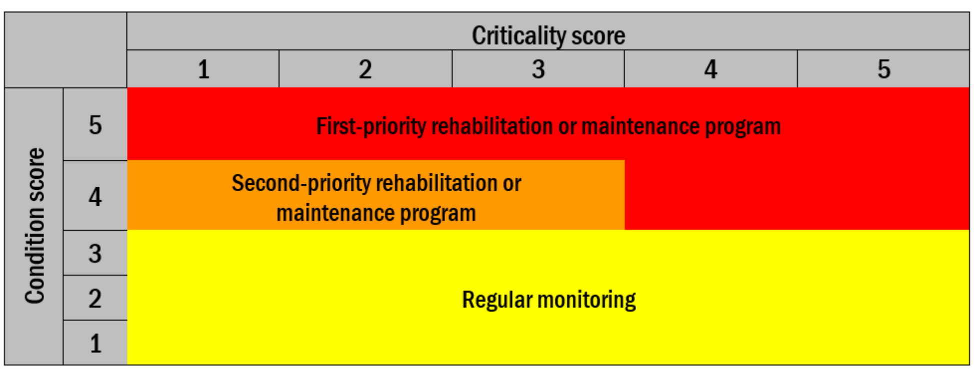

Figure 2-4. Ditch risk management matrix

Table 2-19. Ditch Prioritization

Action	Number of Ditches	Percent of Total Ditch Length	Length of Ditch (ft)
First-priority rehabilitation or maintenance program	406	22	27,799
Second-priority rehabilitation or maintenance program	129	6	8,455
Regular monitoring	1,239	62	79,025
Not inspected/no data	177	10	12,625

Based on discussions with the City, it has been very proactive in correcting deficiencies identified during the inspections and completing the required repairs in a timely manner. In a spot-check of several asset IDs for first-priority rehabilitation ditches, the ditches have all received maintenance according to Cityworks. Most likely the ditches identified for repair as part of this analysis have already been corrected. The method identified here can be used moving forward. An important part of this process is to reset the condition score to 1 following corrective action.

The ditch condition and criticality assessment was completed manually (without the use of an automation tool). A combination of Excel and GIS was used to determine the scores.

2.5 Low-Impact Development Facilities

This section presents the approach taken to develop the condition assessment of LID facilities, including a condition assessment review, gap analysis, and update; criticality analysis; and risk management.

2.5.1 Condition Assessment Review, Gap Analysis, and Update

The Utility's LID facilities are inspected on an annual basis to meet the requirements of the NPDES Phase II permit. Inspection data are analyzed after the inspections are completed. Then based on specific failures, the appropriate corrective work orders are created.

A condition rating methodology is developed from the existing LID facility inspection forms.

Permeable pavement has six pass/fail inspection criteria: (1) sediment, (2) trash and debris, (3) weeds/moss, (4) gravel fill, (5) contamination, and (6) other. Gravel fill applies only to paver-style permeable pavement.

Bioretention has 10 pass/fail inspection criteria: (1) sediment, (2) vegetation, (3) trash and debris, (4) mulch, (5) erosion, (6) contamination, (7) overflow, (8) underdrain, (9) curb cut, and (10) other. These criteria do not universally apply to all bioretention cells.

Swale has 12 pass/fail criteria: (1) sediment, (2) vegetation, (3) inlet/outlet, (4) grass, (5) poor vegetation coverage, (6) erosion, (7) contamination, (8) flow spreader, (9) weir, (10) trash and debris, (11) cannot locate, and (12) other. These criteria do not universally apply to all swales.

For each type of LID facility, condition scoring is based on the number of failed criteria per inspection, and results in a condition score between 1 and 5. Table 2-20 shows the methodology for permeable pavement and bioretention. Table 2-21 shows the methodology for swales.

Table 2-20 Permeable Pavement and Bioretention Rating Methodology	
Number of Failed Criteria	Condition Rating
Not inspected/no data	0
0	1
1 or 2	4
3 or more	5

Table 2-21. Swale Rating Methodology	
Number of Failed Criteria	Condition Rating
Not inspected/no data	0
0	1
1	4
2 or more	5

Tables 2-22 through 2-24 show the distribution of facilities per condition for permeable pavement, bioretention, and swale, respectively. Most permeable pavement and bioretention facilities have condition assessment scores greater than 4. All three types of facilities have assets without a recorded inspection. This is likely a result of the facilities being less than 1 year old and having not received an inspection. Also, inspection and maintenance for permeable pavement has been deferred until required by the Phase II permit. All LID installations shall be inspected and maintained as required by the 2013–18 NPDES Phase II permit.

Table 2-22. Permeable Pavement Condition Scores		
Condition	Number of Pavement(s)	Percent of Pavement(s)
5	34	35
4	34	35
1	0	0
Not inspected/no data	28	30
Total	96	100

Table 2-23. Bioretention Condition Scores		
Condition	Number of Bioretention	Percent of Bioretention
5	53	36
4	72	50
1	8	6
Not inspected/no data	12	8
Total	146	100

Table 2-24. Swales Condition Scores		
Condition	Number of Swale(s)	Percent of Swales
5	4	15
4	1	4
1	10	39
Not inspected/no data	11	42
Total	26	100

2.5.2 Criticality and Risk Management

The LID facilities criticality assessment is very similar to that developed for ditches. While LID facilities convey, store, infiltrate (where possible), and treat surface water, LID criticality is based on the ability to convey or store water out of the right-of-way.

Categories used to rank LID facility criticality include the following:

- **Arterial:** 2 points were assigned to this category for LID facilities within 20 feet of arterial streets as defined in the City's GIS layer "Street."
- **Critical infrastructure parcel:** 2 points were assigned to LID facilities that are within 20 feet of critical infrastructure. Critical infrastructure parcels are those that have been developed to contain hospitals, schools, fire stations, police stations, public health clinics, and solid waste facilities.
- **Flood, slide, or erosion hazard area:** 1 point was assigned to this category for LID facilities intersecting flood, slide, or erosion hazard areas, as defined by King County GIS information. While LID facilities are typically not located in flood, slide, or erosion areas, the criteria are included for possible changes in hazard area delineations or site selection of future facilities.
- **Streamflow:** 1 point was assigned to LID facilities that intersect the City's "nfStreamBuffer" GIS layer.

The criticality score for each LID facility is the sum of the points assigned from each of the four categories above, with a maximum of 5 points. The results of the criticality assessment are presented in Tables 2-25 through 2-27. Nearly all the LID facilities have a criticality score less than 2. This is to be expected because LID features are surface features purposely located away from arterials and critical areas. As more LID facilities are constructed, some may be placed in areas that would result in a higher criticality value.

Table 2-25. Permeable Pavement Criticality Scores		
Criticality	Number of Permeable Pavement Installations	Percent of Permeable Pavement Installations
5	0	0
4	0	0
3	1	1
2	54	56
1	41	43

Table 2-26. Bioretention Criticality Scores

Criticality	Number of Bioretention Facilities	Percent of Bioretention Facilities
5	0	0
4	0	0
3	3	4
2	97	67
1	42	29

Table 2-27. Swales Criticality Scores

Criticality	Number of Swales	Percent of Swales
5	0	0
4	0	0
3	0	0
2	12	46
1	14	54

LID facilities with a condition and criticality score are categorized and prioritized into different activities and programs based on risk management (Figure 2-5).

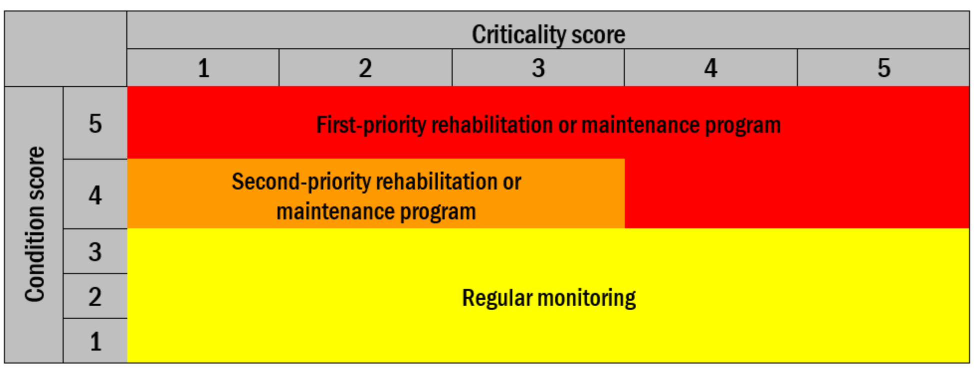

Figure 2-5. LID facility risk management matrix

The results of the prioritization are shown in Tables 2-28 through 2-30 for permeable pavement, bioretention, and swales, respectively. Most permeable pavement and bioretention facilities require first- and second-priority rehabilitation.

Table 2-28. Permeable Pavement Prioritization		
Action	Number of Permeable Pavement Installations	Percent of Permeable Pavement Installations
First-priority rehabilitation or maintenance program	34	35
Second-priority rehabilitation or maintenance program	34	35
Regular monitoring	0	0
Not inspected/no data	28	30

Table 2-29. Bioretention Prioritization		
Action	Number of Bioretention Facilities	Percent of Bioretention Facilities
First-priority rehabilitation or maintenance program	53	36
Second-priority rehabilitation or maintenance program	72	50
Regular monitoring	8	6
Not inspected/no data	12	8

Table 2-30. Swales Prioritization		
Action	Number of Swales	Percent of Swales
First-priority rehabilitation or maintenance program	4	15
Second-priority rehabilitation or maintenance program	1	4
Regular monitoring	10	39
Not inspected/no data	11	42

2.6 Pump Stations

This section presents the approach taken to the condition assessment of pump stations, including a condition assessment review, gaps, and revision; criticality analysis, and risk management.

2.6.1 Condition Assessment Review

The Utility's eight pump stations received an extensive condition and capacity inspection and assessment in 2016 (Kennedy/Jenks 2016). The condition assessment was presented as a list of recommended pump station improvements, as shown in Table 2-31. While two of the pump stations are recommended to be demolished and rebuilt, the recommendations for the remaining pump stations include adding supervisory control and data acquisition (SCADA) instrumentation, redundant pumps, and site access and safety.

Table 2-31. Recommended Pump Station Improvements

Pump Station	Condition Summary and Upgrade Recommendation
Linden Avenue	Upgrade electrical components, add SCADA, provide signs and bollards, purchase redundant pump, and improve wetwell access
Palatine	Upgrade electrical components, add SCADA, provide signs, purchase redundant pump, and improve wetwell access
Pan Terra	Add SCADA, add pressure gauges, improve hatches, and provide guardrail
25	Upgrade/revise PLC program, improve hatches, and provide guardrail
26	Demolish and rebuild station and reuse existing wetwell
30	Demolish and rebuilt station, reuse existing wetwell, provide site improvements around wetwell, and upgrade power service
Ronald Bog	Add SCADA, add pressure gauges, and provide bollards
Serpentine	Add SCADA, add pressure gauges, improve hatches, and provide grading improvement

PLC = programmable logic controller.

Pump stations are inspected annually as part of the regional inspection program, and also as a "hot spot" asset that can be inspected as frequently as weekly or twice weekly during the rainy season to ensure function. These inspections and subsequent maintenance work are scheduled and recorded within work orders in Cityworks rather than an inspection form. The City has an inspection form for pump asset class in Cityworks (see Table 2-32). As of January 2017, the form appears to have not been consistently used as there are few entries and the inspection information had been stored in the inspection work order form. As a result, a condition assessment was not completed based on data collected with this form. Staff reports that inspection reports from Cityworks can be exported for analysis.

Table 2-32. Pump Inspection Form

Criterion	Result	Observation
Floats	Fail	Broken, missing, or nonfunctional
	Pass	Intact, present, and functional
Motor	Fail	Nonfunctional or excessive noise
	Pass	Functional and normal noise
Pump inlet	Fail	Blocked
	Pass	Clear
Other	Fail	Other, comment
	Pass	None

A condition assessment was not completed based on the results of this routine inspection. Instead, the Kennedy/Jenks report was relied upon (Kennedy/Jenks 2016). Based on the information provided in the Kennedy/Jenks report, the pump stations can be assigned a condition rating between 1 and 5. Pump stations 26 and 30, which are recommended to be demolished and rebuilt, receive a condition score of 5. The remaining pump stations require significant upgrades and thus receive a condition rating of 4. A more detailed inspection form is recommended and included in Section 3. Adding additional inspection criteria to the inspection forms such as (1) condition of the equipment (hydraulic, electrical, mechanical, and monitoring), (2) facility or structure (wetwell and housing structure), and (3) access features (lights, ladders, and hatches) provides a more robust assessment.

2.6.2 Criticality and Risk Management

Because each pump station serves a dedicated area that would flood without it, pump stations are a critical asset class, and all assets of this class have been assigned a criticality score of 5.

The risk management priority matrix for pump stations has three strategies: (1) first-priority rehabilitation or maintenance program, (2) second-priority rehabilitation or maintenance program, and (3) frequent assessment. Pump stations 26 and 30 are placed in the first-priority rehabilitation or maintenance program and the remaining six pump stations are in the second-priority rehabilitation or maintenance program. All pump stations are also included in the frequent assessment program and will continue to be inspected on an approximately weekly basis during hot spot inspection and annually during a regional stormwater facility inspections.

Generally, there are so few pump stations and they are of such criticality that any condition fault that impacts the safety and operation of the pump station should be repaired immediately. See Figure 2-6 for the pump station risk management matrix.

		Criticality score
		5
Condition score	5	First-priority rehabilitation or maintenance program
	4	Second-priority rehabilitation or maintenance program
	3	Frequent assessment
	2	
	1	

Figure 2-6. Pump station risk management matrix

Section 3

Implementation Recommendations

This section presents implementation recommendations, including overall recommendations (OR), asset recommendations, and alternative technology recommendations (ATR).

3.1 Overall Recommendations

This CAMP presents a standardized approach for asset management-based condition assessment, criticality scoring, and risk management programming for seven Utility assets. The CAMP is useful in presenting the implementation of asset management principles to staff and demonstrating the asset management elements from the condition assessment work the Utility is currently performing. The following recommendations will help integrate the revised condition assessment approach into the existing condition assessment program. Recommendations are presented for the asset system as a whole, and also on a per-asset basis for the seven assets reviewed in the CAMP.

Six overall recommendations (OR) for the condition assessment management approach are presented below.

OR-1: Update the CAMP as the Asset Management Program Matures. As the City's asset management program matures, the CAMP should be updated to reflect the growth of the program and lessons learned. Updates may include revisions to condition and criticality scoring or the risk management matrices created for each asset. The revisions may be based on changes in how inspection information is gathered, assumptions about criticality, inspection methods, trends in condition change, or coordination with other City and Utility asset management priorities.

OR-2: Apply the CAMP Process to Assets. Condition scores, criticality scores, and assigned risk management levels have been developed for eight asset classes and a copy of the assets' GIS shapefile containing new fields for this information.

OR-3: Provide Dedicated Resources to Maintain Condition Assessment Processes. Dedicated resources should be provided to update inspection information and condition assessment scoring in GIS and Cityworks. This would include updating condition scorings in GIS and Cityworks when new asset information is available from inspections; maintenance and rehabilitation; running GIS and Excel condition assessment tools to update condition scoring and risk management ranking; and reconciling asset management information in PACP/Access databases, GIS, Cityworks, and Excel/GIS.

OR-4: Maintain Methods to Obtain Inspection Information from Cityworks in Tabular Form. A comprehensive list of inspection results for an asset type is helpful in developing and testing condition assessment ranking methodologies. City staff prepared Cityworks reports to extract inspection information from Cityworks for import into Excel. The report is available to select Cityworks users via the Managers tab.

OR-5: Record and Assess Asset Inspection, Condition, Criticality, and Risk Management on a per-Asset Basis Over Time. Tracking asset condition, criticality, and risk management decisions over time can show maintenance and condition trends for a single asset or a group of assets. A trend may show a consistent or recurring condition that may have a different solution than continued maintenance and repair in the same manner.

OR-6: Implement a 1 to 5 Condition and Criticality Scoring System for all Assets. Update Cityworks inspection condition assessment forms to generate a score between 1 and 5 for all assets that have been inspected, where 5 is the poorest condition. A condition rating of zero should be used to indicate that no inspection has been performed.

3.2 Asset Recommendations

This section presents condition assessment recommendations for each of the eight assets identified by the Utility for the CAMP.

3.2.1 Pipe

Five pipe recommendations (PRs) for the pipe asset class are presented below.

PR-1: Maintain Full PACP Databases and Repopulate Full PACP Database for Critical Pipes. For pipes and manholes, it is recommended that the City obtain the full PACP and MACP inspection database following internal inspection of pipes. Full inspection databases contain all information recorded during the inspection, and not just the summary information such as the index scores. The quick scores are the PACP data used in the revised condition assessment process and should be the preferred inspection information maintained in GIS.

PR-2: Develop an Ongoing Pipe Inspection Program. The Utility has a need for ongoing pipe inspection services. The priority of inspection is based on the availability of data, the criticality score, and the risk management score. This ongoing inspection program needs to have a high level of quality control/quality assurance from the inspection firm and project manager. With trying to automate the condition assessment process as much as possible, the data inputs need to be as correct as possible.

The Utility should perform the following ongoing inspection services:

- Thornton Creek basin pipe inspection (pipes without previous inspection attempt)
- Uninspected or incomplete inspection pipes (with maintenance and access issues)
- Regular monitoring (20 years)
- Post-rehabilitation inspection performed as part of the pipe R&R program. It is standard practice to complete a post-rehabilitation CCTV inspection. The results of this inspection should be used to update the condition of the asset in Cityworks following rehabilitation to update the condition value

PR-3: Cross-Check Existing and Revised R&R Program. Based on a comparison of the existing and revised R&R program, the list of first-priority pipes differs between the existing and revised prioritization process. The difference is expected because the revised prioritization pairs the criticality and condition scores instead of combining the scores. Also, pipes in the Storm and Boeing creeks basins did not include criticality in their risk management prioritizations. Of the 308 pipes identified for the first-priority R&R program in the revised process, 102 are included in the current R&R program. The remaining 206 first-priority pipes from the revised prioritization scheme should be reviewed by Utility staff and considered for inclusion in the R&R program. Appendix B contains a list of the first- and second-priority pipes identified with the revised prioritization process that have not been included in the R&R program (Tables B-1 and B-2, respectively). Table 3-1 shows the size distribution for the 308 pipes in the revised process first-priority R&R program.

Table 3-1. First-priority Rehabilitation		
Pipe Diameter (in.)	Number of Pipes	Length (ft)
Unknown	7	727
12	247	24,471
15	1	237
18	41	4,140
24	10	1,185
36	2	312
Total	308	31,073

The current R&R program lists 248 pipes that have been (56 pipes) or will be (192 pipes) part of the open-cut replacement or trenchless CIP. Because pipes included in the Utility's current R&R program have undergone extensive review by City staff and consultants, the 102 pipes with a first-priority ranking in the current and revised R&R programs should remain the top candidates in the R&R program going forward.

PR-4: Update Asset GIS with Rehabilitation Results. The City should review recently completed rehabilitation efforts to confirm that identified pipes have already been repaired. Per GIS information, nine condition-based priority pipes were cured-in-place pipe (CIPP)-lined in 2014. These pipes have not been filtered out of the analysis. Going forward, the City should schedule or require contractors to use CCTV after R&R efforts.

PR-5: Utilize PACP Monitoring Process. To use the PACP method to its fullest extent of monitoring pipe over time and benchmarking condition, the City should maintain PACP data in a centralized and robust database platform such as Access.

3.2.2 Structures

Four structure recommendations (SR) for structures (manholes and catch basins) are presented below.

SR:1: Implement the Condition Scoring Algorithm for Catch Basins in Cityworks. The City has an inspection form and rating methodology for catch basins. This inspection form should be used and fully completed. The scoring algorithm should be run to develop a 1 to 5 condition score. Because of the frequency of catch basin inspections, a labor- and time-intensive MACP inspection is not warranted.

SR-2: Maintain Full MACP Databases and Confirm Use with MACP Reader Software for Manholes. As the City transitions to MACP inspection manholes, the Utility should obtain the full MACP inspection database following internal inspection and confirm that entries are readable in MACP-certified software. Manholes are inspected at a longer interval, 10 to 20 years. It is worthwhile to complete the detailed MACP inspection of these assets.

SR-3: Update Condition and Prioritization Tool for Catch Basins and Manholes. The Criticality and Prioritization Tool (CP Tool) is a processing tool developed in ArcGIS to efficiently calculate the criticality and priority rankings of an asset class with many assets. It may be useful to consider additional structure-specific criteria for calculating criticality, such as: type of structure (Type 1 or 2 catch basin), diameter of Type 2 catch basin, number of pipes connected, and depth of structure.

SR-4: Update GIS Asset Information. The City stated that some catch basins are mislabeled as manholes in GIS. The City should update its data to accurately reflect what a structure is—catch basin or manhole. The classification determines its NPDES requirements, inspection frequency, and inspection methodology.

3.2.3 Ditch

Three ditch recommendations (DR) for the ditch asset class are presented below.

DR-1: Update Ditch Inspection Form to Include Roadway Drainage Criterion. The Utility should add a roadway drainage criterion to the ditch inspection form. A fail score for this criterion during an inspection would result in a high condition score (i.e., poor condition). Some roadside ditches do not collect surface water from the roadway by sheet flow across the shoulder as intended. Mature vegetation and surface deformation from parking or adjacent property owners can limit this sheet flow. The result is concentrated flow for downstream inlets or roadside ponding.

DR-2: Continue with Existing Program and Track Condition and Maintenance Efforts. Since 2008, nearly every ditch has been inspected twice, with nearly every ditch inspected once in the last 3 years. With one third of the ditches being inspected per year and one quarter of the inspected ditches requiring maintenance, approximately 8 percent of the total ditches require maintenance annually. From the current inspection and maintenance data, it is unclear if the same ditches need to be maintained every 3 years or if the maintained ditches have a high criticality score. It is recommended that the Utility maintain its current ditch inspection and maintenance program for another 3-year cycle and track ditch condition and maintenance to determine if some ditches require more maintenance. The risk management approach can be revised based on the inspection and condition assessment data to determine if a more efficient risk management approach should be considered.

DR-3: Use Ditch Outlet Pipe in Ditch Criticality Score. Ditch size is not recorded in GIS. The size of a ditch would be an important indicator of criticality, as larger ditches typically carry more flow and have the potential to have a greater flooding or erosion impact. Update the ditch criticality scoring to include outlet pipe size as a proxy for ditch size and use the size criterion to develop a criticality score. For long ditch systems, it may be more appropriate to use an upstream pipe diameter instead of the downstream pipe diameter.

3.2.4 LID Facilities

Two LID facility recommendations (LFR) (e.g., permeable pavement, bioretention, and swales) are presented below.

LFR-1: Investigate Cityworks for Missing Inspection Data. The condition scoring process for all three LID facilities demonstrated that either inspection data are missing or an inspection did not occur for several assets. Because the Utility is required to inspect LID facilities annually, the only missing inspection data should be for facilities less than 1 year old.

LFR-2: Secure Resources for an LID Maintenance Program. The Utility has contractors to maintain the vegetation components of its LID facilities, but not for the more intensive maintenance and repair. The Utility should develop and provide resources for an ongoing LID maintenance program. Elements such as permeable pavement cleaning require specialized equipment and would be best to contract out. Repairs to bioretention and swales could be performed by an existing O&M contract or by public-works crews currently funded through the Utility.

3.2.5 Pump Station

One pump station recommendation (PSR) for the pump station asset class is presented below.

PSR-1: Create a Pump Station Inspection Form in Cityworks. Pump stations are inspected during the rainy season as a "hotspot" and annually as a stormwater regional facility. These inspections are recorded in work order inspection forms, which include a narrative description of the inspection results and a compilation of individual inspection forms for the various assets associated with the hotspot or regional facility. The existing pump asset inspection form is not sufficient to collect the information necessary to prepare a condition assessment. This form should be expanded to include the condition of the equipment (hydraulic, electrical, mechanical, and monitoring) and facility (wetwell, housing structure, and access features [e.g., ladders, gates, and hatches]). A proposed pump station inspection form is shown in Table 3-2. While some of these features are inspected and recorded on the stormwater facility inspection form, it is difficult to differentiate the pump station information from other stormwater assets for an automated condition assessment process. Including all pump station inspection information on one form will allow the City to perform condition assessment scoring and evaluate R&R needs.

Table 3-2. Proposed Pump Station Inspection Form

Criterion	Result	Observation
Floats	Fail	Broken, missing, or nonfunctional
	Pass	Intact, present, and functional
Motor	Fail	Nonfunctional or excessive noise
	Pass	Functional and normal noise
Pump inlet	Fail	Blocked
	Pass	Clear
Other	Fail	Other, comment
	Pass	None
Hydraulic	Fail	Irregular discharge pressures, excessive run times
	Pass	Normal pressures and run times
Electrical	Fail	Nonfunctional, improper electrical components
	Pass	All electrical components operational
Mechanical (valves, piping)	Fail	Broken, warn, corroded, missing, or nonfunctional
	Pass	Intact, present, and functional
Monitoring equipment	Fail	Faults in SCADA or other monitoring equipment
	Pass	Intact, present, and functional
Facility	Fail	Degradation of building, wet well, vaults, and hatches
	Pass	Intact, present, and functional
Access features	Fail	Broken, corroded ladders, gates, and doors
	Pass	Intact, present, and functional

The condition and maintenance requirements, as well as inspection frequency for individual pump station components, are specified by manufacturer recommendations. A more comprehensive pump station inspection (as was completed in 2016) should occur every 5 to 7 years. This more robust inspection should look at every significant part, and document its age, condition, and expected useful life. A sample detailed pump station condition assessment form is included in Appendix C. A code review should also be completed to see what components may no longer meet applicable codes.

3.2.6 Other Assets

One other asset recommendation (OAR) for the other asset class is presented below.

OAR- 1: Add other Assets to GIS and Prepare Inspection, Condition Assessment, Criticality, and Risk Management Decisions. Consider adding large, stream-bearing or otherwise significant culverts as a new asset class to the GIS database. Such culverts have headwalls and other such features that are of critical importance to inspect and assess.

3.3 Alternative Technology Recommendations

This section presents alternative technology recommendations (ATR) for the Utility to consider in the future. There are three recommendations presented below.

ATR-1: Require Upgraded CCTV Equipment from Contractors. The inspection technologies available for condition assessment have remained consistent during the last few years. Improvements in CCTV inspection video quality (e.g., high-definition video), autonomous cameras (e.g., RedZone Solo), pan/tilt/zoom-able video, and steerable cameras allow for a more detailed picture to more accurately code pipe assets. These improvements are worthwhile for the City to investigate for its own equipment, or to require that contractors use. Autonomous cameras are for pipes between 8 and 12 inches diameter; however, the cameras require that the pipes be very clean. Because of the nature of storm drains, they are seldom very clean. Unless the City wants to clean the pipes prior to inspection, autonomous cameras are not recommended. It is recommended that the City require the use of high-definition video for all inspections. For smaller pipes, 12 inches diameter and less, pan/tilt/zoom-able video (i.e., digital side scanning) is recommended and can be used to speed the inspection process. For larger pipes, having steerable cameras allows for the camera to be steered around obstructions that may otherwise require the inspection to be abandoned.

ATR-2: Consider Installing Cameras on Cleaning Devices. If the City needs to inspect a pipe sooner than the recommended 20-year inspection frequency, the use of a camera on a cleaning device can determine if a pipe has a significant defect. Some companies have installed cameras on jetting nozzles, such as the KleenSight Camera Nozzle System or Insight Vision Jetcam. The main benefit to this is that the operators can quickly see if a pipe has been properly cleaned or if there is a significant defect. However, this method is not good at creating a PACP-compliant inspection. This option is worthwhile for the City to investigate further, only if it wishes to guarantee clean pipes and have a quick visual inspection, but not as a substitution for traditional CCTV inspections. The City of Tacoma has used the KleenSight Camera Nozzle System for quick inspections. It simply rated pipes red (i.e., has failed or needs immediate repair), yellow (i.e., pipe has roots or other problem), or green (i.e., pipe is good).

ATR-3: Consider Using Cameras for Catch Basin Inspections. Most catch basins are very shallow, just a few feet deep; therefore, simply looking into the catch basin and using a handheld camera is suitable for inspections. However, if the City wants to have a detailed look at deeper assets, using a pole-mounted camera such as the Envirosight Quickview is worthwhile. This pole-mounted camera is also suitable to help inspect the short lengths of pipe that the City has “candled” in the past, and that are not CCTV-inspected.

Section 4

Limitations

This document was prepared solely for City of Shoreline in accordance with professional standards at the time the services were performed and in accordance with the contract between the City of Shoreline and Brown and Caldwell dated July 2, 2015. This document is governed by the specific scope of work authorized by the City of Shoreline; it is not intended to be relied upon by any other party except for regulatory authorities contemplated by the scope of work. We have relied on information or instructions provided by the City of Shoreline and other parties and, unless otherwise expressly indicated, have made no independent investigation as to the validity, completeness, or accuracy of such information.

This document sets forth the results of certain services performed by Brown and Caldwell with respect to the property or facilities described therein (the Property). The City of Shoreline recognizes and acknowledges that these services were designed and performed within various limitations, including budget and time constraints. These services were not designed or intended to determine the existence and nature of all possible environmental risks (which term shall include the presence or suspected or potential presence of any hazardous waste or hazardous substance, as defined under any applicable law or regulation, or any other actual or potential environmental problems or liabilities) affecting the Property. The nature of environmental risks is such that no amount of additional inspection and testing could determine as a matter of certainty that all environmental risks affecting the Property had been identified.

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Section 5

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Appendix A: Criticality and Prioritization Tool

Appendix A

Criticality and Prioritization Tool Description

The Criticality and Prioritization Tool (CP Tool) is a processing tool developed in ArcGIS to efficiently calculate the criticality and priority rankings of an asset class with many assets. A CP Tool was created for the City of Shoreline's (City's) pipe and catch basin asset classes. Criticality and priority scores were developed with criteria described in Section 2 of the Condition Assessment Management Plan (CAMP). Existing surface water and streets GIS data sets were obtained from the City's website in January 2017. King County data for critical infrastructure, landslides, and erosion hazard areas utilized with the CP Tool were current as of December 2016.

The CP Tools delivered with the CAMP are intended to be modified for future use to re-assess the criticality and rehabilitation priority after GIS data or criteria are updated. User documentation and necessary shapefiles for both the pipe and catch basin CP Tools are described below.

Pipe Criticality and Prioritization Tool

A description of the data analyzed by the tool to calculate criticality and priority scores for the City pipe assets is provided below. These layers must be added to the map file for the tool to be run successfully.

City data:

Surfacewater.gbd/Stormwater layers:

- swPipe:
  - Stormwater pipe data layer
- swFloodPlain:
  - Delineated floodplain areas
- nfStream:
  - Stream layer
- Streets.gdb/Streets layers:
  - stPavement, Railroad, Street

GIS layers provided with Pipe CP Tool:

- Critical_Infrastructure_Parcels:
  - This shapefile contains parcels where critical infrastructure is located. The City considers it critical to maintain utility service to these facilities.
  - This shapefile was developed by combining King County data points for locations of hospitals, schools, fire stations, police stations, public health clinics, and solid waste facilities within the city limits with the King County parcel data layer.

- Street_Arterial:
  - City street layer modified to contain only streets identified in the data as arterials
- slide_KC_Clip:
  - Modified King County landslide risk areas layer that is clipped to the city limits
- erode_KC_Clip:
  - Modified King County erosion hazard areas layer that is clipped to the city limits

The tool can recalculate scores if referenced shapefile and data field names remain the same. This allows the GIS data tables to be updated to reflect asset changes in the future. In addition to the shapefiles described above, specific data fields referenced by the tool calculations are described below.

Required swPipe fields:

For criticality score diameter calculations:

- PIPEDIAM:
  - Pipe diameter data field

For slope calculations:

- DWNELEV, UPSELEV, Shape_Length:
  - Downstream pipe invert elevation, upstream pipe invert elevation, and pipe length fields, respectively

For priority score calculation:

- ConditionR:
  - Condition rating of the pipe section, developed as described in Section 2.1 of the CAMP. For this analysis, the ConditionR value is the round index score (SPRI) number or the first digit of structural quick score (QSR) when available.

User Steps Before Running Tool. Prior to running the tool, the data of the current swPipe layer should be exported to a copy named “swPipePriority” to avoid altering the original data. The user should also ensure that all required layers referenced in the description above have been added to the user’s .mxd file, and that the required fields contain the respective fields referenced by the tool.

Tool Processing Steps. To run the tool, the user must locate the provided toolbox file (.tbx) in the ArcGIS catalog. Open the toolbox, right-click on the tool file, and select “Edit” to open the edit window. Edit mode allows you to view the tool as it proceeds through the calculation steps. Click the “Model” tab and select “Run Entire Model.” If any errors occur, close the tool dialogue box and click the “Model” tab and select “Run” to continue the calculation where it left off. Once the analysis has finished, the criticality and priority scores will have been added to the data attributes of the swPipePriority shapefile.

The data analysis and calculation steps used by the tool to assess pipe criticality and rank rehabilitation priority are described below:

1. Tool checks for criticality/priority calculation fields
2. If not found, tool creates the following new fields:

- Criticality score fields:
  - ART (arterial score)
  - CROSS (street crossing score)
  - DIAM (diameter score)

  - SLOPE (pipe slope score)
  - FSEArea (flood, slide, or erosion hazard area score)
  - SFLOW (streamflow score, pipe intersections with streams)
  - INFRA (critical infrastructure score)
  - MISC (total miscellanea score calculated from SLOPE, FSEArea, SFLOW, and INFRA scores [maximum of 1 point])
  - CRIT (calculated criticality score)
- Priority score:
  - PVAL (priority value of #.#, which is the condition rating value combined with the criticality rating)
  - PSCORE (priority score letter)

3. If the fields are present, the tool resets all values to zero (and priority score to E) before updating the calculations.
4. Tool selects swPipePriority pipes intersecting with the Street_Arterial layer within a buffer of 30 feet and assigns a value of 2 to the ART field for intersecting pipes.
5. Tool selects swPipePriority pipes intersecting with the Railroad layer and the stPavement layer within a buffer of 5 feet and assigns a value of 1 to the CROSS field for crossing pipes.
6. Tool selects pipes from the swPipePriority layer with diameters larger than 12 inches and assigns a value of 1 to the DIAM field.
7. Tool selects pipes from the swPipePriority layer with slopes greater than or equal to 23 percent by using data in the UPSELEV, DWNELEV, and Shape_Leng fields. A value of 1 is assigned to the SLOPE field for these pipes. (Note: when exporting swPipe into a new layer, Shape_Length was shortened to Shape_Leng. If another version of ArcGIS does not shorten this, an error may occur.)
8. Tool selects pipes from the swPipePriority layer intersecting swFloodPlain, slide_KC_Clip, or erode_KC_Clip within a buffer of 5 feet and assigns a value of 1 to the FSEArea field for intersecting pipes.
9. Tool selects pipes that have an intersection with the nfStream shapefile, without a buffer. A value of 1 is assigned to the SFLOW field for these pipes.
10. Tool selects swPipePriority pipes intersecting the Critical_Infrastructure_Parcels within a buffer of 20 feet and assigns a value of 1 to the INFRA field for pipes within a critical infrastructure parcel.
11. Tool calculates the MISC field value for each pipe based on the SLOPE, FSEArea, SFLOW, and INFRA scores (maximum value of 1).
12. Tool calculates the CRIT field value (criticality score) from the sum of the values in the ART, CROSS, DIAM, and MISC fields.
13. Tool calculates the PVAL field value by combining the ConditionR and CRIT field values into a single score (#.#) or (ConditionR).(CRIT).

14. Tool calculates the PSCORE field value based on the PVAL value and the priority matrix.

- PSCORE letter descriptions:
  - A: first priority
  - B: second priority
  - C: regular monitoring
  - U: uninspected (no condition rating score)
  - N: not scored (catch-all for quality assurance/quality control purposes in case a value falls outside of the matrix range due to a typo etc.; there should be none of these)

The GIS model build of the tool is shown in Figure A-1.

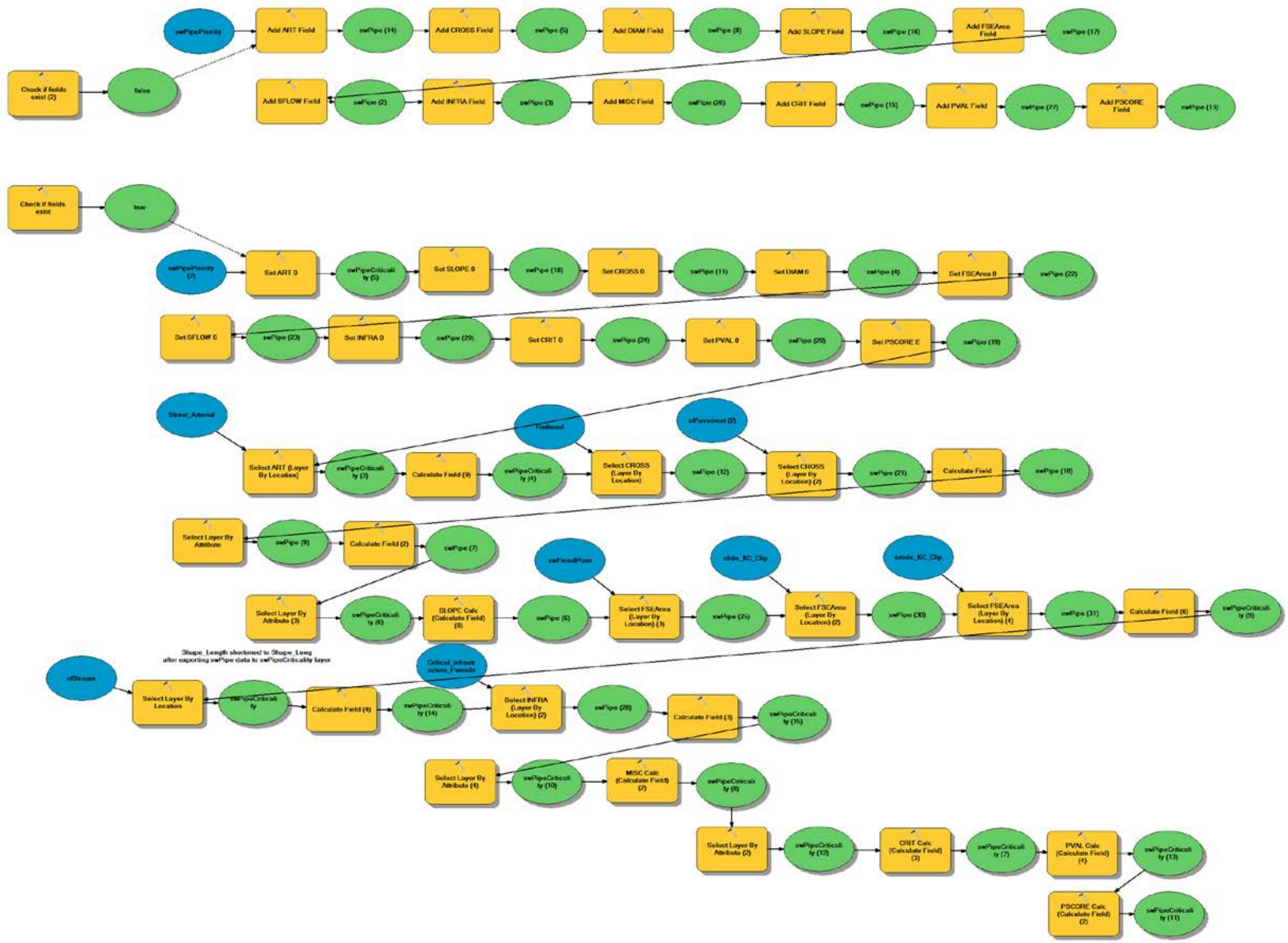


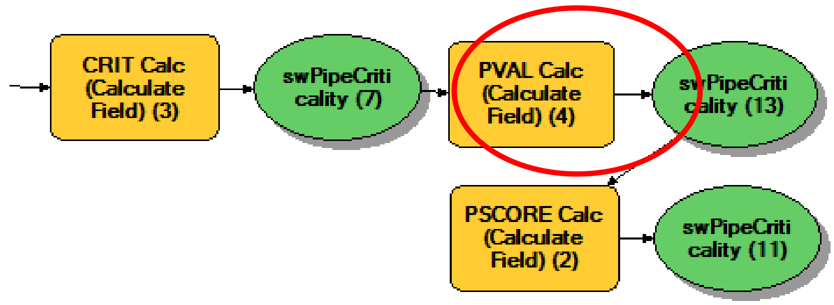
Figure A-1. GIS Pipe CP Tool build diagram

Examples for Modifying the Pipe Criticality and Prioritization Tool

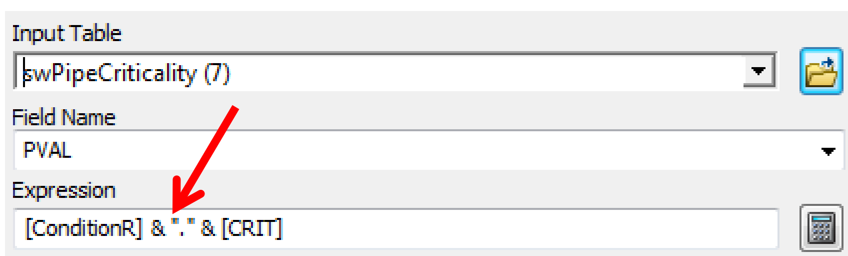
This section describes the steps to make some simple changes to the model.

Updating Tool to use "Condition" field rather than "ConditionR" to Calculate Priority:

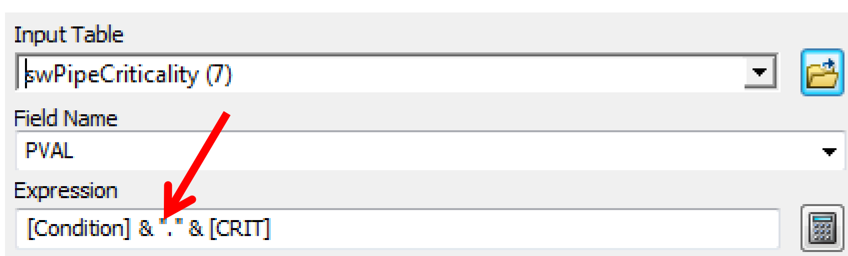
1. Open the tool's edit mode by navigating to the toolbox (.tbx) file in the ArcGIS Catalog. Open the toolbox, right-click on the tool file and select "Edit" to open the edit window. Navigate to the yellow block in the bottom-right corner of the tool containing the code for the PVAL calculation (circled in red). Double-click this block to edit the code for this portion of the tool.



2. The code for the PVAL calculation is shown below. This code combines the condition value and criticality value of the pipes per the priority matrix. Change the referenced field name from "ConditionR" to "Condition" to change the tool to use values from the "Condition" data field.



3.



4. Once the code is changed, click "OK" on the dialogue box to save the new code into the tool.

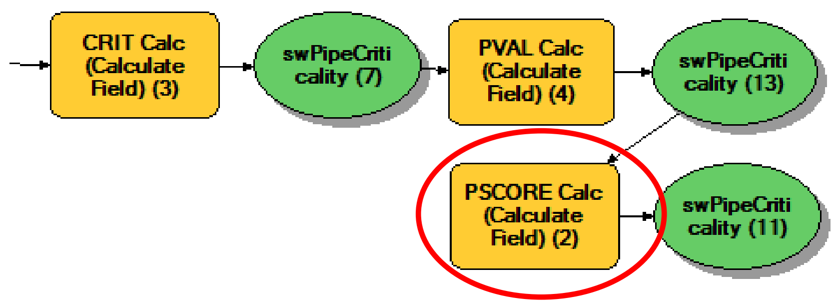
Updating Tool with New Priority Matrix Values:

The existing tool assigns priority values based on the risk management matrix shown in Figure A-1. The different management levels are represented in the tool's code by their numerical intervals. For example, the orange category is represented as the interval 4.1 to 4.3.

<table>
<tr><td colspan="2" rowspan="2"></td><td colspan="5">Criticality score</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr>
<tr><td rowspan="5">Condition score</td><td>5</td><td colspan="5">First-priority rehabilitation or maintenance program</td></tr>
<tr><td>4</td><td colspan="3">Second-priority rehabilitation or maintenance program</td><td colspan="2"></td></tr>
<tr><td>3</td><td colspan="5" rowspan="3">Regular monitoring</td></tr>
<tr><td>2</td></tr>
<tr><td>1</td></tr>
</table>

Figure A-1. Pipe risk management matrix

1. Open the tool's edit mode by navigating to the toolbox (.tbx) file in the ArcGIS Catalog. Open the toolbox, right-click on the tool file and select "Edit" to open the edit window. Navigate to the yellow block in the bottom-right corner of the tool containing the code for the PSCORE calculation (circled in red). Double-click this block to edit the code for this portion of the tool.



2. The original text in the "Code Block" box is shown below. The numerical values of the intervals and assigned letters for each corresponding management category can be edited to match matrix changes. The letter "A" represents the red category, "B" represents orange, and "C" represents yellow:

```
def TextValue(PValue):
 if (PValue ≥ 4.4):
 return "A"
 elif (PValue ≥ 4.0 and PValue ≤ 4.3):
 return "B"
 elif (PValue ≥ 3.0 and PValue ≤ 3.5):
 return "C"
 elif (PValue ≥ 2.0 and PValue ≤ 2.5):
 return "C"
 elif (PValue ≥ 1.0 and PValue ≤ 1.5):
 return "C"
 elif (PValue < 1.0):
 return "U"
 else:
 return "N"
```

3. If the orange rehabilitation category (B) of the matrix was changed as shown, the interval values in the code for categories A and B would need to be changed as highlighted in the text below:

		Criticality score				
		1	2	3	4	5
Condition score	5	First-priority rehabilitation or maintenance program				
	4	Second-priority rehabilitation or maintenance program				
	3	Regular monitoring				
	2					
	1					

```
def TextValue(PValue):
 if (PValue ≥ 5.0):
 return "A"
 elif (PValue ≥ 4.0 and PValue ≤ 4.5):
 return "B"
 elif (PValue ≥ 3.0 and PValue ≤ 3.5):
 return "C"
 elif (PValue ≥ 2.0 and PValue ≤ 2.5):
 return "C"
 elif (PValue ≥ 1.0 and PValue ≤ 1.5):
 return "C"
 elif (PValue < 1.0):
 return "U"
 else:
 return "N"
```

4. Once the code is changed, click "OK" on the dialogue box to save the new code into the tool.

Manhole and Catch Basin Criticality and Prioritization Tool

A description of the data analyzed by the tool to calculate criticality and priority scores for the City of Shoreline (City) catch basin assets is provided below. The manhole CP Tool utilizes the same tool steps but with the swMH_Priority layer.

Priority pipe data:

- swPipePriority:
  - Pipe criticality scores calculated by the Pipe CP Tool

City data:

- Surfacewater.gbd/Stormwater layers:
  - swCatchBasin

GIS layers provided with Catch Basin CP Tool:

- No additional layers required beyond what is included with the pipe prioritization tool and the results of the pipe prioritization tool.
- swCB_Priority:
  - The tool can re-calculate scores if referenced shapefile and data field names remain the same. This allows the GIS data tables to be updated to reflect asset changes in the future.

- In addition to the shapefiles described above, specific data fields referenced by the tool calculations are described below.

Required swCB_Priority fields:

- For criticality score calculation:
  - Catch basins are assigned the highest criticality score for the connected pipe assets
- For priority score calculation:
  - CondRating:
    - This is the condition rating of the catch basin asset. It is a direct copy of the "Condition" rating field modified to:
      - Change the rating of catch basins that have been inspected and have a condition rating of 0 to 1 to show they have been inspected
      - Changed the rating of priority catch basins to 100 to indicate that they need immediate attention

User Steps Before Running Tool:

Prior to running the tool, the data of the current swCatchBasin layer should be exported to a copy named "swCB_Priority" to avoid altering the original data. The user should also ensure that all required layers referenced in the description above have been added to the user's .mxd file, and that the required fields contain the respective fields referenced by the processing tool.

Tool Processing Steps:

To run the tool, the user must locate the provided toolbox file (.tbx) in the ArcGIS catalog. Open the toolbox, right-click on the tool file and select "Edit" to open the edit window. Edit mode allows you to view the tool as it proceeds through the calculation steps. Click the "Model" tab and select "Run Entire Model." If any errors occur, close the tool dialogue box and click the "Model" tab and select "Run" to continue the calculation where it left off. Once the analysis has finished, the criticality and priority scores will have been added to the data attributes of the swCB_Priority shapefile.

The data analysis and calculation steps used by the tool to assess pipe criticality and rank rehabilitation priority are described below:

1. Tool creates new ConditionR field and converts CondRating values of 0 to 100 to 1 to 5 according to the intervals defined in Section 2.2 of the CAMP.
2. Tool joins AssetID, ConditionR, CRIT, PVAL, and PSCORE fields from swPipePriority into the swCB_Priority shapefile attributes:
   1. Data assigned to each catch basin are from the intersecting pipe asset with the maximum criticality score of all pipes intersecting the catch basin within a buffer of 5 feet.
   2. Tool outputs a new shapefile "swCB_Priority%date%" with the joined data. The %date% allows the tool to append the current date onto the name each time it is run.
   3. Tool creates the following new fields:
      1. Priority score fields:
         1. CBPVAL (priority value of #.#, which is the condition rating value combined with the criticality rating)
         2. CBPSCORE (priority score letter)
   4. Tool calculates the CBPVAL field value by combining the ConditionR (Catch Basin) and CRIT (swPipePriority) field values into a single score (#.#) or (ConditionR).(CRIT).

5. Tool calculates the CBPSCORE field value based on the CBPVAL value and the priority matrix

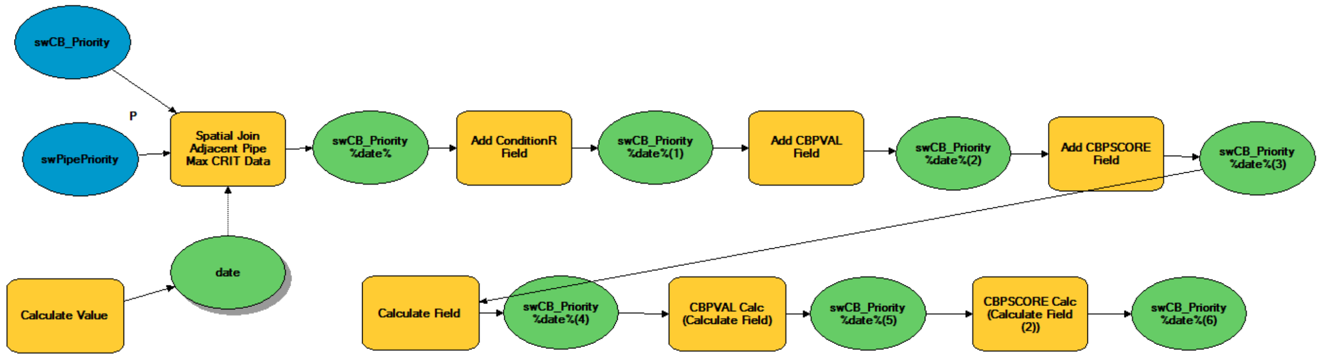


Figure A-2. GIS Catch Basin CP Tool build diagram

Appendix B: First- and Second-Priority Pipes not Previously Identified for SW Pipe Replacement Program

Table B-1. First Priority Tool Identified Pipes Not Identified Previously for R&R

Count	AssetID	BASIN	Inspected	ConditionR	Source	ART	CROSS	Diam	SLOPE	FSEArea	SFLOW	INFRA	MISC	CRIT	PVAL	PSCORE
1	SP-108	MPS	YES	4	Quick Score	2	1	0	0	1	0	0	1	4	4.40	A
2	SP-155	MC	YES	5	Index	0	0	0	0	0	0	0	0	0	5.00	A
3	SP-266	BC	YES	5	Index	0	1	0	0	0	0	0	0	1	5.10	A
4	SP-290	MPS	YES	5	Quick Score	0	0	0	0	0	0	0	0	0	5.00	A
5	SP-352	MC	YES	5	Index	0	1	0	0	1	0	0	1	2	5.20	A
6	SP-422	MPS	YES	5	Quick Score	0	1	0	0	0	0	0	0	1	5.10	A
7	SP-451	MPS	YES	5	Index	0	1	0	0	0	0	0	0	1	5.10	A
8	SP-560	MC	YES	5	Index	2	1	1	0	1	0	0	1	5	5.50	A
9	SP-562	MC	YES	5	Index	2	1	1	0	1	0	0	1	5	5.50	A
10	SP-768	LC	YES	5	Index	0	0	0	0	0	0	0	0	0	5.00	A
11	SP-783	MC	YES	5	Index	2	1	0	0	0	0	0	0	3	5.30	A
12	SP-788	MC	YES	5	Index	0	1	0	0	1	0	0	1	2	5.20	A
13	SP-798	MC	YES	4	Index	2	1	0	0	1	0	0	1	4	4.40	A
14	SP-834	MPS	YES	4	Index	2	1	1	0	0	1	0	1	5	4.50	A
15	SP-910	MC	YES	5	Index	0	0	1	0	0	0	0	0	1	5.10	A
16	SP-947	MPS	YES	5	Quick Score	0	1	0	0	0	0	0	0	1	5.10	A
17	SP-953	MC	YES	5	Index	0	0	0	0	0	0	0	0	0	5.00	A
18	SP-961	MC	YES	5	Index	0	1	0	0	1	0	0	1	2	5.20	A
19	SP-970	MC	YES	5	Index	0	1	0	0	0	0	0	0	1	5.10	A
20	SP-974	BC	YES	5	Index	2	1	0	0	1	0	0	1	4	5.40	A
21	SP-999	BC	YES	5	Index	0	1	0	0	0	0	0	0	1	5.10	A
22	SP-1134	LC	YES	5	Index	0	0	0	0	0	0	0	0	0	5.00	A
23	SP-1140	LC	YES	5	Index	0	0	0	0	0	0	0	0	0	5.00	A
24	SP-1195	BC	YES	5	Index	2	0	1	1	0	0	0	1	4	5.40	A
25	SP-1245	MPS	YES	5	Quick Score	0	1	0	0	0	0	0	0	1	5.10	A
26	SP-1311	MPS	YES	5	Quick Score	0	0	0	0	0	0	0	0	0	5.00	A
27	SP-1406	MC	YES	5	Index	2	1	0	0	0	0	0	0	3	5.30	A
28	SP-1612	MC	YES	5	Index	2	1	0	0	0	0	0	0	3	5.30	A
29	SP-1630	MC	YES	5	Index	0	1	0	0	0	0	0	0	1	5.10	A
30	SP-1765	MC	YES	5	Index	0	1	1	0	0	0	0	0	2	5.20	A
31	SP-1767	MC	YES	5	Index	0	1	0	0	0	0	0	0	1	5.10	A
32	SP-1786	MC	YES	5	Index	2	1	0	0	0	0	0	0	3	5.30	A
33	SP-1788	MC	YES	5	Index	0	0	0	0	0	0	0	0	0	5.00	A
34	SP-1793	MC	YES	5	Index	2	1	0	0	0	0	0	0	3	5.30	A
35	SP-1804	MC	YES	5	Index	0	1	0	0	0	0	0	0	1	5.10	A
36	SP-1864	MPS	YES	5	Quick Score	0	0	0	0	1	0	0	1	1	5.10	A
37	SP-1958	MPS	YES	5	Quick Score	0	0	0	0	0	0	0	0	0	5.00	A
38	SP-2001	MC	YES	4	Index	2	1	1	0	1	0	0	1	5	4.50	A
39	SP-2006	MC	YES	5	Index	2	1	1	0	1	0	0	1	5	5.50	A
40	SP-2040	BC	YES	5	Index	0	1	0	0	0	0	0	0	1	5.10	A
41	SP-2134	MPS	YES	5	Index	2	1	0	1	0	0	0	1	4	5.40	A
42	SP-2143	MPS	YES	5	Quick Score	0	1	0	0	1	0	0	1	2	5.20	A
43	SP-2190	MPS	YES	5	Quick Score	2	1	0	0	0	1	0	1	4	5.40	A
44	SP-2198	MPS	YES	5	Quick Score	2	1	0	0	0	0	0	0	3	5.30	A

Table B-1. First Priority Tool Identified Pipes Not Identified Previously for R&R

Count	AssetID	BASIN	Inspected	ConditionR	Source	ART	CROSS	Diam	SLOPE	FSEArea	SFLOW	INFRA	MISC	CRIT	PVAL	PSCORE
45	SP-2279	BC	YES	4	Index	2	1	0	0	1	0	0	1	4	4.40	A
46	SP-2465	MC	YES	5	Index	0	0	0	0	0	0	0	0	0	5.00	A
47	SP-2480	MC	YES	5	Index	2	1	0	0	0	0	0	0	3	5.30	A
48	SP-2487	MC	YES	5	Index	0	1	0	0	0	0	0	0	1	5.10	A
49	SP-2489	MC	YES	5	Index	0	1	0	0	0	0	0	0	1	5.10	A
50	SP-2616	BC	YES	4	Index	2	1	1	0	0	1	1	1	5	4.50	A
51	SP-2664	MC	YES	5	Index	0	1	0	0	0	0	0	0	1	5.10	A
52	SP-2672	MC	YES	5	Index	0	1	1	0	0	0	0	0	2	5.20	A
53	SP-2734	BC	YES	4	Index	2	1	1	0	0	0	0	0	4	4.40	A
54	SP-2742	BC	YES	5	Index	0	1	0	0	1	0	0	1	2	5.20	A
55	SP-2787	BC	YES	5	Index	2	1	0	0	0	0	0	0	3	5.30	A
56	SP-2790	BC	YES	4	Index	2	1	1	0	1	0	0	1	5	4.50	A
57	SP-2844	MPS	YES	4	Quick Score	2	1	1	0	0	1	0	1	5	4.50	A
58	SP-2851	MPS	YES	5	Quick Score	0	1	0	0	0	0	0	0	1	5.10	A
59	SP-2888	MPS	YES	5	Quick Score	0	1	0	0	0	0	0	0	1	5.10	A
60	SP-2893	MPS	YES	5	Quick Score	0	1	0	0	0	0	0	0	1	5.10	A
61	SP-2907	LC	YES	5	Index	0	0	0	0	0	0	0	0	0	5.00	A
62	SP-2927	MC	YES	4	Index	2	1	0	0	1	0	0	1	4	4.40	A
63	SP-3039	MPS	YES	4	Quick Score	2	1	0	0	1	0	0	1	4	4.40	A
64	SP-3045	MPS	YES	5	Quick Score	0	1	0	0	0	0	1	1	2	5.20	A
65	SP-3050	MPS	YES	5	Quick Score	0	1	0	0	1	0	0	1	2	5.20	A
66	SP-3255	BC	YES	5	Index	2	0	1	0	1	0	0	1	4	5.40	A
67	SP-3324	BC	YES	4	Index	2	1	1	0	1	0	0	1	5	4.50	A
68	SP-3377	MC	YES	5	Index	0	0	0	0	1	1	0	1	1	5.10	A
69	SP-3379	MC	YES	5	Index	0	1	0	0	0	0	0	0	1	5.10	A
70	SP-3393	MC	YES	5	Index	2	1	0	0	0	0	0	0	3	5.30	A
71	SP-3427	WLW	YES	5	Quick Score	0	1	0	0	0	0	0	0	1	5.10	A
72	SP-3439	MC	YES	5	Index	0	0	0	0	0	0	0	0	0	5.00	A
73	SP-3556	MC	YES	5	Index	0	1	0	0	0	0	0	0	1	5.10	A
74	SP-3565	MC	YES	5	Index	0	1	0	0	0	0	0	0	1	5.10	A
75	SP-3629	BC	YES	5	Index	0	0	0	0	0	0	0	0	0	5.00	A
76	SP-3665	BC	YES	5	Index	2	1	0	0	1	1	0	1	4	5.40	A
77	SP-3675	BC	YES	5	Index	2	1	0	0	1	0	0	1	4	5.40	A
78	SP-3723	MPS	YES	5	Quick Score	0	1	0	0	0	0	0	0	1	5.10	A
79	SP-3729	MPS	YES	5	Quick Score	0	1	0	0	0	0	0	0	1	5.10	A
80	SP-3739	MPS	YES	5	Quick Score	2	1	0	0	0	0	0	0	3	5.30	A
81	SP-3754	MPS	YES	5	Quick Score	2	1	0	0	1	0	0	1	4	5.40	A
82	SP-3795	MC	YES	4	Index	2	1	0	0	1	0	0	1	4	4.40	A
83	SP-3796	MC	YES	5	Index	2	1	0	0	1	0	0	1	4	5.40	A
84	SP-3803	MC	YES	5	Index	0	1	0	0	0	0	0	0	1	5.10	A
85	SP-4078	WLW	YES	5	Quick Score	0	1	0	0	0	0	0	0	1	5.10	A
86	SP-4214	MC	YES	5	Index	0	0	0	0	0	0	0	0	0	5.00	A
87	SP-4222	MC	YES	5	Index	0	0	0	0	0	0	0	0	0	5.00	A
88	SP-4246	MC	YES	5	Index	2	1	0	0	0	0	0	0	3	5.30	A

Table B-1. First Priority Tool Identified Pipes Not Identified Previously for R&R

Count	AssetID	BASIN	Inspected	ConditionR	Source	ART	CROSS	Diam	SLOPE	FSEArea	SFLOW	INFRA	MISC	CRIT	PVAL	PSCORE
89	SP-4247	MC	YES	5	Index	0	1	0	0	0	0	0	0	1	5.10	A
90	SP-4251	MC	YES	5	Index	2	1	0	0	0	0	0	0	3	5.30	A
91	SP-4277	MC	YES	5	Index	2	1	0	0	0	0	0	0	3	5.30	A
92	SP-4381	BC	YES	5	Index	0	1	0	0	0	0	0	0	1	5.10	A
93	SP-4427	MC	YES	5	Index	0	1	0	0	0	0	0	0	1	5.10	A
94	SP-4495	BC	YES	5	Index	0	1	0	0	1	0	0	1	2	5.20	A
95	SP-4530	BC	YES	5	Index	2	1	0	0	0	0	0	0	3	5.30	A
96	SP-4539	BC	YES	5	Index	2	1	0	0	1	0	0	1	4	5.40	A
97	SP-4541	BC	YES	5	Index	2	1	0	0	0	0	0	0	3	5.30	A
98	SP-4550	BC	YES	5	Index	2	0	0	0	1	0	0	1	3	5.30	A
99	SP-4588	MPS	YES	5	Quick Score	0	1	0	0	1	0	0	1	2	5.20	A
100	SP-4619	MPS	YES	5	Quick Score	2	1	0	0	0	0	0	0	3	5.30	A
101	SP-4646	MPS	YES	5	Index	0	1	0	0	1	0	0	1	2	5.20	A
102	SP-4654	MPS	YES	5	Quick Score	0	0	0	0	0	0	0	0	0	5.00	A
103	SP-4655	MPS	YES	5	Quick Score	0	1	0	0	0	0	0	0	1	5.10	A
104	SP-4665	MPS	YES	5	Quick Score	0	0	0	0	0	0	0	0	0	5.00	A
105	SP-4698	MC	YES	5	Index	2	0	0	0	1	0	0	1	3	5.30	A
106	SP-4734	MPS	YES	5	Quick Score	2	0	0	0	1	0	0	1	3	5.30	A
107	SP-4740	MPS	YES	5	Quick Score	0	1	0	0	0	0	0	0	1	5.10	A
108	SP-4828	MPS	YES	5	Index	0	0	0	0	0	0	0	0	0	5.00	A
109	SP-4915	MC	YES	5	Index	2	1	1	0	0	0	0	0	4	5.40	A
110	SP-4967	MPS	YES	4	Index	2	1	1	0	0	1	0	1	5	4.50	A
111	SP-5083	MC	YES	5	Index	0	1	0	0	0	0	0	0	1	5.10	A
112	SP-5089	MC	YES	5	Index	0	1	0	0	0	0	0	0	1	5.10	A
113	SP-5095	MC	YES	5	Index	2	0	0	0	0	0	0	0	2	5.20	A
114	SP-5104	MC	YES	5	Index	2	1	0	0	0	0	0	0	3	5.30	A
115	SP-5106	MC	YES	5	Index	0	0	0	0	0	0	0	0	0	5.00	A
116	SP-5123	MC	YES	5	Index	0	0	0	0	0	0	0	0	0	5.00	A
117	SP-5157	MC	YES	5	Index	0	0	0	0	0	0	0	0	0	5.00	A
118	SP-5159	MC	YES	5	Index	0	1	0	0	0	0	0	0	1	5.10	A
119	SP-5259	BC	YES	5	Index	0	0	0	0	0	0	0	0	0	5.00	A
120	SP-5383	BC	YES	4	Index	2	0	1	1	0	0	0	1	4	4.40	A
121	SP-5419	BC	YES	5	Index	2	0	0	0	0	0	0	0	2	5.20	A
122	SP-5433	MPS	YES	5	Index	0	0	0	0	0	0	0	0	0	5.00	A
123	SP-5476	MPS	YES	5	Quick Score	0	1	0	0	0	0	0	0	1	5.10	A
124	SP-5485	MPS	YES	5	Quick Score	0	1	0	0	1	0	0	1	2	5.20	A
125	SP-5505	MPS	YES	5	Quick Score	0	0	0	0	0	0	0	0	0	5.00	A
126	SP-5558	MC	YES	4	Index	2	1	1	0	1	0	0	1	5	4.50	A
127	SP-5559	MC	YES	5	Index	2	1	1	0	0	0	0	0	4	5.40	A
128	SP-5644	BC	YES	5	Index	2	1	0	0	1	0	0	1	4	5.40	A
129	SP-5811	MC	YES	4	Index	2	1	1	0	1	0	0	1	5	4.50	A
130	SP-5958	MC	YES	5	Index	0	1	0	0	0	0	0	0	1	5.10	A
131	SP-5976	MC	YES	5	Index	2	1	0	0	0	0	0	0	3	5.30	A
132	SP-6099	BC	YES	5	Index	0	1	0	0	0	0	0	0	1	5.10	A

Table B-1. First Priority Tool Identified Pipes Not Identified Previously for R&R

Count	AssetID	BASIN	Inspected	ConditionR	Source	ART	CROSS	Diam	SLOPE	FSEArea	SFLOW	INFRA	MISC	CRIT	PVAL	PSCORE
133	SP-6251	BC	YES	5	Index	0	0	0	0	0	0	0	0	0	5.00	A
134	SP-6328	MPS	YES	5	Quick Score	2	1	0	0	0	0	0	0	3	5.30	A
135	SP-6334	MPS	YES	5	Quick Score	0	1	0	0	0	0	0	0	1	5.10	A
136	SP-6346	MPS	YES	5	Quick Score	2	1	0	0	0	0	0	0	3	5.30	A
137	SP-6366	MPS	YES	5	Quick Score	0	1	0	0	0	0	0	0	1	5.10	A
138	SP-6367	MPS	YES	5	Quick Score	0	1	0	0	0	0	0	0	1	5.10	A
139	SP-6419	MC	YES	5	Index	2	0	0	0	1	0	0	1	3	5.30	A
140	SP-6523	BC	YES	5	Index	2	0	0	0	0	0	0	0	2	5.20	A
141	SP-6549	MPS	YES	4	Quick Score	2	1	0	0	1	0	0	1	4	4.40	A
142	SP-6635	BC	YES	5	Index	0	1	1	0	1	0	0	1	3	5.30	A
143	SP-6943	MPS	YES	5	Quick Score	0	1	0	0	0	0	0	0	1	5.10	A
144	SP-6962	BC	YES	5	Index	0	1	0	0	0	0	0	0	1	5.10	A
145	SP-7033	BC	YES	5	Index	0	0	0	0	0	0	0	0	0	5.00	A
146	SP-7062	LC	YES	5	Index	0	0	1	0	1	1	0	1	2	5.20	A
147	SP-7076	MC	YES	5	Index	2	0	0	0	1	0	0	1	3	5.30	A
148	SP-7081	MC	YES	5	Index	2	1	1	0	1	0	0	1	5	5.50	A
149	SP-7094	BC	YES	5	Index	2	1	0	0	0	0	0	0	3	5.30	A
150	SP-7114	BC	YES	5	Index	0	1	0	0	0	0	0	0	1	5.10	A
151	SP-7205	MPS	YES	4	Quick Score	2	1	0	0	1	0	0	1	4	4.40	A
152	SP-7214	MPS	YES	5	Quick Score	0	1	0	0	0	0	0	0	1	5.10	A
153	SP-7215	MPS	YES	5	Quick Score	0	0	0	0	0	0	0	0	0	5.00	A
154	SP-7255	MPS	YES	5	Quick Score	0	1	0	0	0	0	0	0	1	5.10	A
155	SP-7256	MPS	YES	5	Quick Score	2	1	0	0	0	0	0	0	3	5.30	A
156	SP-7257	MPS	YES	5	Quick Score	2	0	0	0	0	0	0	0	2	5.20	A
157	SP-7275	MPS	YES	5	Quick Score	0	1	0	0	0	0	0	0	1	5.10	A
158	SP-7281	MPS	YES	5	Quick Score	0	1	0	0	0	0	0	0	1	5.10	A
159	SP-7292	MPS	YES	5	Quick Score	2	1	0	0	0	0	0	0	3	5.30	A
160	SP-7294	MPS	YES	5	Quick Score	0	1	0	0	0	0	0	0	1	5.10	A
161	SP-7343	MC	YES	5	Index	0	1	0	0	0	0	0	0	1	5.10	A
162	SP-8199	MPS	YES	5	Quick Score	0	0	0	0	0	0	1	1	1	5.10	A
163	SP-8205	MPS	YES	5	Quick Score	0	0	0	0	0	0	1	1	1	5.10	A
164	SP-8491	LC	YES	5	Index	0	0	1	0	0	0	0	0	1	5.10	A
165	SP-8610	MPS	YES	5	Quick Score	0	1	0	0	0	1	0	1	2	5.20	A
166	SP-8617	MPS	YES	5	Quick Score	2	1	1	0	0	1	0	1	5	5.50	A
167	SP-8627	MC	YES	5	Index	0	1	0	0	0	0	0	0	1	5.10	A
168	SP-8654	MC	YES	5	Index	0	1	0	0	0	0	0	0	1	5.10	A
169	SP-8748	WLW	YES	5	Quick Score	0	1	0	1	0	0	1	1	2	5.20	A
170	SP-8761	MPS	YES	5	Quick Score	0	1	0	0	0	0	0	0	1	5.10	A
171	SP-8770	BC	YES	5	Index	0	1	0	0	0	0	0	0	1	5.10	A
172	SP-8957	MPS	YES	5	Quick Score	0	1	1	0	0	0	0	0	2	5.20	A
173	SP-9017	MC	YES	5	Index	2	0	1	0	0	1	0	1	4	5.40	A
174	SP-9075	MPS	YES	5	Quick Score	0	1	1	0	1	1	0	1	3	5.30	A
175	SP-9076	MPS	YES	5	Quick Score	0	1	0	0	1	0	0	1	2	5.20	A
176	SP-9124	MC	YES	4	Index	2	1	1	0	0	0	0	0	4	4.40	A

Table B-1. First Priority Tool Identified Pipes Not Identified Previously for R&R

Count	AssetID	BASIN	Inspected	ConditionR	Source	ART	CROSS	Diam	SLOPE	FSEArea	SFLOW	INFRA	MISC	CRIT	PVAL	PSCORE
177	SP-9275	MC	YES	5	Index	0	1	0	0	0	0	0	0	1	5.10	A
178	SP-9306	MC	YES	5	Index	2	1	0	0	0	0	0	0	3	5.30	A
179	SP-9310	BC	YES	4	Index	2	1	1	0	1	0	0	1	5	4.50	A
180	SP-9320	MC	YES	4	Index	2	1	1	0	0	1	0	1	5	4.50	A
181	SP-9682	MC	YES	5	Index	2	1	0	0	0	1	0	1	4	5.40	A
182	SP-9854	MPS	YES	5	Quick Score	0	1	0	0	0	0	0	0	1	5.10	A
183	SP-9855	MPS	YES	5	Quick Score	0	1	0	0	0	0	0	0	1	5.10	A
184	SP-10398	MC	YES	5	Index	0	0	1	0	0	0	0	0	1	5.10	A
185	SP-10507	MC	YES	5	Index	0	1	0	0	0	0	0	0	1	5.10	A
186	SP-10783	MC	YES	5	Index	0	1	0	0	0	0	0	0	1	5.10	A
187	SP-10940	MPS	YES	5	Quick Score	0	1	0	0	1	0	0	1	2	5.20	A
188	SP-10947	MPS	YES	5	Quick Score	0	1	1	0	0	0	0	0	2	5.20	A
189	SP-12473	MC	YES	5	Index	2	1	0	0	0	0	0	0	3	5.30	A
190	SP-12532	MC	YES	4	Index	2	1	1	0	0	0	0	0	4	4.40	A
191	SP-12534	MC	YES	5	Index	2	0	1	0	0	0	0	0	3	5.30	A
192	SP-12535	MC	YES	5	Index	2	0	1	0	0	0	0	0	3	5.30	A
193	SP-12537	MC	YES	5	Index	2	1	0	0	0	0	0	0	3	5.30	A
194	SP-12836	MC	YES	5	Index	2	1	0	0	0	0	0	0	3	5.30	A
195	SP-12850	MC	YES	5	Index	2	1	0	0	0	0	0	0	3	5.30	A
196	SP-12851	MC	YES	5	Index	2	1	1	0	0	0	0	0	4	5.40	A
197	SP-14269	BC	YES	5	Index	2	0	1	0	0	0	0	0	3	5.30	A
198	SP-14324	BC	YES	4	Index	2	1	0	1	1	0	0	1	4	4.40	A
199	SP-14561	MPS	YES	5	Quick Score	2	1	1	0	0	0	0	0	4	5.40	A
200	SP-15323	MPS	YES	5	Quick Score	0	1	0	0	0	0	0	0	1	5.10	A
201	SP-15133	MC	YES	5	Index	0	1	0	0	0	0	0	0	1	5.10	A
202	SP-15105	LC	YES	5	Index	0	1	0	0	0	0	0	0	1	5.10	A
203	SP-6843	MC	YES	5	Index	2	1	0	0	0	0	0	0	3	5.30	A
204	SP-1719	MPS	YES	5	Quick Score	0	0	0	0	1	0	0	1	1	5.10	A
205	SP-1905	MPS	YES	5	Quick Score	0	0	0	0	1	0	0	1	1	5.10	A
206	SP-7337	MPS	YES	5	Quick Score	2	1	0	0	0	0	0	0	3	5.30	A

Table B-2. Second Priority Tool Identified Pipes Not Identified Previously for R&R

Count	AssetID	BASIN	Inspected	ConditionR	Source	ART	CROSS	Diam	SLOPE	FSEArea	SFLOW	INFRA	MISC	CRIT	PVAL	PSCORE
1	SP-71	BC	YES	4	Index	0	1	0	0	1	0	0	1	2	4.20	B
2	SP-138	MC	YES	4	Index	2	1	0	0	0	0	0	0	3	4.30	B
3	SP-255	BC	YES	4	Index	2	1	0	0	0	0	0	0	3	4.30	B
4	SP-281	BC	YES	4	Index	0	1	0	0	0	1	0	1	2	4.20	B
5	SP-329	BC	YES	4	Index	0	1	0	0	0	0	0	0	1	4.10	B
6	SP-411	MPS	YES	4	Quick Score	0	1	0	0	0	0	0	0	1	4.10	B
7	SP-425	MPS	YES	4	Quick Score	0	1	0	0	0	0	0	0	1	4.10	B
8	SP-757	MC	YES	4	Index	0	1	0	0	0	0	0	0	1	4.10	B
9	SP-766	LC	YES	4	Index	0	0	0	0	0	0	0	0	0	4.00	B
10	SP-786	MC	YES	4	Index	0	1	0	0	1	0	0	1	2	4.20	B
11	SP-917	MC	YES	4	Index	2	1	0	0	0	0	0	0	3	4.30	B
12	SP-951	MC	YES	4	Index	0	0	0	0	0	0	0	0	0	4.00	B
13	SP-1011	BC	YES	4	Index	2	1	0	0	0	0	0	0	3	4.30	B
14	SP-1025	MPS	YES	4	Quick Score	0	0	0	0	0	0	0	0	0	4.00	B
15	SP-1078	MPS	YES	4	Index	0	1	0	0	0	0	0	0	1	4.10	B
16	SP-1087	MPS	YES	4	Index	0	1	0	0	0	0	0	0	1	4.10	B
17	SP-1098	MPS	YES	4	Quick Score	0	1	0	0	0	0	0	0	1	4.10	B
18	SP-1121	MPS	YES	4	Quick Score	0	1	0	0	0	0	0	0	1	4.10	B
19	SP-1170	BC	YES	4	Index	2	1	0	0	0	0	0	0	3	4.30	B
20	SP-1267	MPS	YES	4	Quick Score	0	1	0	0	0	0	0	0	1	4.10	B
21	SP-1278	MPS	YES	4	Index	0	0	1	0	0	0	0	0	1	4.10	B
22	SP-1288	MPS	YES	4	Index	2	1	0	0	0	0	0	0	3	4.30	B
23	SP-1313	MPS	YES	4	Quick Score	0	1	0	0	0	0	0	0	1	4.10	B
24	SP-1333	MPS	YES	4	Quick Score	0	1	0	0	0	0	0	0	1	4.10	B
25	SP-1598	MC	YES	4	Index	0	1	0	0	0	0	0	0	1	4.10	B
26	SP-1632	MC	YES	4	Index	0	0	0	0	1	0	0	1	1	4.10	B
27	SP-1671	BC	YES	4	Index	2	1	0	0	0	0	0	0	3	4.30	B
28	SP-1787	MC	YES	4	Index	2	1	0	0	0	0	0	0	3	4.30	B
29	SP-1818	MC	YES	4	Index	2	1	0	0	0	0	0	0	3	4.30	B
30	SP-1844	BC	YES	4	Index	0	1	0	0	0	0	0	0	1	4.10	B
31	SP-1845	BC	YES	4	Index	2	1	0	0	0	0	0	0	3	4.30	B
32	SP-1863	BC	YES	4	Index	2	1	0	0	0	0	0	0	3	4.30	B
33	SP-1871	BC	YES	4	Index	2	1	0	0	0	0	0	0	3	4.30	B
34	SP-1972	MPS	YES	4	Quick Score	0	0	0	0	0	0	0	0	0	4.00	B
35	SP-1973	LC	YES	4	Index	0	0	1	0	1	0	1	1	2	4.20	B
36	SP-1978	LC	YES	4	Index	0	1	1	0	0	0	0	0	2	4.20	B
37	SP-1980	LC	YES	4	Index	0	0	1	0	0	1	0	1	2	4.20	B
38	SP-2010	MC	YES	4	Index	0	0	0	0	0	1	0	1	1	4.10	B
39	SP-2201	MPS	YES	4	Quick Score	0	1	0	0	0	0	0	0	1	4.10	B
40	SP-2362	MPS	YES	4	Quick Score	0	1	0	0	0	0	0	0	1	4.10	B
41	SP-2365	MPS	YES	4	Quick Score	2	1	0	0	0	0	0	0	3	4.30	B
42	SP-2530	MC	YES	4	Index	0	1	0	0	0	0	0	0	1	4.10	B
43	SP-2551	MC	YES	4	Index	0	1	0	0	1	0	0	1	2	4.20	B

Table B-2. Second Priority Tool Identified Pipes Not Identified Previously for R&R

Count	AssetID	BASIN	Inspected	ConditionR	Source	ART	CROSS	Diam	SLOPE	FSEArea	SFLOW	INFRA	MISC	CRIT	PVAL	PSCORE
44	SP-2647	BC	YES	4	Index	0	0	0	0	0	0	0	0	0	4.00	B
45	SP-2655	MC	YES	4	Index	0	1	1	0	0	0	0	0	2	4.20	B
46	SP-2674	MC	YES	4	Index	0	0	0	0	0	0	0	0	0	4.00	B
47	SP-2690	MC	YES	4	Index	0	0	0	0	0	0	0	0	0	4.00	B
48	SP-2795	BC	YES	4	Index	0	1	0	0	0	0	0	0	1	4.10	B
49	SP-2807	BC	YES	4	Index	0	1	1	0	1	0	0	1	3	4.30	B
50	SP-2842	MPS	YES	4	Index	0	1	0	0	1	0	0	1	2	4.20	B
51	SP-2859	MPS	YES	4	Index	0	1	0	0	0	0	0	0	1	4.10	B
52	SP-2862	MPS	YES	4	Quick Score	0	1	0	0	0	1	0	1	2	4.20	B
53	SP-2908	LC	YES	4	Index	0	0	1	0	1	1	0	1	2	4.20	B
54	SP-2915	LC	YES	4	Index	0	0	0	0	0	0	0	0	0	4.00	B
55	SP-3031	MPS	YES	4	Quick Score	0	1	0	0	0	0	0	0	1	4.10	B
56	SP-3064	MPS	YES	4	Index	2	0	0	0	0	0	0	0	2	4.20	B
57	SP-3388	MC	YES	4	Index	2	1	0	0	0	0	0	0	3	4.30	B
58	SP-3413	MC	YES	4	Index	0	0	0	0	0	0	0	0	0	4.00	B
59	SP-3472	BC	YES	4	Index	0	1	1	0	0	0	0	0	2	4.20	B
60	SP-3584	BC	YES	4	Index	0	1	0	0	0	0	0	0	1	4.10	B
61	SP-3707	MPS	YES	4	Index	2	1	0	0	0	0	0	0	3	4.30	B
62	SP-3731	MPS	YES	4	Index	0	1	0	0	0	0	0	0	1	4.10	B
63	SP-3732	MPS	YES	4	Quick Score	0	1	0	0	0	0	0	0	1	4.10	B
64	SP-3775	LC	YES	4	Index	0	0	0	0	0	0	1	1	1	4.10	B
65	SP-3893	MC	YES	4	Index	2	1	0	0	0	0	0	0	3	4.30	B
66	SP-4079	MC	YES	4	Index	0	1	0	0	0	0	0	0	1	4.10	B
67	SP-4218	MC	YES	4	Index	0	1	0	0	0	0	0	0	1	4.10	B
68	SP-4232	MPS	YES	4	Quick Score	0	1	0	0	0	0	0	0	1	4.10	B
69	SP-4250	MC	YES	4	Index	2	1	0	0	0	0	0	0	3	4.30	B
70	SP-4261	MC	YES	4	Index	0	1	0	0	0	0	0	0	1	4.10	B
71	SP-4274	MC	YES	4	Index	0	1	0	0	1	0	0	1	2	4.20	B
72	SP-4438	MPS	YES	4	Index	0	1	0	0	0	0	0	0	1	4.10	B
73	SP-4441	BC	YES	4	Index	0	0	0	0	0	1	0	1	1	4.10	B
74	SP-4559	MPS	YES	4	Quick Score	0	1	0	0	0	0	0	0	1	4.10	B
75	SP-4607	MPS	YES	4	Quick Score	0	1	0	0	0	0	0	0	1	4.10	B
76	SP-4628	MPS	YES	4	Index	0	0	0	0	0	0	0	0	0	4.00	B
77	SP-4677	LC	YES	4	Index	0	1	1	1	1	1	0	1	3	4.30	B
78	SP-4682	LC	YES	4	Index	0	0	0	0	0	0	0	0	0	4.00	B
79	SP-4780	LC	YES	4	Index	0	0	0	0	0	0	0	0	0	4.00	B
80	SP-4805	MPS	YES	4	Quick Score	2	1	0	0	0	0	0	0	3	4.30	B
81	SP-4810	MPS	YES	4	Index	2	1	0	0	0	0	0	0	3	4.30	B
82	SP-4823	MPS	YES	4	Quick Score	0	1	0	0	0	0	0	0	1	4.10	B
83	SP-5092	MC	YES	4	Index	0	1	0	0	0	0	0	0	1	4.10	B
84	SP-5141	MC	YES	4	Index	2	1	0	0	0	0	0	0	3	4.30	B
85	SP-5210	BC	YES	4	Index	0	0	0	0	0	0	0	0	0	4.00	B
86	SP-5260	BC	YES	4	Index	0	0	0	0	0	0	0	0	0	4.00	B

Table B-2. Second Priority Tool Identified Pipes Not Identified Previously for R&R

Count	AssetID	BASIN	Inspected	ConditionR	Source	ART	CROSS	Diam	SLOPE	FSEArea	SFLOW	INFRA	MISC	CRIT	PVAL	PSCORE
87	SP-5312	BC	YES	4	Index	2	1	0	0	0	0	0	0	3	4.30	B
88	SP-5441	MPS	YES	4	Quick Score	0	1	0	0	0	0	0	0	1	4.10	B
89	SP-5453	MPS	YES	4	Quick Score	0	1	0	0	0	0	0	0	1	4.10	B
90	SP-5490	MPS	YES	4	Index	0	1	0	0	0	0	0	0	1	4.10	B
91	SP-5647	BC	YES	4	Index	2	1	0	0	0	0	0	0	3	4.30	B
92	SP-5673	Middle Pug	YES	4	Quick Score	0	0	0	0	0	0	0	0	0	4.00	B
93	SP-5749	BC	YES	4	Index	0	1	0	0	1	0	0	1	2	4.20	B
94	SP-5853	BC	YES	4	Index	0	1	0	0	1	0	0	1	2	4.20	B
95	SP-6031	MC	YES	4	Index	2	1	0	0	0	0	0	0	3	4.30	B
96	SP-6072	BC	YES	4	Index	2	0	0	0	0	0	0	0	2	4.20	B
97	SP-6127	MC	YES	4	Index	0	1	1	0	0	0	0	0	2	4.20	B
98	SP-6132	MC	YES	4	Index	0	1	1	0	0	0	1	1	3	4.30	B
99	SP-6144	MC	YES	4	Index	0	0	0	0	0	0	0	0	0	4.00	B
100	SP-6236	BC	YES	4	Index	2	1	0	0	0	0	0	0	3	4.30	B
101	SP-6300	MPS	YES	4	Quick Score	0	1	0	0	1	0	0	1	2	4.20	B
102	SP-6343	MPS	YES	4	Quick Score	0	1	0	0	0	0	0	0	1	4.10	B
103	SP-6361	MPS	YES	4	Index	0	1	0	0	0	0	0	0	1	4.10	B
104	SP-6393	MPS	YES	4	Index	0	1	0	0	0	0	0	0	1	4.10	B
105	SP-6681	MC	YES	4	Index	0	1	0	0	1	0	0	1	2	4.20	B
106	SP-6682	MC	YES	4	Index	0	1	0	0	1	0	0	1	2	4.20	B
107	SP-6809	MC	YES	4	Index	0	1	0	0	0	0	0	0	1	4.10	B
108	SP-6812	MC	YES	4	Index	0	1	1	0	0	0	0	0	2	4.20	B
109	SP-6831	MC	YES	4	Index	0	0	0	0	0	0	0	0	0	4.00	B
110	SP-6906	LC	YES	4	Index	0	0	0	0	0	0	0	0	0	4.00	B
111	SP-6929	BC	YES	4	Index	2	1	0	0	0	0	0	0	3	4.30	B
112	SP-6969	BC	YES	4	Index	0	0	0	0	0	1	0	1	1	4.10	B
113	SP-6970	BC	YES	4	Index	0	1	1	0	0	0	0	0	2	4.20	B
114	SP-6994	BC	YES	4	Index	0	1	0	0	0	0	0	0	1	4.10	B
115	SP-6995	BC	YES	4	Index	2	1	0	0	0	0	0	0	3	4.30	B
116	SP-7046	MPS	YES	4	Quick Score	2	0	0	0	0	0	0	0	2	4.20	B
117	SP-7066	LC	YES	4	Index	0	1	0	0	0	0	0	0	1	4.10	B
118	SP-7098	BC	YES	4	Index	0	0	0	0	0	0	0	0	0	4.00	B
119	SP-7196	MPS	YES	4	Quick Score	0	1	0	0	1	0	0	1	2	4.20	B
120	SP-7198	MPS	YES	4	Quick Score	0	1	0	0	1	0	0	1	2	4.20	B
121	SP-7303	MC	YES	4	Index	0	1	0	0	1	0	0	1	2	4.20	B
122	SP-7319	MPS	YES	4	Quick Score	0	0	0	0	0	0	0	0	0	4.00	B
123	SP-7356	MPS	YES	4	Quick Score	2	0	0	0	0	0	0	0	2	4.20	B
124	SP-8637	MC	YES	4	Index	0	0	1	0	0	0	0	0	1	4.10	B
125	SP-8674	MC	YES	4	Index	0	1	0	0	0	0	0	0	1	4.10	B
126	SP-8744	MPS	YES	4	Index	2	1	0	0	0	0	0	0	3	4.30	B
127	SP-8803	MC	YES	4	Index	2	1	0	0	0	0	0	0	3	4.30	B
128	SP-8876	MC	YES	4	Index	2	1	0	0	0	0	0	0	3	4.30	B
129	SP-9009	MPS	YES	4	Quick Score	0	1	1	0	0	0	0	0	2	4.20	B

Table B-2. Second Priority Tool Identified Pipes Not Identified Previously for R&R

Count	AssetID	BASIN	Inspected	ConditionR	Source	ART	CROSS	Diam	SLOPE	FSEArea	SFLOW	INFRA	MISC	CRIT	PVAL	PSCORE
130	SP-9016	LC	YES	4	Index	0	1	1	0	1	1	0	1	3	4.30	B
131	SP-9223	MC	YES	4	Index	2	1	0	0	0	0	0	0	3	4.30	B
132	SP-9243	MC	YES	4	Index	2	0	0	0	0	0	0	0	2	4.20	B
133	SP-9269	MPS	YES	4	Quick Score	0	1	1	0	0	0	0	0	2	4.20	B
134	SP-9676	MPS	YES	4	Quick Score	0	0	0	0	1	0	0	1	1	4.10	B
135	SP-10246	BC	YES	4	Index	0	1	0	0	0	1	1	1	2	4.20	B
136	SP-10508	MC	YES	4	Index	0	1	0	0	0	0	0	0	1	4.10	B
137	SP-12023	MC	YES	4	Index	0	1	0	0	0	0	0	0	1	4.10	B
138	SP-12230	MC	YES	4	Index	2	1	0	0	0	0	0	0	3	4.30	B
139	SP-12529	MC	YES	4	Index	2	1	0	0	0	0	0	0	3	4.30	B
140	SP-12682	MC	YES	4	Index	2	1	0	0	0	0	0	0	3	4.30	B
141	SP-15080	MC	YES	4	Index	0	0	0	0	0	0	0	0	0	4.00	B
142	SP-15336	MPS	YES	4	Quick Score	0	1	0	0	1	0	0	1	2	4.20	B
143	SP-15649	MPS	YES	4	Quick Score	0	1	0	0	0	0	0	0	1	4.10	B

Appendix C: Sample Pumping Station Condition Assessment Form

PUMPING STATION CONDITION ASSESSMENT FORM

Inspector Names: ______________________________ Assessment Date: ____________ Time: ____________

PS #: ____________ PS. Name: ______________________________ PS. Address: ______________________________

Lift Station Type: ☐ Flooded Suction ☐ Wet Well Mounted ☐ Recessed Wet Well ☐ Submersible Pumps ☐ Air Ejector

House Keeping: ☐ Good ☐ N/A ☐ Poor Lighting ☐ Tripping Hazards Present ☐ No Fall Protection ☐ Potential for Shock or Electrocution ☐ Exposure to Raw Wastewater in Dry Well ☐ Sump Pump Inoperable ☐ Electric Space Heater Inoperable ☐ Other:

Confined Space Entry Required?: N ☐ Y☐ Permitted Confined Space?: N ☐ Y☐

Urgent Repairs or Issues to Address: ______________________________

Health and Safety Issues: ______________________________

Asset Class	CMMS Code	Asset Present	Year Installed	Cond. Rank.	Perf. Rank.	Utiliz. (%)	Field Observation / Comments
Site Improvements (SIM)		Y / N				N/A	
▪ *Access Driveway*		*Y / N*				*N/A*	
▪ *Parking*		*Y / N*				*N/A*	
▪ *Sidewalks*		*Y / N*				*N/A*	
▪ *Landscaping*		*Y / N*				*N/A*	
▪ *Gate and Fencing*		*Y / N*				*N/A*	
▪ *Wash Water Station*		*Y / N*				*N/A*	
▪ *Backflow Preventer*		*Y / N*				*N/A*	
▪ *Site Drainage*		*Y / N*				*N/A*	
▪ *Lightning Protection*		*Y / N*				*N/A*	
▪ *Grounding System*		*Y / N*				*N/A*	
▪ *General Site Electrical Observations*		*Y / N*				*N/A*	

Access Driveway Details: ☐ *Gravel or aggregate base course only* ☐ *Concrete pavement* ☐ *Bituminous pavement* *Approximate driveway area (SF):*

Curb and Gutter Details: ☐ *None* ☐ *Cement concrete curbs* *If applicable, length of curb (LF):*

Parking Details: ☐ *None* ☐ *Gravel* ☐ *Paved* *If applicable, approximate parking area (SF):*

Sidewalk Details: ☐ *None* ☐ *Bituminous* ☐ *Brick* ☐ *Concrete* *If applicable, approximate sidewalk area (SF):*

Fence Details: Fence type: ☐ *Chain Link* ☐ *Other(Specify)*____________ *Fence height (feet):* ________ *Fence length (feet):* ________ *Gate type: Single* ☐ *Double* ☐

*Backflow Preventer Details: Manufacturer:*____________ *Model:*____________ *Serial No:*____________ *Size (Inches):*____________- *Maximum Pressure (psi):*________

Flow Meter for Wash Water: ☐ *None* ☐ *Flow Meter* ☐ *Size (in):*________

Site Improvements Field Observations: ☐ *Good* ☐ *N/A* ☐ *Fencing Not Secure* ☐ *Access Driveway Cracked* ☐ *Sidewalks Cracked* ☐ *Tripping Hazard* ☐ *Sidewalks Not Well Maintained* ☐ *Site too Close to Traffic* ☐ *Shrubbery or Bushes Not Well Kept* ☐ *Erosion of driveway, parking area or sidewalks* ☐ *Other:*

Grounding System Details: ☐ *Present* ☐ *Grounding Rings* ☐ *Grounding Rods* ☐ *Grounding Test Wells* ☐ *Observations:*

Asset Class	CMMS Code	Asset Present	Year Installed	Cond. Rank.	Perf. Rank.	Utiliz. (%)	Field Observation / Comments
Buildings, Wet Well and Dry Well (PST)						N/A	
▪ *Building*		*Y / N*				*N/A*	

Building structures (tick all that apply): ☐ *No building* ☐ *Concrete walls* ☐ *Concrete floor slabs* ☐ *Brick walls* ☐ *Roof/Type:*____________
☐ *Windows* ☐ *Doors* ☐ *Total Floor Area (SF):*______

Plan Floor Area (SF): __________ ☐ *Ground Floor* ☐ *Intermediate Floor* ☐ *Lower Floor Level*

Building Field Observations: ☐ *Good* ☐ *N/A* ☐ *Roof Degraded* ☐ *Windows Cracked* ☐ *Doors and Security Failing* ☐ *Needs Paint* ☐ *Cracks on the Wall* ☐ *Cracks in Floor Slab* ☐ *Other:*

Condition Ranking: 1) Excellent 2) Slight Visible Degradation 3) Visible Degradation 4) Integrity of Component Moderately Compromised 5) Integrity of Component Severely Compromised
Performance Ranking: 1) Component Functioning As Intended 2) In-Service, But Higher Than Expected O&M 3) In-Service, But Function Is Impaired 4) In-Service, But Function Is Highly Impaired 5) Component Is Not Functioning As Intended

PUMPING STATION CONDITION ASSESSMENT FORM

Asset Class	CMMS Code	Asset Present	Year Installed	Cond. Rank.	Perf. Rank.	Utiliz. (%)	Field Observation / Comments
▪ Odor Control		Y / N				N/A	

Odor Details: ☐ *Chemical Addition* ☐ *Biofilter* ☐ *Details:*______________________________

Field Observations: ☐ *Odor control is operational and in use* ☐ *Odor control facility is on site but not required* ☐ *Does not operate, requires repair* ☐ *Other:*

Asset Class	CMMS Code	Asset Present	Year Installed	Cond. Rank.	Perf. Rank.	Utiliz. (%)	Field Observation / Comments
▪ Crane		Y / N				N/A	

Crane Details: ☐ *Manufacturer:*_______________ *Model:*_____________ *Serial No:* ______________ *Capacity:*_______________

Field Observations: ☐ *Good operating condition* ☐ *Does not operate, requires repair* ☐ *Other:*

Asset Class	CMMS Code	Asset Present	Year Installed	Cond. Rank.	Perf. Rank.	Utiliz. (%)	Field Observation / Comments
▪ Crane I-Beam		Y / N				N/A	

:Field Observations: ☐ *Good Condition* ☐ *Structural Corrosion* ☐ *Other:*

Asset Class	CMMS Code	Asset Present	Year Installed	Cond. Rank.	Perf. Rank.	Utiliz. (%)	Field Observation / Comments
▪ Wet Well Measurements	N/A	N/A	N/A	N/A	N/A	N/A	

Shape: ☐ *Circular* ☐ *Rectangular* ☐ *Other (provide separate sketch)*

Circular Wet Well Dimensions: ☐ *N/A* ☐ *Internal Diameter (ft)* ____________ ☐ *Wall thickness (inches):*_____________

Rectangular Wet Well Dimensions: ☐ *N/A* ☐ Length (ft):____________ ☐ Width (ft): __________________ ☐ Wall thickness (inches):________________

Level Control Measurements:

Z_1 = _______________ *feet (TOC to high level HH level)*

Z_2 = _______________*feet (TOC to lag on level)*

Z_3 = ________________*feet (TOC to lead on level)*

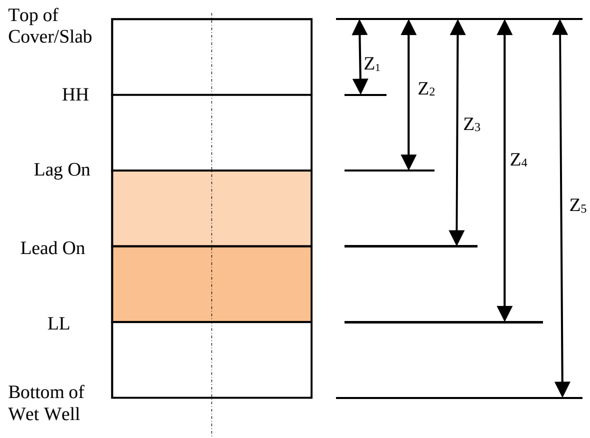
Z_4 = ________________*feet (TOC to low level LL)*

Z_5 = ________________*feet (TOC to bottom of wet well)*

For Circular Wet Well-Mounted Lift Stations:

Suction pipe 1 diameter (inches): ___________

Suction pipe 2 diameter (inches): ___________



Clock Diagram and Sewer Invert Measurements (from top of cover/slab)

Force Main: *Diameter (inches):* ____________

*Material:*___________________

Pipe 1: *Depth from top of cover/slab to pipe invert (feet):*___________

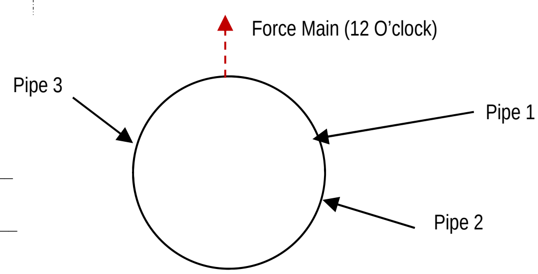
*Diameter (inches):*______ *Material:* _______________ *Slope (%):* __________

Pipe 2: *Depth from top of cover/slab to pipe invert (feet):*___________

*Diameter (inches):*______ *Material:* _______________ *Slope (%):* __________

Pipe 3: *Depth from top of cover/slab to pipe invert (feet):* ____________

*Diameter (inches):*_______ *Material:* _______________ *Slope (%):* ___________



Asset Class	CMMS Code	Asset Present	Year Installed	Cond. Rank.	Perf. Rank.	Utiliz. (%)	Field Observation / Comments
▪ Bar Screen		Y/N					

System Description: ☐ *No Bar Screen* ☐ *Manually Raked Bar Screen* ☐ *Mechanically Raked Bar Screen* ☐ *Screen Bypass provided?*

Mechanical Bar Screens: ☐ *N/A* ☐ *Manufacturer:* ______________ ☐ *Model:*________________ ☐ *Serial No:*_______________ ☐ *Power Requirements (hp):*________________

*Other Information:*____

Field Observations: ☐ *N/A* ☐ *Screens need frequent cleaning* ☐ *Short Response Time* ☐ *Odor or fly nuisance* ☐ *Screens not in use* ☐ *Other:*______________________________

Asset Class	CMMS Code	Asset Present	Year Installed	Cond. Rank.	Perf. Rank.	Utiliz. (%)	Field Observation / Comments
▪ Flow Meter		Y/N					

Type: : ☐ *N/A* ☐ *Type:*_______________________ *Manufacturer:*______________________ *Model:* _________________________ *Serial No:*____________________

Flow Meter Field Observation: ☐ *Operational* ☐ *Other:*

Asset Class	CMMS Code	Asset Present	Year Installed	Cond. Rank.	Perf. Rank.	Utiliz. (%)	Field Observation / Comments
▪ Influent Valves		Y/N				N/A	

Influent Valve 1 Details: ☐ *N/A* ☐ *Type:*____________ *Manufacturer:*______________ *Model:* _________________ *Serial No:*___________________

Influent Valve 2 Details: ☐ *N/A* ☐ *Type:*____________ *Manufacturer:*______________ *Model:* _________________ *Serial No:*___________________

Influent Valve Field Obs: ☐ *Good* ☐ *Fair: Operates But Does Not Close Fully* ☐ *Poor: Does Not Operate* ☐ *Other:*

Condition Ranking: 1) Excellent 2) Slight Visible Degradation 3) Visible Degradation 4) Integrity of Component Moderately Compromised 5) Integrity of Component Severely Compromised
Performance Ranking: 1) Component Functioning As Intended 2) In-Service, But Higher Than Expected O&M 3) In-Service, But Function Is Impaired 4) In-Service, But Function Is Highly Impaired 5) Component Is Not Functioning As Intended

PUMPING STATION CONDITION ASSESSMENT FORM

▪ *Lift Station Bypass*		*Y/N*				

Bypass Details: ☐ *Bypass Description:*____
☐ *Recommendation for lift station bypass if not currently provided:*______________________________
Bypass Pipework Field Observations: ☐ *Good* ☐ *Fair: Slight Corrosion But Pipe Intact* ☐ *Fair: Slight Bolt or Pipe Corrosion; Minor Paint Peeling* ☐ *Poor: Corroded Pipe or Bolts; Severe Paint Peeling* ☐ *Valve not operational* ☐ *Other:*

▪ *Wet Well*		*Y/N*				

Walls: ☐ *Reinforced Concrete* ☐ *Steel* ☐ *Brick*
Slab/Cover: ☐ *Reinforced Concrete* ☐ *Steel* ☐ *Pumps, motors and electric panel are mounted on cover/slab directly over wet well*
Pump control system: ☐ *Floats* ☐ *Bubbler System* ☐ *Ultrasonic*
H_2S Measurement (PPM): ________________
Wet Well Field Observations: ☐ *Good* ☐ *N/A* ☐ *Hatch Damaged or Difficult to Open* ☐ *Wet Structure Spalling or Cracked* ☐ *Evidence of Concrete Corrosion* ☐ *Wet Well Needs Cleaning - Solids/Grease* ☐ *Other:*

Hatch Field Observations: ☐ *Good* ☐ *Fair: Minor Corrosion to Hatches, Hinges, or Latches* ☐ *Poor: Corroded or Broken Hatches, Hinges, or Latches* ☐ *Other:*

Wet Well Ladder Field Observations: ☐ *N/A* ☐ *Good* ☐ *Fair: Surface Corrosion; Steps Intact and Solid; Minor Anchor Bolt Corrosion* ☐ *Poor: Corroded or Broken Steps; Corroded or Broken Wall Anchors* ☐ *Other:*

Wet Well Wall Field Observations: ☐ *Good* ☐ *Fair: Concrete Sealant Peeled or Cracked; Concrete Soft at Surface* ☐ *Poor: Exposed/Missing Aggregate; Exposed/Missing Re-bar* ☐ *Other:*

Slab/Cover Field Observations: ☐ *Good* ☐ *Fair: Concrete or Aluminum Grate Slightly Corroded But Safe* ☐ *Poor: Concrete Aggregate Missing/Exposed; Grate Corroded or Warped; Debris Over Platform* ☐ *Other:*

Influent Pipe Field Observations: ☐ *Good* ☐ *Fair: Slight Corrosion; Pipe Intact* ☐ *Poor: Severe Pipe Corrosion* ☐ *Other:*

Alarm Float Field Observations: ☐ *Good* ☐ *Fair: Some Grease But Operating Properly* ☐ *Poor: Covered in Grease or Broken* ☐ *Other:*

Pump Vent Line Field Observations: ☐ *Good* ☐ *Fair: Slight Corrosion But Operates Properly; Needs Sealant Around Opening* ☐ *Poor: Any One Vent Does Not Operate; Corroded or Broken Off at Wall* ☐ *Other:*

Bypass Pump Riser Pipe Field Observations: ☐ *Good* ☐ *Fair: Slight Corrosion But Pipe Intact* ☐ *Poor: Severe Corrosion; Pipe Has Broken Off* ☐ *Other:*

Scratch Test Field Observations: ☐ *Good* ☐ *Fair: Minor Surface Penetration* ☐ *Poor: Significant Surface Penetration; Aggregate Pulled From Surface* ☐ *Other:*

Acidity Test Results/Field Observations:

▪ *Dry Well*		*Y/N*				

Location/Type: ☐ *None* ☐ *Underground pump vault with access tube and ladder* ☐ *Located below grade inside building*
Lighting: ☐ *Yes* ☐ *No*
Cathodic protection: ☐ *Not Required* ☐ *None* ☐ *Yes*

Access Tube and Ladder Field Observations: ☐ *N/A* ☐ *Good* ☐ *Fair: Surface Corrosion; Steps Intact and Solid; Minor Anchor Bolt Corrosion* ☐ *Poor: Corroded or Broken Steps; Corroded or Broken Wall Anchors* ☐ *Other:*

Underground Vault Field Observations: ☐ *N/A* ☐ *Good* ☐ *Fair: Surface Corrosion* ☐ *Poor: Corrosion* ☐ *Other*

Building Floor Slabs: ☐ *N/A* ☐ *Good* ☐ *Fair: Concrete Sealant Peeled or Cracked; Concrete Soft at Surface* ☐ *Poor: Exposed/Missing Aggregate; Exposed/Missing Re-bar* ☐ *Standing Water* ☐ *Other:*

Staircases/stairwells: ☐ *N/A* ☐ *Good* ☐ *Fair: Concrete Cracked; Concrete Soft at Surface* ☐ *Poor: Exposed/Missing Aggregate; Exposed/Missing Re-bar* ☐ *Hand railing missing or loose* ☐ *Good lighting* ☐ *Inadequate lighting*

Building Walls: ☐ *N/A* ☐ *Good* ☐ *Fair: Concrete Sealant Peeled or Cracked; Concrete Soft at Surface* ☐ *Poor: Exposed/Missing Aggregate; Exposed/Missing Re-bar* ☐ *Other:*

Sump Pump: ☐ *No* ☐ *Yes* ☐ *Type of pump:*________________ ☐ *Model:*____________ ☐ *Power (hp):*________ ☐ *TDH (ft)* ☐ *Serial No:*
Field Observations: ☐ *Not operational* ☐ *Poor floor drainage* ☐ *Other:*

▪ *Cathodic Protection*		*Y/N*				

Field Observations: ☐ *Disconnected* ☐ *Other:*

HVAC (HVA)		Y / N					
▪ *Dry Well HVAC*		*Y / N*					

Asset Size: _________ ☐ *KVA* ☐ *HP*
Heating/Cooling Unit: ☐ *Wall/Window Mounted* ☐ *Furnace/AC Unit* ☐*: Details:*__________________________________
Dry Well HVAC Field Obs: ☐ *Good* ☐ *N/A* ☐ *Old* ☐ *Ventilation Fans Inoperable* ☐ *Makes Noise* ☐ *Fans Vibrate* ☐ *Belts Loose or Torn* ☐ *Ventilation Duct Work Corroded* ☐ *Louvers* ☐ *Roof vents* ☐ *Other:*

Condition Ranking: 1) Excellent 2) Slight Visible Degradation 3) Visible Degradation 4) Integrity of Component Moderately Compromised 5) Integrity of Component Severely Compromised
Performance Ranking: 1) Component Functioning As Intended 2) In-Service, But Higher Than Expected O&M 3) In-Service, But Function Is Impaired 4) In-Service, But Function Is Highly Impaired 5) Component Is Not Functioning As Intended

▪ *Wet Well HVAC*		*Y / N*					

Asset Size: : ________ ☐ *KVA* ☐ *HP*
Heating/Cooling Unit: ☐ *Wall/Window Mounted* ☐ *Furnace/AC Unit* ☐*: Details:*___________________________________
Wet Well HVAC Field Obs: ☐ *Good* ☐ *N/A* ☐ *Old* ☐ *Ventilation Fans Inoperable* ☐ *Makes Noise* ☐ *Fans Vibrate* ☐ *Belts Loose or Torn* ☐ *Ventilation Duct Work Corroded* ☐ *Louvers* ☐ *Roof vents* ☐ *Other:*

Electrical Systems (ELE)		Y / N				N/A	
▪ *Control Panel*		*Y / N*				*N/A*	

Asset Size: ☐ *120 V* ☐ *208 V* ☐ *220 V* ☐ *240 V* ☐ *460 V* ☐ *480 V* ☐ *Single Phase* ☐ *Three Phase*
Manufacturer: *Model:* *Serial No:*
Electrical Systems Field Obs: ☐ *Good* ☐ *N/A* ☐ *Control Panel Corroded* ☐ *Old/Outdated/Obsolete* ☐ *Contacts Loose* ☐ *Cables Fatigued and Checked* ☐ *Dust Inside Panel* ☐ *Exposed Wires* ☐ *Switch Gear Worn* ☐ *Other:*

▪ *Lighting Panel*		*Y / N*				*N/A*	

Asset Size: ☐ *120 V* ☐ *208 V* ☐ *220 V* ☐ *240 V* ☐ *460 V* ☐ *480 V*
Manufacturer: *Model:* *Serial No:*
Electrical Systems Field Obs: ☐ *Good* ☐ *N/A* ☐ *Control Panel Corroded* ☐ *Old/Outdated/Obsolete* ☐ *Contacts Loose* ☐ *Cables Fatigued and Checked* ☐ *Dust Inside Panel* ☐ *Exposed Wires* ☐ *Switch Gear Worn* ☐ *Other:*

▪ *Main Switch*		*Y / N*				*N/A*	

Asset Size: ☐ *120 V* ☐ *208 V* ☐ *220 V* ☐ *240 V* ☐ *460 V* ☐ *480 V*
Manufacturer: *Model:* *Serial No:*
Electrical Systems Field Obs: ☐ *Good* ☐ *N/A* ☐ *Control Panel Corroded* ☐ *Old/Outdated/Obsolete* ☐ *Contacts Loose* ☐ *Cables Fatigued and Checked* ☐ *Dust Inside Panel* ☐ *Exposed Wires* ☐ *Switch Gear Worn* ☐ *Other:*

▪ *Transfer Switch*		*Y / N*				*N/A*	

Asset Size: ☐ *120 V* ☐ *208 V* ☐ *220 V* ☐ *240 V* ☐ *460 V* ☐ *480 V*
Manufacturer: *Model:* *Serial No:*
Electrical Systems Field Obs: ☐ *Good* ☐ *N/A* ☐ *Control Panel Corroded* ☐ *Old/Outdated/Obsolete* ☐ *Contacts Loose* ☐ *Cables Fatigued and Checked* ☐ *Dust Inside Panel* ☐ *Exposed Wires* ☐ *Switch Gear Worn* ☐ *Other:*

▪ *Motor Control Center*		*Y / N*				*N/A*	

Asset Size: ☐ *120 V* ☐ *208 V* ☐ *220 V* ☐ *240 V* ☐ *460 V* ☐ *480 V*
Manufacturer: *Model:* *Serial No:*
Electrical Systems Field Obs: ☐ *Good* ☐ *N/A* ☐ *Control Panel Corroded* ☐ *Old/Outdated/Obsolete* ☐ *Contacts Loose* ☐ *Cables Fatigued and Checked* ☐ *Dust Inside Panel* ☐ *Exposed Wires* ☐ *Switch Gear Worn* ☐ *Other:*

Generator (GEN)		Y / N				N/A	
▪ *Emergency Generator*		*Y / N*				*N/A*	
▪ *Emer. Gen. Connector*		*Y / N*				*N/A*	

Asset Size: ☐ *KVA* ☐ *HP*
Manufacturer: *Model:* *Serial No:*
Type: ☐ *Diesel* ☐ *Gas* ☐ *Propane*
Generator Field Obs: ☐ *Good* ☐ *N/A* ☐ *Contacts Loose* ☐ *Cables Fatigued and Checked* ☐ *Engine Fluids Low* ☐ *Poor Housekeeping* ☐ *Poor Accessibility* ☐ *Other:*

Instrumentation (INS)		Y / N				N/A	
▪ *RTU*		*Y / N*				*N/A*	
▪ *Float Controls*		*Y / N*				*N/A*	
▪ *Bubbler Controls*		*Y / N*				*N/A*	
▪ *Ultrasonic Controls*		*Y / N*				*N/A*	

Instrumentation Field Obs: ☐ *Good* ☐ *N/A* ☐ *Bubbler Compressor Failing* ☐ *Air Lines Clogged / Full of Moisture* ☐ *Drain Condensate Traps in Air System* ☐ *Floats Tangled* ☐ *Controls Obsolete* ☐ *Other:*

SCADA Hard. & Software (SCA)		Y / N				N/A	

SCADA Hard. & Software Field Obs: ☐ *Good* ☐ *N/A* ☐ *Obsolete* ☐ *Other:*

Condition Ranking: 1) Excellent 2) Slight Visible Degradation 3) Visible Degradation 4) Integrity of Component Moderately Compromised 5) Integrity of Component Severely Compromised
Performance Ranking: 1) Component Functioning As Intended 2) In-Service, But Higher Than Expected O&M 3) In-Service, But Function Is Impaired 4) In-Service, But Function Is Highly Impaired 5) Component Is Not Functioning As Intended

PUMPING STATION CONDITION ASSESSMENT FORM

Variable Frequency Drive (VFD)		Y / N				N/A	
▪ *VFD Panel*		*Y / N*				*N/A*	

Asset Size (HP):
Manufacturer:
Model:
Variable Frequency Drive Field Obs: ☐ *Good* ☐ *N/A* ☐ *Makes Noise* ☐ *Obsolete* ☐ *Panel Corroded/Dusty/Leaky* ☐ *Other:*

Motors (MTR)							
▪ *Motor 1*		*Y / N*					

Asset Size (HP):
Manufacturer:
Model:
Serial No:
Observed RPM:
Motor 1 Field Obs: ☐ *Good* ☐ *N/A* ☐ *Makes Noise* ☐ *Vibrates* ☐ *Shaft Bearing Noise* ☐ *Opposite End Bearing Noise* ☐ *Overheating* ☐ *Needs Lubrication* ☐ *Over Lubricated* ☐ *Mount Failing* ☐ *Leaking* ☐ *Emergency Stop Button in Dry Well Inoperable* ☐ *Other:*

▪ *Motor 2*		*Y / N*					

Asset Size (HP):
Manufacturer:
Model:
Serial No:
Motor 2 Field Obs: ☐ *Good* ☐ *N/A* ☐ *Makes Noise* ☐ *Vibrates* ☐ *Shaft Bearing Noise* ☐ *Opposite End Bearing Noise* ☐ *Overheating* ☐ *Needs Lubrication* ☐ *Over Lubricated* ☐ *Mount Failing* ☐ *Leaking* ☐ *Emergency Stop Button in Dry Well Inoperable* ☐ *Other:*

▪ *Motor 3*							

Asset Size (HP):
Manufacturer:
Model:
Serial No:
Motor 3 Field Obs: ☐ *Good* ☐ *N/A* ☐ *Makes Noise* ☐ *Vibrates* ☐ *Shaft Bearing Noise* ☐ *Opposite End Bearing Noise* ☐ *Overheating* ☐ *Needs Lubrication* ☐ *Over Lubricated* ☐ *Mount Failing* ☐ *Leaking* ☐ *Emergency Stop Button in Dry Well Inoperable* ☐ *Other:*

▪ *Motor 4*		*Y / N*					

Asset Size (HP):
Manufacturer:
Model:
Serial No:
Motor 4 Field Obs: ☐ *Good* ☐ *N/A* ☐ *Makes Noise* ☐ *Vibrates* ☐ *Shaft Bearing Noise* ☐ *Opposite End Bearing Noise* ☐ *Overheating* ☐ *Needs Lubrication* ☐ *Over Lubricated* ☐ *Mount Failing* ☐ *Leaking* ☐ *Emergency Stop Button in Dry Well Inoperable* ☐ *Other:*

Hor. And Vert. Centrifugal Pumps (PMS)							
▪ *Pump 1*		*Y / N*					

Manufacturer:		*Model:*	*Serial No:*	
Discharge Size:		*Suction Diameter:*	*Pump Size (GPM):*	*TDH:*
Priming Pump ☐	*Manufacturer:*	*Model:*	*Serial No:*	*Motor Size (hp):*

Pump 1 Field Obs: ☐ *Good* ☐ *N/A* ☐ *Seals Leaking* ☐ *Vibrating* ☐ *Shaft Deflection* ☐ *Cavitating* ☐ *Belts Loose* ☐ *Bearing Noise* ☐ *Mount Failing* ☐ *Evidence of Pipe Strain* ☐ *Other:*

▪ *Pump 2*		*Y / N*					

Manufacturer:		*Model:*	*Serial No:*	
Discharge Size:		*Suction Diameter:*	*Pump Size (GPM):*	*TDH:*
Priming Pump ☐	*Manufacturer:*	*Model:*	*Serial No:*	*Motor Size (hp)*

Pump 2 Field Obs: ☐ *Good* ☐ *N/A* ☐ *Seals Leaking* ☐ *Vibrating* ☐ *Shaft Deflection* ☐ *Cavitating* ☐ *Belts Loose* ☐ *Bearing Noise* ☐ *Mount Failing* ☐ *Evidence of Pipe Strain* ☐ *Other:*

Condition Ranking: 1) Excellent 2) Slight Visible Degradation 3) Visible Degradation 4) Integrity of Component Moderately Compromised 5) Integrity of Component Severely Compromised
Performance Ranking: 1) Component Functioning As Intended 2) In-Service, But Higher Than Expected O&M 3) In-Service, But Function Is Impaired 4) In-Service, But Function Is Highly Impaired 5) Component Is Not Functioning As Intended

▪ *Pump 3*		*Y / N*					
Manufacturer: *Model:* *Serial No:*							
Discharge Size: *Suction Diameter:* *Pump Size (GPM):* *TDH:*							
Pump 3 Field Obs: ☐ *Good* ☐ *N/A* ☐ *Seals Leaking* ☐ *Vibrating* ☐ *Shaft Deflection* ☐ *Cavitating* ☐ *Belts Loose* ☐ *Bearing Noise* ☐ *Mount Failing* ☐ *Evidence of Pipe Strain* ☐ *Other:*							
▪ *Pump 4*		*Y / N*					
Manufacturer: *Model:* *Serial No:*							
Discharge Size: *Suction Diameter:* *Pump Size (GPM):* *TDH:*							
Pump 4 Field Obs: ☐ *Good* ☐ *N/A* ☐ *Seals Leaking* ☐ *Vibrating* ☐ *Shaft Deflection* ☐ *Cavitating* ☐ *Belts Loose* ☐ *Bearing Noise* ☐ *Mount Failing* ☐ *Evidence of Pipe Strain* ☐ *Other:*							
Submersible Pumps (SUB)							
▪ *Pump 1*		*Y / N*					
Manufacturer: *Model:* *Serial No:*							
Discharge Size: *Suction Diameter:* *Pump Size (HP):* *Pump Size (CPM):* *TDH:*							
Pump and Motor 1 Field Obs: ☐ *Good* ☐ *N/A* ☐ *Rail System Corroded* ☐ *Does Not Seat Well* ☐ *Cables Corroded or Failing* ☐ *Other:*							
▪ *Pump 2*		*Y / N*					
Manufacturer: *Model:* *Serial No:*							
Discharge Size: *Suction Diameter:* *Pump Size (HP):* *Pump Size (CPM):* *TDH:*							
Pump and Motor 2 Field Obs: ☐ *Good* ☐ *N/A* ☐ *Rail System Corroded* ☐ *Does Not Seat Well* ☐ *Cables Corroded or Failing* ☐ *Other:*							
▪ *Pump 3*		*Y / N*					
Manufacturer: *Model:* *Serial No:*							
Discharge Size: *Suction Diameter:* *Pump Size (HP):* *Pump Size (CPM):* *TDH:*							
Pump and Motor 3 Field Obs: ☐ *Good* ☐ *N/A* ☐ *Rail System Corroded* ☐ *Does Not Seat Well* ☐ *Cables Corroded or Failing* ☐ *Other:*							
Piping and Valves (MEC)		Y / N				N/A	
Suction Isolation Valves							
▪ *Pump 1*		*Y / N*				*N/A*	
Suction Iso Valve Size: ☐ *3 in.* ☐ *4 in.* ☐ *6 in.* ☐ *8 in.* ☐ *10 in.* ☐ *12 in.* ☐ *14 in.* ☐ *24 in.* ☐ *36 in.*							
Manufacturer: *Model:* *Serial No:*							
Piping and Valves Field Obs: ☐ *Good* ☐ *N/A* ☐ *Valve Operator Stuck* ☐ *Valve Seat Leaking* ☐ *Flanges Leaking* ☐ *Valve Not Seating* ☐ *Valve Not Operating* ☐ *Evidence of Pipe Strain* ☐ *Other:*							
▪ *Pump 2*		*Y / N*				*N/A*	
Suction Iso Valve Size: ☐ *3 in.* ☐ *4 in.* ☐ *6 in.* ☐ *8 in.* ☐ *10 in.* ☐ *12 in.* ☐ *14 in.* ☐ *24 in.* ☐ *36 in.*							
Manufacturer: *Model:* *Serial No:*							
Piping and Valves Field Obs: ☐ *Good* ☐ *N/A* ☐ *Valve Operator Stuck* ☐ *Valve Seat Leaking* ☐ *Flanges Leaking* ☐ *Valve Not Seating* ☐ *Valve Not Operating* ☐ *Evidence of Pipe Strain* ☐ *Other:*							
▪ *Pump 3*		*Y / N*				*N/A*	
Suction Iso Valve Size: ☐ *3 in.* ☐ *4 in.* ☐ *6 in.* ☐ *8 in.* ☐ *10 in.* ☐ *12 in.* ☐ *14 in.* ☐ *24 in.* ☐ *36 in.*							
Manufacturer: *Model:* *Serial No:*							
Piping and Valves Field Obs: ☐ *Good* ☐ *N/A* ☐ *Valve Operator Stuck* ☐ *Valve Seat Leaking* ☐ *Flanges Leaking* ☐ *Valve Not Seating* ☐ *Valve Not Operating* ☐ *Evidence of Pipe Strain* ☐ *Other:*							
▪ *Pump 4*		*Y / N*				*N/A*	
Suction Iso Valve Size: ☐ *3 in.* ☐ *4 in.* ☐ *6 in.* ☐ *8 in.* ☐ *10 in.* ☐ *12 in.* ☐ *14 in.* ☐ *24 in.* ☐ *36 in.*							
Manufacturer: *Model:* *Serial No:*							
Piping and Valves Field Obs: ☐ *Good* ☐ *N/A* ☐ *Valve Operator Stuck* ☐ *Valve Seat Leaking* ☐ *Flanges Leaking* ☐ *Valve Not Seating* ☐ *Valve Not Operating* ☐ *Evidence of Pipe Strain* ☐ *Other:*							

Discharge Isolation Valves							
▪ *Pump 1*		*Y / N*				*N/A*	

Discharge Iso Valve Size: ☐ *3 in.* ☐ *4 in.* ☐ *6 in.* ☐ *8 in.* ☐ *10 in.* ☐ *12 in.* ☐ *14 in.* ☐ *24 in.* ☐ *36 in.*
Manufacturer: *Model:* *Serial No:*
Piping and Valves Field Obs: ☐ *Good* ☐ *N/A* ☐ *Valve Operator Stuck* ☐ *Valve Seat Leaking* ☐ *Flanges Leaking* ☐ *Valve Not Seating* ☐ *Valve Not Operating* ☐ *Evidence of Pipe Strain* ☐ *Other:*

▪ *Pump 2*		*Y / N*				*N/A*	

Discharge Iso Valve Size: ☐ *3 in.* ☐ *4 in.* ☐ *6 in.* ☐ *8 in.* ☐ *10 in.* ☐ *12 in.* ☐ *14 in.* ☐ *24 in.* ☐ *36 in.*
Manufacturer: *Model:* *Serial No:*
Piping and Valves Field Obs: ☐ *Good* ☐ *N/A* ☐ *Valve Operator Stuck* ☐ *Valve Seat Leaking* ☐ *Flanges Leaking* ☐ *Valve Not Seating* ☐ *Valve Not Operating* ☐ *Evidence of Pipe Strain* ☐ *Other:*

▪ *Pump 3*		*Y / N*				*N/A*	

Discharge Iso Valve Size: ☐ *3 in.* ☐ *4 in.* ☐ *6 in.* ☐ *8 in.* ☐ *10 in.* ☐ *12 in.* ☐ *14 in.* ☐ *24 in.* ☐ *36 in.*
Manufacturer: *Model:* *Serial No:*
Piping and Valves Field Obs: ☐ *Good* ☐ *N/A* ☐ *Valve Operator Stuck* ☐ *Valve Seat Leaking* ☐ *Flanges Leaking* ☐ *Valve Not Seating* ☐ *Valve Not Operating* ☐ *Evidence of Pipe Strain* ☐ *Other:*

▪ *Pump 4*		*Y / N*				*N/A*	

Discharge Iso Valve Size: ☐ *3 in.* ☐ *4 in.* ☐ *6 in.* ☐ *8 in.* ☐ *10 in.* ☐ *12 in.* ☐ *14 in.* ☐ *24 in.* ☐ *36 in.*
Manufacturer: *Model:* *Serial No:*
Piping and Valves Field Obs: ☐ *Good* ☐ *N/A* ☐ *Valve Operator Stuck* ☐ *Valve Seat Leaking* ☐ *Flanges Leaking* ☐ *Valve Not Seating* ☐ *Valve Not Operating* ☐ *Evidence of Pipe Strain* ☐ *Other:*

Check Valves							
▪ *Pump 1*		*Y / N*				*N/A*	

Check Valve Size: ☐ *3 in.* ☐ *4 in.* ☐ *6 in.* ☐ *8 in.* ☐ *10 in.* ☐ *12 in.* ☐ *14 in.* ☐ *24 in.* ☐ *36 in.*
Manufacturer: *Model:* *Serial No:*
Piping and Valves Field Obs: ☐ *Good* ☐ *N/A* ☐ *Valve Operator Stuck* ☐ *Valve Seat Leaking* ☐ *Flanges Leaking* ☐ *Valve Not Seating* ☐ *Check Valve Not Operating* ☐ *Evidence of Pipe Strain* ☐ *Other:*

▪ *Pump 2*		*Y / N*				*N/A*	

Check Valve Size: ☐ *3 in.* ☐ *4 in.* ☐ *6 in.* ☐ *8 in.* ☐ *10 in.* ☐ *12 in.* ☐ *14 in.* ☐ *24 in.* ☐ *36 in.*
Manufacturer: *Model:* *Serial No:*
Piping and Valves Field Obs: ☐ *Good* ☐ *N/A* ☐ *Valve Operator Stuck* ☐ *Valve Seat Leaking* ☐ *Flanges Leaking* ☐ *Valve Not Seating* ☐ *Check Valve Not Operating* ☐ *Evidence of Pipe Strain* ☐ *Other:*

▪ *Pump 3*		*Y / N*				*N/A*	

Check Valve Size: ☐ *3 in.* ☐ *4 in.* ☐ *6 in.* ☐ *8 in.* ☐ *10 in.* ☐ *12 in.* ☐ *14 in.* ☐ *24 in.* ☐ *36 in.*
Manufacturer: *Model:* *Serial No:*
Piping and Valves Field Obs: ☐ *Good* ☐ *N/A* ☐ *Valve Operator Stuck* ☐ *Valve Seat Leaking* ☐ *Flanges Leaking* ☐ *Valve Not Seating* ☐ *Check Valve Not Operating* ☐ *Evidence of Pipe Strain* ☐ *Other:*

▪ *Pump 4*		*Y / N*				*N/A*	

Check Valve Size: ☐ *3 in.* ☐ *4 in.* ☐ *6 in.* ☐ *8 in.* ☐ *10 in.* ☐ *12 in.* ☐ *14 in.* ☐ *24 in.* ☐ *36 in.*
Manufacturer: *Model:* *Serial No:*
Piping and Valves Field Obs: ☐ *Good* ☐ *N/A* ☐ *Valve Operator Stuck* ☐ *Valve Seat Leaking* ☐ *Flanges Leaking* ☐ *Valve Not Seating* ☐ *Check Valve Not Operating* ☐ *Evidence of Pipe Strain* ☐ *Other:*

Condition Ranking: 1) Excellent 2) Slight Visible Degradation 3) Visible Degradation 4) Integrity of Component Moderately Compromised 5) Integrity of Component Severely Compromised
Performance Ranking: 1) Component Functioning As Intended 2) In-Service, But Higher Than Expected O&M 3) In-Service, But Function Is Impaired 4) In-Service, But Function Is Highly Impaired 5) Component Is Not Functioning As Intended

Appendix D: Support for Projects and Programs

D-1 Program Summaries
D-2 Program Prioritization
D-3 List of Programs by Management Strategy
D-4 Program Performance Measures
D-5 Project Summaries
D-6 Project Prioritization

D-1 Program Summaries

PROGRAM COST ESTIMATE

Program Name: Aquatic Habitat Studies
Program Group: Public
Program Category: Aquatic Habitat Enhancement
Program ID: CW-PRG-AH01
Program Description: The Aquatic Habitat Program improves natural stream aquatic habitat including conducting surveys, removing invasive plants and planting native species along riparian zones.

Program Staff: Surface Water Quality Specialist

Activity	Number per Year	Unit	Hours per Unit	Other Direct Cost	Non-Labor Cost per Unit	Per Year Implemen-tation	City Staff					Contractor/Consultant Staff				Total Cost
							Hours	FTE	Labor Cost	Other Direct Costs	Subtotal Cost	Hours	Labor Costs	Other Direct Costs	Subtotal Cost	
Management and administration		Percent of program					8	0.00	$600	$0	$600	0	$0	$0	$0	$600
Annual study	1	Annual study		$50,000			0	0.00	$0	$0	$0	0	$0	$50,000	$50,000	$50,000
Program management	1	Program	50				50	0.03	$4,000	$0	$4,000	0	$0	$0	$0	$4,000
Annual Program Subtotal						**1**	**58**	**0.03**	**$4,600**	**$0**	**$4,600**	**0**	**$0**	**$50,000**	**$50,000**	**$54,600**

FTE and Rate Assumptions

Staff availability (hrs/year/FTE)	1768
Percent of total Program FTE for Management, Supervision and Admin	0.15
Program/Project Management 1hr/$1000 contract	0.001
Staff Loaded Rate, $/hour	80
Contractor Rate, $/hour	130

Activity Assumptions
Management and admin: Percent of total program FTE for Management, Supervision and Admin. Source: Industry estimate
Annual study: Average study or activity cost is performed by contractor and is $50,000. One study is performed per year.
Program management: Staff participates in study effort, reviews results and documentation, reports findings to internal staff, council, writes summaries for plans and webpage.

PROGRAM COST ESTIMATE

Program Name: Thornton Creek Stewardship
Program Group: Public
Program Category: Water Quality Improvement
Program ID: CW-PRG-WQ01
Program Description: The Thornton Creek Stewardship Program provides a watershed-based public involvement and stewardship program for one of the City's most degraded waterways.

Program Staff: Surface Water Quality Specialist

Activity	Number per Year	Unit	Hours per Unit	Other Direct Cost	Non-Labor Cost per Unit	Per Year Implemen-tation	City Staff					Contractor/Consultant Staff				Total Cost
							Hours	FTE	Labor Cost	Other Direct Costs	Subtotal Cost	Hours	Labor Costs	Other Direct Costs	Subtotal Cost	
Management and administration		Percent of program					30	0.02	$2,400	$0	$2,400	0	$0	$0	$0	$2,400
Promote and participate in planned community events	5	Event	16	$1,000			80	0.05	$6,400	$1,000	$7,400	0	$0	$0	$0	$7,400
Prepare year end report	1	Report	40	$0			40	0.02	$3,200	$0	$3,200	0	$0	$0	$0	$3,200
Surveys and analysis for program effectiveness	1	Survey	80	$500			80	0.05	$6,400	$500	$6,900	0	$0	$0	$0	$6,900
Annual Program Subtotal						**1**	**230**	**0.13**	**$18,400**	**$1,500**	**$19,900**	**0**	**$0**	**$0**	**$0**	**$19,900**

FTE and Rate Assumptions

Staff availability (hrs/year/FTE)	1768
Percent of total Program FTE for Management, Supervision and Admin	0.15
Program/Project Management 1hr/$1000 contract	0.001
Staff Loaded Rate	80
Contractor Rate	130

Activity Assumptions

Management and admin: Percent of total program FTE for Management, Supervision and Admin. Source: Industry estimate
Community events: 5 events, 8 hours each for promotion and participation. Equipment and materials for stewardship efforts $1k (5320000). Source: Operations Draft Budget.pdf
Year end report: Summarize data, prepare draft, final and present to staff.
Surveys: 80 hours per survey per year. Topic materials approx. 1/4 of Stewardship program materials. Program description from Thornton Creek Basin Plan. Source: Soak it up Program survey cost estimates.

PROGRAM COST ESTIMATE

Program Name: Business Inspection Source Control (Minimum Effort)
Program Group: Public
Program Category: Water Quality Improvement
Program ID: CW-PRG-WQ02
Program Description: The Business Inspection Program (Minimum Effort) provides initial and minimum resources for the inspection for 20 percent of the city's businesses for detection and correction of potential pollution sources as part of the new 2019-2024 Phase II NPDES Permit.
Program Staff: Surface Water Quality Specialist

Activity	Number per Year	Unit	Hours per Unit	Other Direct Cost	Non-Labor Cost per Unit	Per Year Implementation	City Staff					Contractor/Consultant Staff				Total Cost
							Hours	FTE	Labor Cost	Other Direct Costs	Subtotal Cost	Hours	Labor Costs	Other Direct Costs	Subtotal Cost	
Management and administration		Percent of program					11	0.01	$895	$0	$895	0	$0	$0	$0	$895
Inspection (prep, inspection, post)	76	Business	0.85		$5		65	0.04	$5,168	$0	$5,168	65	$8,398	$380	$8,778	$13,946
Program management	1	Program	10				10	0.01	$800	$0	$800	0	$0	$0	$0	$800
Annual Program Subtotal						**1**	**86**	**0.05**	**$6,863**	**$0**	**$6,863**	**64.6**	**$8,398**	**$380**	**$8,778**	**$15,641**

FTE and Rate Assumptions

Staff availability (hrs/year/FTE)	1768
Percent of total Program FTE for Management, Supervision and Admin	0.15
Program/Project Management 1hr/$1000 contract	0.001
Staff Loaded Rate	80
Contractor Rate	130

Activity Assumptions

Management and admin: Percent of total program FTE for Management, Supervision and Admin. Source: Industry estimate
Inspection: 20% of businesses inspected by the end of the permit cycle. Estimate 1880 businesses, 25% pollution generating. SPU estimates 8 hours per inspection including prep, inspection, follow-up, documentation.
Program management: Staff manages program for approximately 1 hour per month.

PROGRAM COST ESTIMATE

Program Name: Business Inspection Source Control
Program Group: Public
Program Category: Water Quality Improvement
Program ID: CW-PRG-WQ03
Program Description: The Business Inspection Program provides resources for the inspection for 20 percent of the city's businesses for detection and correction of potential pollution sources as part of the new 2019-2024 Phase II NPDES Permit.

Program Staff: Surface Water Quality Specialist

Activity	Number per Year	Unit	Hours per Unit	Other Direct Cost	Non-Labor Cost per Unit	Per Year Implemen-tation	City Staff					Contractor/Consultant Staff				Total Cost
							Hours	FTE	Labor Cost	Other Direct Costs	Subtotal Cost	Hours	Labor Costs	Other Direct Costs	Subtotal Cost	
Management and administration		Percent of program					12	0.01	$960	$0	$960	0	$0	$0	$0	$960
Inspection (prep, inspection, post)	76	Business	8		$5		0	0.00	$0	$0	$0	608	$79,040	$380	$79,420	$79,420
Program management	1	Program	80				80	0.05	$6,400	$0	$6,400	0	$0	$0	$0	$6,400
Annual Program Subtotal						**1**	**92**	**0.05**	**$7,360**	**$0**	**$7,360**	**608**	**$79,040**	**$380**	**$79,420**	**$86,780**

FTE and Rate Assumptions

Staff availability (hrs/year/FTE)	1768
Percent of total Program FTE for Management, Supervision and Admin	0.15
Program/Project Management 1hr/$1000 contract	0.001
Staff Loaded Rate	80
Contractor Rate	130

Activity Assumptions

Management and admin: Percent of total program FTE for Management, Supervision and Admin. Source: Industry estimate
Inspection: 20% of businesses inspected by the end of the permit cycle. Estimate 1880 businesses, 25% pollution generating. SPU estimates 8 hours per inspection including prep, inspection, follow-up, documentation.
Program management: Staff manages program for approximately 6.5 hour per month.

PROGRAM COST ESTIMATE

Program Name: Water Quality Monitoring (Enhanced)
Program Group: Operations
Program Category: Water Quality Improvement
Program ID: CW-PRG-WQ04
Program Description: Supports the Water Quality protection through stream and beach monitoring, and lake stewardship.

Program Staff: Extra Help

Activity	Number per Year	Unit	Hours per Unit	Other Direct Cost	Non-Labor Cost per Unit	Per Year Implemen-tation	City Staff					Contractor/Consultant Staff				Total Cost
							Hours	FTE	Labor Cost	Other Direct Costs	Subtotal Cost	Hours	Labor Costs	Other Direct Costs	Subtotal Cost	
Management and administration		Percent of program					58	0.03	$4,620	$0	$4,620	0	$0	$0	$0	$4,620
Monitoring	1	Programs	385				385	0.22	$30,800	$0	$30,800	385	$50,050	$0	$50,050	$80,850
Annual Program Subtotal						**1**	**443**	**0.25**	**$35,420**	**$0**	**$35,420**	**385**	**$50,050**	**$0**	**$50,050**	**$85,470**

FTE and Rate Assumptions

Staff availability (hrs/year/FTE)	1768
Percent of total Program FTE for Management, Supervision and Admin	0.15
Program/Project Management 1hr/$1000 contract	0.001
Staff Loaded Rate	80
Contractor Rate	130

Activity Assumptions

Management and admin: Percent of total program FTE for Management, Supervision and Admin. Source: Industry estimate
Monitoring: Represents the 0.25 extra help that assist with water quality monitoring.

PROGRAM COST ESTIMATE

Program Name: Stormwater Permit
Program Group: Operations
Program Category: Operations & Maintenance
Program ID: CW-PRG-UM01
Program Description: The Stormwater Permit Program provides a single standard process for permitting on-site stormwater systems and connections to the MS4 and an opportunity for improved information recording and communication.

Program Staff: CIP Engineer

Activity	Number per Year	Unit	Hours per Unit	Other Direct Cost	Non-Labor Cost per Unit	Per Year Implemen-tation	City Staff					Contractor/Consultant Staff				Total Cost
							Hours	FTE	Labor Cost	Other Direct Costs	Subtotal Cost	Hours	Labor Costs	Other Direct Costs	Subtotal Cost	
Management and administration		Percent of program					78	0.04	$6,240	$0	$6,240	0	$0	$0	$0	$6,240
Staff review time	40	Permits	12				480	0.27	$38,400	$0	$38,400	0	$0	$0	$0	$38,400
Program management and coordination	1	PM	40				40	0.02	$3,200	$0	$3,200	0	$0	$0	$0	$3,200
Annual Program Subtotal						**1**	**598**	**0.34**	**$47,840**	**$0**	**$47,840**	**0**	**$0**	**$0**	**$0**	**$47,840**

FTE and Rate Assumptions

Staff availability (hrs/year/FTE)	1768
Percent of total Program FTE for Management, Supervision and Admin	0.15
Program/Project Management 1hr/$1000 contract	0.001
Staff Loaded Rate	80
Contractor Rate	130

Activity Assumptions

Management and admin: Percent of total program FTE for Management, Supervision and Admin. Source: Industry estimate
Staff review: Assumes 40 stormwater permits per year, includes review, occasional field visit and record keeping. Source: Industry estimate.
PM and coordination: Interdepartmental coordination.

PROGRAM COST ESTIMATE

Program Name: NPDES Compliance (Enhanced, Minimum Effort)
Program Group: Operations
Program Category: Operations & Maintenance
Program ID: CW-PRG-UM02
Program Description: The NPDES Compliance (Minimum Effort) provides initial and minimum resources for coordinating the requirements from the new 2019-2024 NPDES Phase II Permit.

Program Staff: SW and Env Svcs Manager

Activity	Number per Year	Unit	Hours per Unit	Other Direct Cost	Non-Labor Cost per Unit	Per Year Implemen-tation	City Staff					Contractor/Consultant Staff				Total Cost
							Hours	FTE	Labor Cost	Other Direct Costs	Subtotal Cost	Hours	Labor Costs	Other Direct Costs	Subtotal Cost	
Management and administration		Percent of program					13	0.01	$1,020	$0	$1,020	0	$0	$0	$0	$1,020
Gap and needs study with code and implementation support	0.25	Study		$30,000			0	0.00	$0		$0	0	$0	$7,500	$7,500	$7,500
Additional permit coordination	1	PM	75				75	0.04	$6,000	$0	$6,000	0	$0	$0	$0	$6,000
Program management	1	Program	10				10	0.01	$800	$0	$800	0	$0	$0	$0	$800
Annual Program Subtotal						**1**	**98**	**0.06**	**$7,820**	**$0**	**$7,820**	**0**	**$0**	**$7,500**	**$7,500**	**$15,320**

FTE and Rate Assumptions

Staff availability (hrs/year/FTE)	1768
Percent of total Program FTE for Management, Supervision and Admin	0.15
Program/Project Management 1hr/$1000 contract	0.001
Staff Loaded Rate	80
Contractor Rate	130

Activity Assumptions

Management and admin: Percent of total program FTE for Management, Supervision and Admin. Source: Industry estimate
Gap and needs study: Assumes one $30k study or analysis every other year.
Additional coordination and planning efforts associated with new permit for Utility staff.
PM and coordination: Interdepartmental coordination.

PROGRAM COST ESTIMATE

Program Name: NPDES Compliance (Enhanced)
Program Group: Operations
Program Category: Operations & Maintenance
Program ID: CW-PRG-UM02
Program Description: The NPDES Compliance provides additional resources for coordinating the requirements from the new 2019-2024 NPDES Phase II Permit.

Program Staff: SW and Env Svcs Manager

Activity	Number per Year	Unit	Hours per Unit	Other Direct Cost	Non-Labor Cost per Unit	Per Year Implemen-tation	City Staff					Contractor/Consultant Staff				Total Cost
							Hours	FTE	Labor Cost	Other Direct Costs	Subtotal Cost	Hours	Labor Costs	Other Direct Costs	Subtotal Cost	
Management and administration		Percent of program					29	0.02	$2,280	$0	$2,280	0	$0	$0	$0	$2,280
Gap and needs study with code and implementation support	0.5	Study		$30,000			0	0.00	$0		$0	0	$0	$15,000	$15,000	$15,000
Additional permit coordination	1	PM	170				170	0.10	$13,600	$0	$13,600	0	$0	$0	$0	$13,600
Program management	1	Program	20				20	0.01	$1,600	$0	$1,600	0	$0	$0	$0	$1,600
Annual Program Subtotal						**1**	**219**	**0.12**	**$17,480**	**$0**	**$17,480**	**0**	**$0**	**$15,000**	**$15,000**	**$32,480**

FTE and Rate Assumptions

Staff availability (hrs/year/FTE)	1768
Percent of total Program FTE for Management, Supervision and Admin	0.15
Program/Project Management 1hr/$1000 contract	0.001
Staff Loaded Rate	80
Contractor Rate	130

Activity Assumptions

Management and admin: Percent of total program FTE for Management, Supervision and Admin. Source: Industry estimate
Gap and needs study: Assumes one $30k study or analysis every other year.
Permit coordination: Additional coordination and planning efforts associated with new permit for Utility staff.
PM and coordination: Interdepartmental coordination.

PROGRAM COST ESTIMATE

Program Name: Drainage Assessment (Enhanced)
Program Group: Operations
Program Category: Flood Mitigation
Program ID: CW-PRG-FM01
Program Description: The Drainage Assessment Program investigates flooding and drainage problems based on customer service requests and evaluates the need for easement acquisition or system relocation to the right-of-way.

Program Staff: Utility Operations Specialist

Activity	Number per Year	Unit	Hours per Unit	Other Direct Cost	Non-Labor Cost per Unit	Per Year Implemen-tation	City Staff					Contractor/Consultant Staff				Total Cost
							Hours	FTE	Labor Cost	Other Direct Costs	Subtotal Cost	Hours	Labor Costs	Other Direct Costs	Subtotal Cost	
Management and administration		Percent of program					41	0.02	$3,240	$0	$3,240	0	$0	$0	$0	$3,240
Drainage assessment effort	20	Assessment	58					0.00	$0	$0	$0	1160	$150,800	$0	$150,800	$150,800
Easement acquisition evaluation	4	Evaluation	30				120	0.07	$9,600	$0	$9,600		$0	$0	$0	$9,600
Program management	1	Program	150				150	0.08	$12,000	$0	$12,000	0	$0	$0	$0	$12,000
Annual Program Subtotal						**1**	**311**	**0.18**	**$24,840**	**$0**	**$24,840**	**1160**	**$150,800**	**$0**	**$150,800**	**$175,640**

FTE and Rate Assumptions

Staff availability (hrs/year/FTE)	1768
Percent of total Program FTE for Management, Supervision and Admin	0.15
Program/Project Management 1hr/$1000 contract	0.001
Staff Loaded Rate	80
Contractor Rate	130

Activity Assumptions
Management and admin: Percent of total program FTE for Management, Supervision and Admin. Source: Industry estimate
Assessments: Average of 20 assessments per year and contractor hours to fulfill the scope of work for a $150,000 drainage assessment contract.
Easement evaluation: City Staff time based on 4 easement acquisition evaluations per year. 30 hours per evaluation.
PM and coordination: Interdepartmental coordination.

PROGRAM COST ESTIMATE

Program Name: Catch Basin Repair and Replacement
Program Group: Maintenance
Program Category: Repair & Replacement
Program ID: CW-PRG-AM01
Program Description: The Catch Basin Repair and Replacement Program provides resources necessary to repair or replace catch basins within 6 months of inspection as required by the City existing Phase II NDPES Permit.

Program Staff: Engineering Technician

Activity	Number per Year	Unit	Hours per Unit	Other Direct Cost	Non-Labor Cost per Unit	Per Year Implemen-tation	City Staff					Contractor/Consultant Staff				Total Cost
							Hours	FTE	Labor Cost	Other Direct Costs	Subtotal Cost	Hours	Labor Costs	Other Direct Costs	Subtotal Cost	
Management and administration		Percent of program					45	0.03	$3,600	$0	$3,600	0	$0	$0	$0	$3,600
Repair catch basins	120	Catch basins			$1,000		0	0.00	$0	$0	$0	0	$0	$120,000	$120,000	$120,000
Replace catch basins	40	Catch basins			$5,000		0	0.00	$0	$0	$0	0	$0	$200,000	$200,000	$200,000
Vactoring	130	Catch basins			$50		0	0.00	$0	$0	$0	0	$0	$6,500	$6,500	$6,500
Program management	1	Program	300				300	0.17	$24,000	$0	$24,000	0	$0	$0	$0	$24,000
Annual Program Subtotal						**1**	**345**	**0.20**	**$27,600**	**$0**	**$27,600**	**0**	**$0**	**$326,500**	**$326,500**	**$354,100**

FTE and Rate Assumptions

Staff availability (hrs/year/FTE)	1768
Percent of total Program FTE for Management, Supervision and Admin	0.15
Program/Project Management 1hr/$1000 contract	0.001
Staff Loaded Rate	80
Contractor Rate	130

Activity Assumptions

Management and admin: Percent of total program FTE for Management, Supervision and Admin. Source: Industry estimate
Repair CBS: Half of 8000 catch basins will be inspected per year. City staff estimate 3% will need to be repaired. Source: Utility staff.
Replace CBs: Half of 8000 catch basins will be inspected per year. City staff estimate 1% will need to be replaced. Source: Utility staff.
Vactoring: A portion of this is Included in existing operation costs. The difference between vactor 1/3 of the CBs and 1/2 of the CBs is 1/6.Half of 8000 catch basins will be inspected per year. City staff estimate 20% will need to be vactored
PM and coordination: Interdepartmental coordination.

PROGRAM COST ESTIMATE

Program Name: Pump Station Maintenance
Program Group: Maintenance
Program Category: Operations & Maintenance
Program ID: CW-PRG-AM02
Program Description: The Pump Station Maintenance Program addresses maintenance of pump station equipment (hydraulic, mechanical and electrical), structure and facility access.

Program Staff: Engineering Technician

Activity	Number per Year	Unit	Hours per Unit	Other Direct Cost	Non-Labor Cost per Unit	Per Year Implemen-tation	City Staff					Contractor/Consultant Staff				Total Cost
							Hours	FTE	Labor Cost	Other Direct Costs	Subtotal Cost	Hours	Labor Costs	Other Direct Costs	Subtotal Cost	
Management and administration		Percent of program					9	0.01	$720	$0	$720	0	$0	$0	$0	$720
Maintain pump stations and other pumps	8	Pump stations	52		$500			0.00	$0	$0	$0	416	$54,080	$4,000	$58,080	$58,080
Program management	1	Program	60				60	0.03	$4,800	$0	$4,800	0	$0	$0	$0	$4,800
Annual Program Subtotal						**1**	**69**	**0.04**	**$5,520**	**$0**	**$5,520**	**416**	**$54,080**	**$4,000**	**$58,080**	**$63,600**

FTE and Rate Assumptions

Staff availability (hrs/year/FTE)	1768
Percent of total Program FTE for Management, Supervision and Admin	0.15
Program/Project Management 1hr/$1000 contract	0.001
Staff Loaded Rate	80
Contractor Rate	130

Activity Assumptions

Management and admin: Percent of total program FTE for Management, Supervision and Admin. Source: Industry estimate
Maintenance program: 8 PS. 2 hours per pump station per week. $500/PS/year of miscellaneous material and equipment. Assume contractor has access to facilities and does not need utility oversight during maintenance.
PM and coordination: Interdepartmental coordination.

PROGRAM COST ESTIMATE

Program Name: LID Maintenance
Program Group: Maintenance
Program Category: Operations & Maintenance
Program ID: CW-PRG-AM03
Program Description: The LID Maintenance Program enhances existing maintenance program that requires structural repairs for facilities within one year of inspection as required by the City's existing Phase II NPDES Permit.

Program Staff: Engineering Technician

Activity	Number per Year	Unit	Hours per Unit	Other Direct Cost	Non-Labor Cost per Unit	Per Year Implemen-tation	City Staff					Contractor/Consultant Staff				Total Cost
							Hours	FTE	Labor Cost	Other Direct Costs	Subtotal Cost	Hours	Labor Costs	Other Direct Costs	Subtotal Cost	
Management and administration		Percent of program					48	0.03	$3,852	$0	$3,852	0	$0	$0	$0	$3,852
Structural repairs every three years.	57	Facility	5	$150		3		0.00	$0	$150	$150	285	$37,050	$0	$37,050	$37,200
Permeable pavement cleaning	2	7000 sq. ft	18	$2,000				0.00	$0	$4,000	$4,000	36	$4,680	$0	$4,680	$8,680
Program management	1	Program	50				50	0.03	$4,000	$0	$4,000	0	$0	$0	$0	$4,000
Annual Program Subtotal						**1**	**98**	**0.06**	**$7,852**	**$4,150**	**$12,002**	**321**	**$41,730**	**$0**	**$41,730**	**$53,732**

FTE and Rate Assumptions

Staff availability (hrs/year/FTE)	1768
Percent of total Program FTE for Management, Supervision and Admin	0.15
Program/Project Management 1hr/$1000 contract	0.001
Staff Loaded Rate	80
Contractor Rate	130

Activity Assumptions

Management and admin: Percent of total program FTE for Management, Supervision and Admin. Source: Industry estimate
Structural repairs: Structures repair and replacement (Soil, mulch, berm, underdrain, inlet, outlet and jetting). 171 facilities and each facility needs structural repairs every 3 years. Source: City GIS and industry estimate.
Perm pavement: Six facilities at avg 7000 sf. 3 person crew, 1 day (6 hrs)/7000 sf facility. Equipment rental and waste disposal $2000/facility/day. Clean each facility every 3 years. Source: Industry estimate and City GIS.
PM and coordination: Interdepartmental coordination.

PROGRAM COST ESTIMATE

Program Name: Utility Crossing Removal
Program Group: Maintenance
Program Category: Repair & Replacement
Program ID: CW-PRG-AM04
Program Description: The Utility Crossing Removal Program provides resources for coordination with other utilities to remove their lines and repair storm drains that have been damaged because of crossings.

Program Staff: CIP Engineer

Activity	Number per Year	Unit	Hours per Unit	Other Direct Cost	Non-Labor Cost per Unit	Per Year Implemen-tation	City Staff					Contractor/Consultant Staff				Total Cost
							Hours	FTE	Labor Cost	Other Direct Costs	Subtotal Cost	Hours	Labor Costs	Other Direct Costs	Subtotal Cost	
Management and administration		Percent of program					30	0.02	$2,400	$0	$2,400	0	$0	$0	$0	$2,400
Utility crossing management for pipe R&R	10	Crossing	20				200	0.11	$16,000	$0	$16,000	0	$0	$0	$0	$16,000
Annual Program Subtotal						**1**	**230**	**0.13**	**$18,400**	**$0**	**$18,400**	**0**	**$0**	**$0**	**$0**	**$18,400**

FTE and Rate Assumptions

Staff availability (hrs/year/FTE)	1768
Percent of total Program FTE for Management, Supervision and Admin	0.15
Program/Project Management 1hr/$1000 contract	0.001
Staff Loaded Rate	80
Contractor Rate	130

Activity Assumptions

Management and admin: Percent of total program FTE for Management, Supervision and Admin. Source: Industry estimate
Utility crossing: Effort includes multiple coordination efforts with other utilities and field visits.

PROGRAM COST ESTIMATE

Program Name: Improper Connection Repair
Program Group: Maintenance
Program Category: Repair & Replacement
Program ID: CW-PRG-AM05
Program Description: The Improper Connection Removal Program fixes non-standard or improperly installed stormwater drains not included in other capital project planning by adding properly designed structures.

Program Staff: CIP Engineer

Activity	Number per Year	Unit	Hours per Unit	Other Direct Cost	Non-Labor Cost per Unit	Per Year Implemen-tation	City Staff					Contractor/Consultant Staff				Total Cost
							Hours	FTE	Labor Cost	Other Direct Costs	Subtotal Cost	Hours	Labor Costs	Other Direct Costs	Subtotal Cost	
Management and administration		Percent of program					9	0.01	$720	$0	$720	0	$0	$0	$0	$720
Improper connection repair work	5	Connection	50		$11,000			0.00	$0	$0	$0		$0	$55,000	$55,000	$55,000
Program management	1	Program	60				60	0.03	$4,800	$0	$4,800	0	$0	$0	$0	$4,800
Annual Program Subtotal						**1**	**69**	**0.04**	**$5,520**	**$0**	**$5,520**	**0**	**$0**	**$55,000**	**$55,000**	**$60,520**

FTE and Rate Assumptions

Staff availability (hrs/year/FTE)	1768
Percent of total Program FTE for Management, Supervision and Admin	0.15
Program/Project Management 1hr/$1000 contract	0.001
Staff Loaded Rate	80
Contractor Rate	130

Activity Assumptions

Management and admin: Percent of total program FTE for Management, Supervision and Admin. Source: Industry estimate
Improper connection: Poor connection replacement as part of a drainage assessment. Hrs calc'ed w/ 3 person crew for 2, 6-hour days for installation, 14 hours of engineer/PM, 2000 for CB, MH and connections.
PM and coordination: Interdepartmental coordination.

PROGRAM COST ESTIMATE

Program Name: Pipe Condition Assessment Program (Enhanced)
Program Group: Maintenance
Program Category: Operations & Maintenance
Program ID: CW-PRG-AM06
Program Description: The Pipe Condition Assessment Program continues the existing inspection efforts by initiating the final basin wide inspection project (Thornton Creek Basin) and then cleaning and inspecting previously inaccessible pipes.

Program Staff: Utility Operations Specialist

Activity	Number per Year	Unit	Hours per Unit	Other Direct Cost	Non-Labor Cost per Unit	Per Year Implemen-tation	City Staff					Contractor/Consultant Staff				Total Cost
							Hours	FTE	Labor Cost	Other Direct Costs	Subtotal Cost	Hours	Labor Costs	Other Direct Costs	Subtotal Cost	
Management and administration		Percent of program					78	0.04	$6,240	$0	$6,240	0	$0	$0	$0	$6,240
Program management and coordination	1	EA	520				520	0.29	$41,600	$0	$41,600	0	$0	$0	$0	$41,600
Pipe to inspect	37500	LF			$3									$112,500	$112,500	$112,500
Annual Program Subtotal						**1**	**598**	**0.34**	**$47,840**	**$0**	**$47,840**	**0**	**$0**	**$112,500**	**$112,500**	**$160,340**

FTE and Rate Assumptions

Staff availability (hrs/year/FTE)	1768
Percent of total Program FTE for Management, Supervision and Admin	0.15
Program/Project Management 1hr/$1000 contract	0.001
Staff Loaded Rate	80
Contractor Rate	130

Activity Assumptions

Management and admin: Percent of total program FTE for Management, Supervision and Admin. Source: Industry estimate
Program management: Hour estimate based on current contract.
Estimate $3/lf for accessible pipe and 3X for inaccessible or difficult to access pipes. Includes City staff PM time as well as Management and Admin.

PROGRAM COST ESTIMATE

Program Name: Asset Management Program (Enhanced)
Program Group: Operations
Program Category: Operations & Maintenance
Program ID: CW-PRG-AM07
Program Description: The Asset Management Program enhances the existing program with activities ranging from coordination and communication to developing risk policy and asset templates.

Program Staff: SW and Env Svcs Manager

Activity	Number per Year	Unit	Hours per Unit	Other Direct Cost	Non-Labor Cost per Unit	Per Year Implemen-tation	City Staff					Contractor/Consultant Staff				Total Cost
							Hours	FTE	Labor Cost	Other Direct Costs	Subtotal Cost	Hours	Labor Costs	Other Direct Costs	Subtotal Cost	
Management and administration		Percent of program					53	0.03	$4,200	$0	$4,200	0	$0	$0	$0	$4,200
Follow recommendations outlined in the AMWP.		Program				1	350	0.20	$28,000	$9,000	$37,000	200	$26,000	$2,000	$28,000	$65,000
Annual Program Subtotal						**1**	**403**	**0.23**	**$32,200**	**$9,000**	**$41,200**	**200**	**$26,000**	**$2,000**	**$28,000**	**$69,200**

FTE and Rate Assumptions

Staff availability (hrs/year/FTE)	1768
Percent of total Program FTE for Management, Supervision and Admin	0.15
Program/Project Management 1hr/$1000 contract	0.001
Staff Loaded Rate	80
Contractor Rate	130

Activity Assumptions
Management and admin: Percent of total program FTE for Management, Supervision and Admin. Source: Industry estimate
AMWP tasks: Incorporating actions outlined in the Asset Management Work Plan specific to the SW Utility as an ongoing enhanced AM program

PROGRAM COST ESTIMATE

Program Name: Private Facility Inspection and Maintenance (Enhanced)
Program Group: Maintenance
Program Category: Operations & Maintenance
Program ID: CW-PRG-AM08 (Average over first 6 years of implementation)
Program Description: The Private Facility Inspection and Maintenance Enforcement Program is a proposed self certification program for facility inspection and maintenance.

Program Staff: Surface Water Quality Specialist

Activity	Number per Year	Unit	Hours per Unit	Other Direct Cost	Non-Labor Cost per Unit	Per Year Implemen-tation	City Staff					Contractor/Consultant Staff				Total Cost
							Hours	FTE	Labor Cost	Other Direct Costs	Subtotal Cost	Hours	Labor Costs	Other Direct Costs	Subtotal Cost	
Management and administration		Percent of program					97	0.06	$7,782	$0	$7,782	0	$0	$0	$0	$7,782
Non-program inspection	80	BMP	3.3				396	0.22	$31,680	$0	$31,680	0	$0	$0	$0	$31,680
Program spot check inspection	50	BMP	1.5				53	0.03	$4,200	$0	$4,200	0	$0	$0	$0	$4,200
Enforcement, recording applications, filing covenants and program management	50	BMP	4				200	0.11	$16,000	$0	$16,000	0	$0	$0	$0	$16,000
Program materials	253	BMP	0		$10		0	0.00	$0	$2,530	$2,530		$0	$0	$0	$2,530
Annual Program Subtotal						**1**	**746**	**0.42**	**$59,662**	**$2,530**	**$62,192**	**0**	**$0**	**$0**	**$0**	**$62,192**

FTE and Rate Assumptions

Staff availability (hrs/year/FTE)	1768
Percent of total Program FTE for Management, Supervision and Admin	0.15
Program/Project Management 1hr/$1000 contract	0.001
Staff Loaded Rate	80
Contractor Rate	130

Activity Assumptions

Management and admin: Percent of total program FTE for Management, Supervision and Admin. Source: Industry estimate
Non-spot inspection: Assumes on average 30% of private facilities will participate in the self certification program over the six year planning period.
Spot inspection: Average number of spot checks per year for a 6-year implementation period based on percentage of best and good performers.
Program Management: Average number of applicants per year for six years. Requires customer communication and filing, recording and tracking covenant information.
Program materials: Average per year for six years. Develop and updated applications and outreach materials

PROGRAM COST ESTIMATE

Program Name: Private Facility Inspection and Maintenance (Enhanced)
Program Group: Maintenance
Program Category: Operations & Maintenance
Program ID: CW-PRG-AM08 (First year of implementation)
Program Description: The Private Facility Inspection and Maintenance Enforcement Program is a proposed self certification program for facility inspection and maintenance.

Program Staff: Surface Water Quality Specialist

Activity	Number per Year	Unit	Hours per Unit	Other Direct Cost	Non-Labor Cost per Unit	Per Year Implemen-tation	City Staff					Contractor/Consultant Staff				Total Cost
							Hours	FTE	Labor Cost	Other Direct Costs	Subtotal Cost	Hours	Labor Costs	Other Direct Costs	Subtotal Cost	
Management and administration		Percent of program					114	0.06	$9,096	$0	$9,096	0	$0	$0	$0	$9,096
Non-program inspection	160	BMP	3.3				528	0.30	$42,240	$0	$42,240	0	$0	$0	$0	$42,240
Program spot check inspection	20	BMP	1.5				30	0.02	$2,400	$0	$2,400	0	$0	$0	$0	$2,400
Enforcement, recording applications, filing covenants and program management	50	BMP	4				200	0.11	$16,000	$0	$16,000	0	$0	$0	$0	$16,000
Program materials	253	BMP	0		$10		0	0.00	$0	$2,530	$2,530		$0	$0	$0	$2,530
Annual Program Subtotal						**1**	**872**	**0.49**	**$69,736**	**$2,530**	**$72,266**	**0**	**$0**	**$0**	**$0**	**$72,266**

FTE and Rate Assumptions

Staff availability (hrs/year/FTE)	1768
Percent of total Program FTE for Management, Supervision and Admin	0.15
Program/Project Management 1hr/$1000 contract	0.001
Staff Loaded Rate	80
Contractor Rate	130

Activity Assumptions
Management and admin: Percent of total program FTE for Management, Supervision and Admin. Source: Industry estimate
Typical Inspection: Assume 64% of 253 facilities will need traditional inspection
Spot check: Average number of spot checks per year for a 6-year implementation period based on percentage of best and good performers.
Tracking: Average number of applicants per year for six years. Requires customer communication and filing, recording and tracking covenant information.
Materials: Average per year for six years. Develop and updated applications and outreach materials

PROGRAM COST ESTIMATE

Program Name: Private Facility Inspection and Maintenance (Enhancement)
Program Group: Maintenance
Program Category: Operations & Maintenance
Program ID: CW-PRG-AM08 (Sixth year of implementation)
Program Description: The Private Facility Inspection and Maintenance Enforcement Program is a proposed self certification program for facility inspection and maintenance.

Program Staff: Surface Water Quality Specialist

Activity	Number per Year	Unit	Hours per Unit	Other Direct Cost	Non-Labor Cost per Unit	Per Year Implemen-tation	City Staff					Contractor/Consultant Staff				Total Cost
							Hours	FTE	Labor Cost	Other Direct Costs	Subtotal Cost	Hours	Labor Costs	Other Direct Costs	Subtotal Cost	
Management and administration		Percent of program					81	0.05	$6,468	$0	$6,468	0	$0	$0	$0	$6,468
Non-program inspection	80	BMP	3.3				264	0.15	$21,120	$0	$21,120	0	$0	$0	$0	$21,120
Program spot check inspection	50	BMP	1.5				75	0.04	$6,000	$0	$6,000	0	$0	$0	$0	$6,000
Enforcement, recording applications, filing covenants and program management	50	BMP	4				200	0.11	$16,000	$0	$16,000	0	$0	$0	$0	$16,000
Program materials	253	BMP	0		$10		0	0.00	$0	$2,530	$2,530		$0	$0	$0	$2,530
Annual Program Subtotal						**1**	**620**	**0.35**	**$49,588**	**$2,530**	**$52,118**	**0**	**$0**	**$0**	**$0**	**$52,118**

FTE and Rate Assumptions

Staff availability (hrs/year/FTE)	1768
Percent of total Program FTE for Management, Supervision and Admin	0.15
Program/Project Management 1hr/$1000 contract	0.001
Staff Loaded Rate	80
Contractor Rate	130

Activity Assumptions

Management and admin: Percent of total program FTE for Management, Supervision and Admin. Source: Industry estimate
Typical Inspection: Assume 64% of 253 facilities will need traditional inspection
Spot check: Average number of spot checks per year for a 6-year implementation period based on percentage of best and good performers.
Tracking: Average number of applicants per year for six years. Requires customer communication and filing, recording and tracking covenant information.
Materials: Average per year for six years. Develop and updated applications and outreach materials

PROGRAM COST ESTIMATE

Program Name: Private Facility Inspection and Maintenance
Program Group: Maintenance
Program Category: Operations & Maintenance
Program ID: CW-PRG-AM08 (status quo)
Program Description: The Private Facility Inspection and Maintenance Enforcement Program ensures private stormwater facilities are inspected and maintenance is enforced as required by the City's existing Phase II NDPES Permit.

Program Staff: Surface Water Quality Specialist

Activity	Number per Year	Unit	Hours per Unit	Other Direct Cost	Non-Labor Cost per Unit	Per Year Implemen-tation	City Staff					Contractor/Consultant Staff				Total Cost
							Hours	FTE	Labor Cost	Other Direct Costs	Subtotal Cost	Hours	Labor Costs	Other Direct Costs	Subtotal Cost	
Management and administration		Percent of program					127	0.07	$10,140	$0	$10,140	0	$0	$0	$0	$10,140
Inspection	160	BMP	3.5				560	0.32	$44,800	$0	$44,800	0	$0	$0	$0	$44,800
Enforcement and program management	12	BMP	20				240	0.14	$19,200	$0	$19,200	0	$0	$0	$0	$19,200
Maintenance	3	BMP	15				45	0.03	$3,600	$0	$3,600	45	$0	$5,850	$5,850	$9,450
Annual Program Subtotal						**1**	**972**	**0.55**	**$77,740**	**$0**	**$77,740**	**45**	**$0**	**$5,850**	**$5,850**	**$83,590**

FTE and Rate Assumptions

Staff availability (hrs/year/FTE)	1768
Percent of total Program FTE for Management, Supervision and Admin	0.15
Program/Project Management 1hr/$1000 contract	0.001
Staff Loaded Rate	80
Contractor Rate	130

Activity Assumptions

Management and admin: Percent of total program FTE for Management, Supervision and Admin. Source: Industry estimate
Inspection: Inspection costs based on 2017 estimates for Full time staff and part time staff effort. Assume 63% of sites are inspected per year.
Enforcement and program management: Assume half of the existing 10-20% non compliant facility owners will need escalating enforcement.
Maintenance management: Assume 25% of non-compliant properties will require the Utility to coordinate maintenance contract.

PROGRAM COST ESTIMATE

Program Name: SW Pipe Replacement Program (Existing)
Program Group: Maintenance
Program Category: Repair & Replacement
Program ID: CW-PRG-AM09
Program Description: The Stormwater Pipe Replacement Program repairs and replaces the failing stormwater pipes identified during the condition assessment video inspections.

Program Staff: CIP Engineer

Activity	Number per Year	Unit	Hours per Unit	Other Direct Cost	Non-Labor Cost per Unit	Per Year Implemen-tation	City Staff					Contractor/Consultant Staff				Total Cost
							Hours	FTE	Labor Cost	Other Direct Costs	Subtotal Cost	Hours	Labor Costs	Other Direct Costs	Subtotal Cost	
Management and administration		Percent of program					36	0.02	$2,880	$0	$2,880	0	$0	$0	$0	$2,880
Engineering and coordination	12	No. of Pipe	20				240	0.14	$19,200	$0	$19,200	0	$0	$0	$0	$19,200
Construction costs	12	No. of Pipe			$20,000		0	0.00	$0	$0	$0	0	$0	$240,000	$240,000	$240,000
Annual Program Subtotal						**1**	**276**	**0.16**	**$22,080**	**$0**	**$22,080**	**0**	**$0**	**$240,000**	**$240,000**	**$262,080**

FTE and Rate Assumptions

Staff availability (hrs/year/FTE)	1768
Percent of total Program FTE for Management, Supervision and Admin	0.15
Program/Project Management 1hr/$1000 contract	0.001
Staff Loaded Rate	80
Contractor Rate	130

Activity Assumptions

Management and admin: Percent of total program FTE for Management, Supervision and Admin. Source: Industry estimate
Engineering and coordination: Assume 1 project every other year with 25 pipes per project. City estimates 200 hours per R&R bid package to review and coordinate.
Costs: Construction cost varies greatly based on pipe location but assume $500,000 per 25 pipe count project. Source: previous projects.

PROGRAM COST ESTIMATE

Program Name: SW Pipe Replacement Program (Enhanced)
Program Group: Maintenance
Program Category: Repair & Replacement
Program ID: CW-PRG-AM10
Program Description: The Stormwater Pipe Replacement Program repairs and replaces the failing stormwater pipes identified during the condition assessment video inspections.

Program Staff: CIP Engineer

Activity	Number per Year	Unit	Hours per Unit	Other Direct Cost	Non-Labor Cost per Unit	Per Year Implemen-tation	City Staff					Contractor/Consultant Staff				Total Cost
							Hours	FTE	Labor Cost	Other Direct Costs	Subtotal Cost	Hours	Labor Costs	Other Direct Costs	Subtotal Cost	
Management and administration		Percent of program					120	0.07	$9,600	$0	$9,600	0	$0	$0	$0	$9,600
Engineering and coordination	40	No. of Pipe	20				800	0.45	$64,000	$0	$64,000	0	$0	$0	$0	$64,000
Construction costs	40	No. of Pipe			$22,000		0	0.00	$0	$0	$0	0	$0	$880,000	$880,000	$880,000
Annual Program Subtotal						**1**	**920**	**0.52**	**$73,600**	**$0**	**$73,600**	**0**	**$0**	**$880,000**	**$880,000**	**$953,600**

FTE and Rate Assumptions

Staff availability (hrs/year/FTE)	1768
Percent of total Program FTE for Management, Supervision and Admin	0.15
Program/Project Management 1hr/$1000 contract	0.001
Staff Loaded Rate	80
Contractor Rate	130

Activity Assumptions

Management and admin: Percent of total program FTE for Management, Supervision and Admin. Source: Industry estimate
Approx. 780 pipes to be replaced over 20 years. Assume two projects a year with 20 pipes per project. Source: City staff.
Costs for previous R&R projects.

PROGRAM COST ESTIMATE

Program Name: SW Pipe Replacement Program (Enhanced)
Program Group: Maintenance
Program Category: Repair & Replacement
Program ID: CW-PRG-AM10 (Six year average for proactive management strategy)
Program Description: The Stormwater Pipe Replacement Program repairs and replaces the failing stormwater pipes identified during the condition assessment video inspections.

Program Staff: CIP Engineer

Activity	Number per Year	Unit	Hours per Unit	Other Direct Cost	Non-Labor Cost per Unit	Per Year Implemen-tation	City Staff					Contractor/Consultant Staff				Total Cost
							Hours	FTE	Labor Cost	Other Direct Costs	Subtotal Cost	Hours	Labor Costs	Other Direct Costs	Subtotal Cost	
Management and administration		Percent of program					120	0.07	$9,600	$0	$9,600	0	$0	$0	$0	$9,600
Engineering and coordination	40	No. of Pipe	20				800	0.45	$64,000	$0	$64,000	0	$0	$0	$0	$64,000
Construction costs	26	No. of Pipe			$22,000		0	0.00	$0	$0	$0	0	$0	$577,918	$577,918	$577,918
Annual Program Subtotal						**1**	**920**	**0.52**	**$73,600**	**$0**	**$73,600**	**0**	**$0**	**$577,918**	**$577,918**	**$651,518**

FTE and Rate Assumptions

Staff availability (hrs/year/FTE)	1768
Percent of total Program FTE for Management, Supervision and Admin	0.15
Program/Project Management 1hr/$1000 contract	0.001
Staff Loaded Rate	80
Contractor Rate	130

Activity Assumptions

Management and admin: Percent of total program FTE for Management, Supervision and Admin. Source: Industry estimate
Approx. 780 pipes to be replaced over 20 years. Assume two projects a year with 20 pipes per project. Source: Utility staff estimates.
Costs for previous R&R projects.

PROGRAM COST ESTIMATE

Program Name: Surface Water Small Projects (Existing)
Program Group: Maintenance
Program Category: Repair & Replacement
Program ID: CW-PRG-AM11
Program Description: The Surface Water Small Projects Program reduces localized flooding or surface water related problems at various locations throughout the city.

Program Staff: CIP Engineer

Activity	Number per Year	Unit	Hours per Unit	Other Direct Cost	Non-Labor Cost per Unit	Per Year Implemen-tation	City Staff					Contractor/Consultant Staff				Total Cost
							Hours	FTE	Labor Cost	Other Direct Costs	Subtotal Cost	Hours	Labor Costs	Other Direct Costs	Subtotal Cost	
Small Works Program	1	Program	138	$238,960			138	0.08	$11,040		$11,040	0	$0	$238,960	$238,960	$250,000
Annual Program Subtotal						**1**	**138**	**0.08**	**$11,040**	**$0**	**$11,040**	**0**	**$0**	**$238,960**	**$238,960**	**$250,000**

FTE and Rate Assumptions

Staff availability (hrs/year/FTE)	1768
Percent of total Program FTE for Management, Supervision and Admin	0.15
Program/Project Management 1hr/$1000 contract	0.001
Staff Loaded Rate	80
Contractor Rate	130

Activity Assumptions

Capitalized program included in operation budget for planning purposes. Historical costs from Utility staff.

PROGRAM COST ESTIMATE

Program Name: Surface Water Small Projects (Enhanced)
Program Group: Maintenance
Program Category: Repair & Replacement
Program ID: CW-PRG-AM12
Program Description: The Surface Water Small Projects Program reduces localized flooding or surface water related problems at various locations throughout the city.

Program Staff: CIP Engineer

Activity	Number per Year	Unit	Hours per Unit	Other Direct Cost	Non-Labor Cost per Unit	Per Year Implemen-tation	City Staff					Contractor/Consultant Staff				Total Cost
							Hours	FTE	Labor Cost	Other Direct Costs	Subtotal Cost	Hours	Labor Costs	Other Direct Costs	Subtotal Cost	
Small Works Program	1	Program	276	$477,920			276	0.16	$22,080		$22,080	0	$0	$477,920	$477,920	$500,000
Annual Program Subtotal						**1**	**276**	**0.16**	**$22,080**	**$0**	**$22,080**	**0**	**$0**	**$477,920**	**$477,920**	**$500,000**

FTE and Rate Assumptions

Staff availability (hrs/year/FTE)	1768
Percent of total Program FTE for Management, Supervision and Admin	0.15
Program/Project Management 1hr/$1000 contract	0.001
Staff Loaded Rate	80
Contractor Rate	130

Activity Assumptions

Capitalized program included in operation budget for planning purposes. Historical costs from Utility staff.

PROGRAM COST ESTIMATE

Program Name: Surface Water Small Projects (Enhanced)
Program Group: Maintenance
Program Category: Repair & Replacement
Program ID: CW-PRG-AM12 (First three year ramp up for proactive management strategy)
Program Description: The Surface Water Small Projects Program reduces localized flooding or surface water related problems at various locations throughout the city.

Program Staff: CIP Engineer

Activity	Number per Year	Unit	Hours per Unit	Other Direct Cost	Non-Labor Cost per Unit	Per Year Implemen-tation	City Staff					Contractor/Consultant Staff				Total Cost
							Hours	FTE	Labor Cost	Other Direct Costs	Subtotal Cost	Hours	Labor Costs	Other Direct Costs	Subtotal Cost	
Small Works Program	1	Program	276	$277,920			276	0.16	$22,080		$22,080	0	$0	$277,920	$277,920	$300,000
Annual Program Subtotal						**1**	**276**	**0.16**	**$22,080**	**$0**	**$22,080**	**0**	**$0**	**$277,920**	**$277,920**	**$300,000**

FTE and Rate Assumptions

Staff availability (hrs/year/FTE)	1768
Percent of total Program FTE for Management, Supervision and Admin	0.15
Program/Project Management 1hr/$1000 contract	0.001
Staff Loaded Rate	80
Contractor Rate	130

Activity Assumptions

Capitalized program included in operation budget for planning purposes. Historical costs from Utility staff.

PROGRAM COST ESTIMATE

Program Name: Surface Water Small Projects (Enhanced)
Program Group: Maintenance
Program Category: Repair & Replacement
Program ID: CW-PRG-AM12 (Six year average for proactive management strategy)
Program Description: The Surface Water Small Projects Program reduces localized flooding or surface water related problems at various locations throughout the city.

Program Staff: CIP Engineer

Activity	Number per Year	Unit	Hours per Unit	Other Direct Cost	Non-Labor Cost per Unit	Per Year Implemen-tation	City Staff					Contractor/Consultant Staff				Total Cost
							Hours	FTE	Labor Cost	Other Direct Costs	Subtotal Cost	Hours	Labor Costs	Other Direct Costs	Subtotal Cost	
Small Works Program	1	Program	276	$377,920			276	0.16	$22,080		$22,080	0	$0	$377,920	$377,920	$400,000
Annual Program Subtotal						**1**	**276**	**0.16**	**$22,080**	**$0**	**$22,080**	**0**	**$0**	**$377,920**	**$377,920**	**$400,000**

FTE and Rate Assumptions

Staff availability (hrs/year/FTE)	1768
Percent of total Program FTE for Management, Supervision and Admin	0.15
Program/Project Management 1hr/$1000 contract	0.001
Staff Loaded Rate	80
Contractor Rate	130

Activity Assumptions

Capitalized program included in operation budget for planning purposes. Historical costs from Utility staff.

PROGRAM COST ESTIMATE

Program Name: System Inspection (Enhanced)
Program Group: Maintenance
Program Category: Operations & Maintenance
Program ID: CW-PRG-AM13
Program Description: Catch basin inspection and vactoring frequency increasing from every three years to every other year as per current NPDES permit beginning 2018.

Program Staff: Engineering Technician

Activity	Number per Year	Unit	Hours per Unit	Other Direct Cost	Non-Labor Cost per Unit	Per Year Implemen-tation	City Staff					Contractor/Consultant Staff				Total Cost
							Hours	FTE	Labor Cost	Other Direct Costs	Subtotal Cost	Hours	Labor Costs	Other Direct Costs	Subtotal Cost	
Management and administration		percent of program					58	0.03	$4,633	$0	$4,633	0	$0	$0	$0	$4,633
Inspect catch basins	1170	EA	0.33				386	0.22	$30,888	$0	$30,888	0	$0	$0	$0	$30,888
Vactor	230				$50		0	0.00	$0	$0	$0	0	$0	$11,500	$11,500	$11,500
Annual Program Subtotal						**1**	**444**	**0.25**	**$35,521**	**$0**	**$35,521**	**0**	**$0**	**$11,500**	**$11,500**	**$47,021**

FTE and Rate Assumptions

Staff availability (hrs/year/FTE)	1768
Percent of total Program FTE for Management, Supervision and Admin	0.15
Program/Project Management 1hr/$1000 contract	0.001
Staff Loaded Rate	80
Contractor Rate	130

Activity Assumptions

Management and admin: Percent of total program FTE for Management, Supervision and Admin. Source: Industry estimate
Inspection CBs: Cost estimates derived from Utility staff 2016 CB inspection and vactoring work and cost rates.
Vactor CBs: Cost estimates derived from Utility staff 2016 CB inspection and vactoring work and cost rates.

PROGRAM COST ESTIMATE

Program Name: O&M for Optimum CIP
Program Group: Maintenance
Program Category: Operations & Maintenance
Program ID: CW-PRG-AM14
Program Description: Operation and maintenance activities needed to support new CIP projects identified for the optimal management strategy; averaged per year over 6 year period.

Program Staff: Engineering Technician

Activity	Number per Year	Unit	Hours per Unit	Other Direct Cost	Non-Labor Cost per Unit	Per Year Implemen-tation	City Staff					Contractor/Consultant Staff				Total Cost
							Hours	FTE	Labor Cost	Other Direct Costs	Subtotal Cost	Hours	Labor Costs	Other Direct Costs	Subtotal Cost	
O&M for Optimum CIP							950	0.54	$76,000						$950,000	$1,026,000
Annual Program Subtotal						**6**	**158**	**0.09**	**$12,667**	**$0**	**$0**	**0**	**$0**	**$0**	**$158,333**	**$158,333**

FTE and Rate Assumptions

Staff availability (hrs/year/FTE)	1768
Percent of total Program FTE for Management, Supervision and Admin	0.15
Program/Project Management 1hr/$1000 contract	0.001
Staff Loaded Rate	80
Contractor Rate	130

Activity Assumptions

O&M needs for optimum management strategy (from project life cycle costs).

PROGRAM COST ESTIMATE

Program Name: O&M for Proactive CIP
Program Group: Maintenance
Program Category: Operations & Maintenance
Program ID: CW-PRG-AM13
Program Description: Operation and maintenance activities needed to support new CIP projects identified for the proactive management strategy; averaged per year over 6 year period.

Program Staff: Engineering Technician

Activity	Number per Year	Unit	Hours per Unit	Other Direct Cost	Non-Labor Cost per Unit	Per Year Implemen-tation	City Staff					Contractor/Consultant Staff				Total Cost
							Hours	FTE	Labor Cost	Other Direct Costs	Subtotal Cost	Hours	Labor Costs	Other Direct Costs	Subtotal Cost	
O&M for Proactive CIP							950	0.54	$76,000						$950,000	$1,026,000
Annual Program Subtotal						**6**	**158**	**0.09**	**$12,667**	**$0**	**$0**	**0**	**$0**	**$0**	**$158,333**	**$171,000**

FTE and Rate Assumptions

Staff availability (hrs/year/FTE)	1768
Percent of total Program FTE for Management, Supervision and Admin	0.15
Program/Project Management 1hr/$1000 contract	0.001
Staff Loaded Rate	80
Contractor Rate	130

Activity Assumptions

O&M needs for proactive management strategy (from project life cycle costs).

PROGRAM COST ESTIMATE

Program Name: O&M for Minimum CIP
Program Group: Maintenance
Program Category: Operations & Maintenance
Program ID: CW-PRG-AM14
Program Description: Operation and maintenance activities needed to support new CIP projects identified for the minimum management strategy; averaged per year over 6 year period.

Program Staff: Engineering Technician

Activity	Number per Year	Unit	Hours per Unit	Other Direct Cost	Non-Labor Cost per Unit	Per Year Implemen-tation	City Staff					Contractor/Consultant Staff				Total Cost
							Hours	FTE	Labor Cost	Other Direct Costs	Subtotal Cost	Hours	Labor Costs	Other Direct Costs	Subtotal Cost	
O&M for Minimum CIP							190	0.11	$15,200						$188,000	$203,200
Annual Program Subtotal						**6**	**32**	**0.02**	**$2,533**	**$0**	**$0**	**0**	**$0**	**$0**	**$31,333**	**$33,867**

FTE and Rate Assumptions

Staff availability (hrs/year/FTE)	1768
Percent of total Program FTE for Management, Supervision and Admin	0.15
Program/Project Management 1hr/$1000 contract	0.001
Staff Loaded Rate	80
Contractor Rate	130

Activity Assumptions

O&M needs for minimum management strategy (from project life cycle costs).

PROGRAM COST ESTIMATE

Program Name: O&M for Current CIP
Program Group: Maintenance
Program Category: Operations & Maintenance
Program ID: CW-PRG-AM15
Program Description: Operation and maintenance activities needed to support new CIP projects identified for the current management strategy; averaged per year over 6 year period.

Program Staff: Engineering Technician

Activity	Number per Year	Unit	Hours per Unit	Other Direct Cost	Non-Labor Cost per Unit	Per Year Implementation	City Staff					Contractor/Consultant Staff				Total Cost
							Hours	FTE	Labor Cost	Other Direct Costs	Subtotal Cost	Hours	Labor Costs	Other Direct Costs	Subtotal Cost	
O&M for Current CIP							160	0.09	$12,800						$164,000	$176,800
Annual Program Subtotal						**6**	**27**	**0.02**	**$2,133**	**$0**	**$0**	**0**	**$0**	**$0**	**$27,333**	**$29,467**

FTE and Rate Assumptions

Staff availability (hrs/year/FTE)	1768
Percent of total Program FTE for Management, Supervision and Admin	0.15
Program/Project Management 1hr/$1000 contract	0.001
General Staff Loaded Rate	80
Contractor Rate	130

Activity Assumptions

O&M needs for current management strategy (from project life cycle costs).

D-2 Program Prioritization

Existing Program Prioritization

Shoreline Surface Water Master Plan

Updated: 27-Mar-18

Level of Service (LOS)		Prioritization System						Project Scoring								
			Scoring					Cur-1	Cur-2	Cur-3	Cur-4	Cur-5	Cur-6	Cur-7	Cur-8	Cur-9
Expectations	Targets	Evaluation Criteria	0	1	2	Weighting Factor	Maximum Scores	NPDES Compliance	Floodplain Management	Administration and Management	Drainage Assessment	Water Quality Monitoring	Asset Management	Street Sweeping	System Maintenance	Small Repairs
Manage public health, safety and environmental risks from impaired water quality, flooding, and failed infrastructure	**A. Flooding and Erosion** No verifiable health and safety issues or environmental damage caused by flooding or erosion outside of an accepted risk tolerance	**A.1 System Capacity** Program addresses capacity deficiencies.	Not directly applicable	Provides a moderate and direct benefit	Provides a substantial and direct benefit	60	320	0	0	1	2	0	1	1	1	1
		A.2 Hazard Reduction Program addresses an apparent public safety hazard.	Not directly applicable	Provides a moderate and direct benefit	Provides a substantial and direct benefit	60		0	0	1	2	0	0	2	2	1
		A.3 Erosion Control Program addresses erosion problems related to public stormwater conveyance.	Not directly applicable	Provides a moderate and direct benefit	Provides a substantial and direct benefit	40		0	0	1	1	0	0	0	1	0
	B. Water Quality Improve the quality of stormwater discharged to impaired receiving waters to mitigate environmental damage	**B.1 Stormwater Treatment** Programs addresses stormwater treatment in accordance with applicable regulatory standards.	Not directly applicable	Provides a moderate and direct benefit	Provides a substantial and direct benefit	40	160	1	0	1	0	2	2	0	0	0
		B.2 Low Impact Development (LID) Program supports or encourages LID principles.	Not directly applicable	Provides a moderate and direct benefit	Provides a substantial and direct benefit	5		1	0	1	0	1	2	0	0	0
		B.3 Impaired Water Impacts Stormwater impacts to impaired water bodies should be reduced where cost-efficient opportunities are present.	Not directly applicable	Provides a moderate and direct benefit	Provides a substantial and direct benefit	35		1	0	1	0	2	2	2	1	1
	C. Habitat Protect aquatic habitat by reducing impacts to ecosystem health and biotic diversity in lakes, streams, and wetlands	**C.1 Habitat Protection** Program protects aquatic habitat from degradation to minimize the loss of ecosystem function and diversity.	Not directly applicable	Provides a moderate and direct benefit	Provides a substantial and direct benefit	25	100	0	1	1	0	1	1	1	1	1
		C.2 Habitat Restoration Program restores ecosystem function and diversity, is cost-effective, and provides multiple benefits.	Not directly applicable	Provides a moderate and direct benefit	Provides a substantial and direct benefit	25		0	0	1	0	1	1	0	1	1
Provide consistent, equitable standards of service to the citizens of Shoreline at a reasonable cost, within rates and budget	**D. Responsible Stewardship** Provide equitable services through cost-effective planning and management of utility assets, sound fiscal planning, and efficient operations.	**D.1 System Preservation (Asset Management)** Program supports Asset Management Program.	Not directly applicable	Provides a moderate and direct benefit	Provides a substantial and direct benefit	80	460	0	0	1	1	0	0	1	2	2
		D.2 Operations and Maintenance Program supports operations and maintenance needed for existing and planned assets.	Not directly applicable	Provides a moderate and direct benefit	Provides a substantial and direct benefit	20		1	1	1	2	0	0	2	2	2
		D.3 Financial Planning Program supports sound financial planning and/or helps the Utility qualify for alternative funding sources.	Not directly applicable	Provides a moderate and direct benefit	Provides a substantial and direct benefit	20		0	0	1	1	0	0	0	2	1
		D.4 Future growth Program supports future population and/or economic growth.	Not directly applicable	Provides a moderate and direct benefit	Provides a substantial and direct benefit	30		0	0	1	0	2	1	0	0	0
		D.5 Customer service Program improves customer service.	Not directly applicable	Provides a moderate and direct benefit	Provides a substantial and direct benefit	20		0	0	1	2	1	2	2	1	2
	E. Internal Resources Manage internal resources to provide adequate resources, training, and	**E.1 Workforce** Program increases/retains the capabilities of City staff.	Not directly applicable	Provides a moderate and direct benefit	Provides a substantial and direct benefit	60		0	0	1	0	0	0	2	1	1
Engage in transparent communication through public education and outreach	**F. Customer Service and Communications** Provide effective communication, public education, and outreach.	**F.1 Communication and Education** Program provides opportunities or supports public education, outreach, and communications.	Not directly applicable	Provides a moderate and direct benefit	Provides a substantial and direct benefit	20	40	2	0	1	0	2	2	1	0	0
Comply with regulatory requirements for the urban drainage system	**G. Regulatory Compliance** Meet state and federal regulatory requirements for stormwater utilities.	**G.1. Regulatory** Program addresses regulatory requirements.	Not directly applicable	Provides a moderate and direct benefit	Provides a substantial and direct benefit	200	400	2	2	1	0	0	2	2	1	0
						Maximum Score:	1480	540	445	740	460	325	780	975	825	525
								11	14	9	13	16	8	2	5	12

Brown AND Caldwell

Existing Program Prioritization

Shoreline Surface Water Master Plan

Updated: 27-Mar-18

Level of Service (LOS)		Prioritization System														
			Scoring					Cur-10	Cur-11	Cur-12	Cur-13	Cur-14	Cur-15	Cur-16	Cur-17	Cur-18
Expectations	Targets	Evaluation Criteria	0	1	2	Weighting Factor	Maximum Scores	Thornton Creek Cond Assessment	SW Pipe Replacement	Surface Water Small Projects	Private Facility Inspection	System Inspection	Soak it Up LID Rebate	Adopt a Drain	Local Source Control	Water Quality Public Outreach
Manage public health, safety and environmental risks from impaired water quality, flooding, and failed infrastructure	**A. Flooding and Erosion** No verifiable health and safety issues or environmental damage caused by flooding or erosion outside of an accepted risk tolerance	**A.1 System Capacity** Program addresses capacity deficiencies.	Not directly applicable	Provides a moderate and direct benefit	Provides a substantial and direct benefit	60	320	1	2	2	0	1	1	1	0	0
		A.2 Hazard Reduction Program addresses an apparent public safety hazard.	Not directly applicable	Provides a moderate and direct benefit	Provides a substantial and direct benefit	60		1	1	1	0	2	0	1	1	1
		A.3 Erosion Control Program addresses erosion problems related to public stormwater conveyance.	Not directly applicable	Provides a moderate and direct benefit	Provides a substantial and direct benefit	40		0	0	0	0	2	1	1	0	0
	B. Water Quality Improve the quality of stormwater discharged to impaired receiving waters to mitigate environmental damage	**B.1 Stormwater Treatment** Programs addresses stormwater treatment in accordance with applicable regulatory standards.	Not directly applicable	Provides a moderate and direct benefit	Provides a substantial and direct benefit	40	160	0	0	0	1	2	2	0	0	2
		B.2 Low Impact Development (LID) Program supports or encourages LID principles.	Not directly applicable	Provides a moderate and direct benefit	Provides a substantial and direct benefit	5		0	0	0	0	1	2	0	0	0
		B.3 Impaired Water Impacts Stormwater impacts to impaired water bodies should be reduced where cost-efficient opportunities are present.	Not directly applicable	Provides a moderate and direct benefit	Provides a substantial and direct benefit	35		0	0	0	0	1	1	1	1	2
	C. Habitat Protect aquatic habitat by reducing impacts to ecosystem health and biotic diversity in lakes, streams, and wetlands	**C.1 Habitat Protection** Program protects aquatic habitat from degradation to minimize the loss of ecosystem function and diversity.	Not directly applicable	Provides a moderate and direct benefit	Provides a substantial and direct benefit	25	100	0	0	0	0	1	1	0	1	0
		C.2 Habitat Restoration Program restores ecosystem function and diversity, is cost-effective, and provides multiple benefits.	Not directly applicable	Provides a moderate and direct benefit	Provides a substantial and direct benefit	25		0	0	0	0	1	1	0	1	0
Provide consistent, equitable standards of service to the citizens of Shoreline at a reasonable cost, within rates and budget	**D. Responsible Stewardship** Provide equitable services through cost-effective planning and management of utility assets, sound fiscal planning, and efficient operations.	**D.1 System Preservation (Asset Management)** Program supports Asset Management Program.	Not directly applicable	Provides a moderate and direct benefit	Provides a substantial and direct benefit	80	460	2	1	1	1	2	0	2	1	0
		D.2 Operations and Maintenance Program supports operations and maintenance needed for existing and planned assets.	Not directly applicable	Provides a moderate and direct benefit	Provides a substantial and direct benefit	20		2	1	1	1	2	0	2	2	2
		D.3 Financial Planning Program supports sound financial planning and/or helps the Utility qualify for alternative funding sources.	Not directly applicable	Provides a moderate and direct benefit	Provides a substantial and direct benefit	20		2	1	1	0	2	0	2	2	2
		D.4 Future growth Program supports future population and/or economic growth.	Not directly applicable	Provides a moderate and direct benefit	Provides a substantial and direct benefit	30		2	0	0	0	1	2	0	0	2
		D.5 Customer service Program improves customer service.	Not directly applicable	Provides a moderate and direct benefit	Provides a substantial and direct benefit	20		1	0	0	1	2	2	0	2	2
	E. Internal Resources Manage internal resources to provide adequate resources, training, and	**E.1 Workforce** Program increases/retains the capabilities of City staff.	Not directly applicable	Provides a moderate and direct benefit	Provides a substantial and direct benefit	60		0	0	0	0	2	0	0	0	2
Engage in transparent communication through public education and outreach	**F. Customer Service and Communications** Provide effective communication, public education, and outreach.	**F.1 Communication and Education** Program provides opportunities or supports public education, outreach, and communications.	Not directly applicable	Provides a moderate and direct benefit	Provides a substantial and direct benefit	20	40	0	0	0	1	1	2	1	2	2
Comply with regulatory requirements for the urban drainage system	**G. Regulatory Compliance** Meet state and federal regulatory requirements for stormwater utilities.	**G.1. Regulatory** Program addresses regulatory requirements.	Not directly applicable	Provides a moderate and direct benefit	Provides a substantial and direct benefit	200	400	0	0	0	2	2	2	2	2	2
						Maximum Score:	1480	440	300	300	580	1280	815	855	785	950
								15	17	17	10	1	6	4	7	3

New and Enhanced Program Prioritization

Shoreline Surface Water Master Plan

Updated: 31-Jan-18

Level of Service (LOS)		Prioritization System						Program Scoring									
			Scoring					CW-PRG-AH01	CW-PRG-AM01	CW-PRG-AM02	CW-PRG-AM03	CW-PRG-AM04	CW-PRG-AM05	CW-PRG-AM06	CW-PRG-AM07	CW-PRG-AM08	CW-PRG-AM09
Expectations	Targets	Evaluation Criteria	0	1	2	Weighting Factor	Maximum Scores	Aquatic Habitat Studies	Catch Basin Repair and Replacement	Pump Station Maintenance	LID Maintenance	Utility Crossing Removal	Improper Connection Repair	Pipe Condition Assessment Program (Enhanced)	Asset Management Program (Enhanced)	Private Facility Inspection and Maintenance (Enhanced)	SW Pipe Replacement Program (Existing)
Manage public health, safety and environmental risks from impaired water quality, flooding, and failed infrastructure	**A. Flooding and Erosion** No verifiable health and safety issues or environmental damage caused by flooding or erosion outside of an accepted risk tolerance	**A.1 System Capacity** Program addresses capacity deficiencies.	Not directly applicable	Provides a moderate and direct benefit	Provides a substantial and direct benefit	60	320	0	1	1	0	1	1	1	0	0	2
		A.2 Hazard Reduction Program addresses an apparent public safety hazard.	Not directly applicable	Provides a moderate and direct benefit	Provides a substantial and direct benefit	60		0	1	0	0	1	1	2	0	0	1
		A.3 Erosion Control Program addresses erosion problems related to public stormwater conveyance.	Not directly applicable	Provides a moderate and direct benefit	Provides a substantial and direct benefit	40		0	0	0	0	0	0	0	0	0	0
	B. Water Quality Improve the quality of stormwater discharged to impaired receiving waters to mitigate environmental damage	**B.1 Stormwater Treatment** Programs addresses stormwater treatment in accordance with applicable regulatory standards.	Not directly applicable	Provides a moderate and direct benefit	Provides a substantial and direct benefit	40	160	0	0	0	1	0	0	0	0	1	0
		B.2 Low Impact Development (LID) Program supports or encourages LID principles.	Not directly applicable	Provides a moderate and direct benefit	Provides a substantial and direct benefit	5		0	0	0	2	0	0	0	0	0	0
		B.3 Impaired Water Impacts Stormwater impacts to impaired water bodies should be reduced where cost-efficient opportunities are present.	Not directly applicable	Provides a moderate and direct benefit	Provides a substantial and direct benefit	35		1	0	0	1	0	0	0	0	0	0
	C. Habitat Protect aquatic habitat by reducing impacts to ecosystem health and biotic diversity in lakes, streams, and wetlands	**C.1 Habitat Protection** Program protects aquatic habitat from degradation to minimize the loss of ecosystem function and diversity.	Not directly applicable	Provides a moderate and direct benefit	Provides a substantial and direct benefit	25	100	2	0	0	0	0	0	0	0	0	0
		C.2 Habitat Restoration Program restores ecosystem function and diversity, is cost-effective, and provides multiple benefits.	Not directly applicable	Provides a moderate and direct benefit	Provides a substantial and direct benefit	25		2	0	0	0	0	0	0	0	0	0
Provide consistent, equitable standards of service to the citizens of Shoreline at a reasonable cost, within rates and budget	**D. Responsible Stewardship** Provide equitable services through cost-effective planning and management of utility assets, sound fiscal planning, and efficient operations.	**D.1 System Preservation (Asset Management)** Program supports Asset Management Program.	Not directly applicable	Provides a moderate and direct benefit	Provides a substantial and direct benefit	80	460	0	2	2	0	2	1	2	2	1	1
		D.2 Operations and Maintenance Program supports operations and maintenance needed for existing and planned assets.	Not directly applicable	Provides a moderate and direct benefit	Provides a substantial and direct benefit	20		0	2	2	2	2	1	2	2	1	1
		D.3 Financial Planning Program supports sound financial planning and/or helps the Utility qualify for alternative funding sources.	Not directly applicable	Provides a moderate and direct benefit	Provides a substantial and direct benefit	20		0	0	0	0	0	0	2	2	0	1
		D.4 Future growth Program supports future population and/or economic growth.	Not directly applicable	Provides a moderate and direct benefit	Provides a substantial and direct benefit	30		0	0	0	0	0	0	2	2	0	0
		D.5 Customer service Program improves customer service.	Not directly applicable	Provides a moderate and direct benefit	Provides a substantial and direct benefit	20		0	0	0	0	0	0	0	2	1	0
	E. Internal Resources Manage internal resources to provide adequate resources, training, and	**E.1 Workforce** Program increases/retains the capabilities of City staff.	Not directly applicable	Provides a moderate and direct benefit	Provides a substantial and direct benefit	60		0	0	0	0	0	0	0	1	0	0
Engage in transparent communication through public education and outreach	**F. Customer Service and Communications** Provide effective communication, public education, and outreach.	**F.1 Communication and Education** Program provides opportunities or supports public education, outreach, and communications.	Not directly applicable	Provides a moderate and direct benefit	Provides a substantial and direct benefit	20	40	1	0	0	0	0	0	0	0	1	0
Comply with regulatory requirements for the urban drainage system	**G. Regulatory Compliance** Meet state and federal regulatory requirements for stormwater utilities.	**G.1. Regulatory** Program addresses regulatory requirements.	Not directly applicable	Provides a moderate and direct benefit	Provides a substantial and direct benefit	200	400	0	2	0	2	0	0	0	0	2	0
						Maximum Score:	**1480**	155 20	720 3	260 17	525 7	320 14	220 18	480 9	400 13	580 4	300 15

Brown AND Caldwell

New and Enhanced Program Prioritization

Shoreline Surface Water Master Plan

Updated: 31-Jan-18

Level of Service (LOS)		Prioritization System															
Expectations	Targets	Evaluation Criteria	Scoring: 0	Scoring: 1	Scoring: 2	Weighting Factor	Maximum Scores	CW-PRG-AM10 SW Pipe Replacement Program (Enhanced)	CW-PRG-AM11 Surface Water Small Projects (Existing)	CW-PRG-AM12 Surface Water Small Projects (Enhanced)	CW-PRG-AM13 System Inspection (Enhanced)	CW-PRG-FM01 Drainage Assessment (Enhanced)	CW-PRG-UM01 Stormwater Permit	CW-PRG-UM02 NPDES Compliance (Enhanced, Minimum Effort)	CW-PRG-WQ01 Thornton Creek Stewardship	CW-PRG-WQ02 Business Inspection Source Control (Minimum Effort)	CW-PRG-WQ03 Business Inspection Source Control
Manage public health, safety and environmental risks from impaired water quality, flooding, and failed infrastructure	**A. Flooding and Erosion** No verifiable health and safety issues or environmental damage caused by flooding or erosion outside of an accepted risk tolerance	**A.1 System Capacity** Program addresses capacity deficiencies.	Not directly applicable	Provides a moderate and direct benefit	Provides a substantial and direct benefit	60	320	2	2	2	2	2	1	0	0	0	0
		A.2 Hazard Reduction Program addresses an apparent public safety hazard.	Not directly applicable	Provides a moderate and direct benefit	Provides a substantial and direct benefit	60		1	1	2	2	2	0	0	0	0	0
		A.3 Erosion Control Program addresses erosion problems related to public stormwater conveyance.	Not directly applicable	Provides a moderate and direct benefit	Provides a substantial and direct benefit	40		0	0	1	1	1	0	0	0	0	0
	B. Water Quality Improve the quality of stormwater discharged to impaired receiving waters to mitigate environmental damage	**B.1 Stormwater Treatment** Programs addresses stormwater treatment in accordance with applicable regulatory standards.	Not directly applicable	Provides a moderate and direct benefit	Provides a substantial and direct benefit	40	160	0	0	0	2	0	1	1	1	2	2
		B.2 Low Impact Development (LID) Program supports or encourages LID principles.	Not directly applicable	Provides a moderate and direct benefit	Provides a substantial and direct benefit	5		0	0	0	2	0	1	1	1	0	1
		B.3 Impaired Water Impacts Stormwater impacts to impaired water bodies should be reduced where cost-efficient opportunities are present.	Not directly applicable	Provides a moderate and direct benefit	Provides a substantial and direct benefit	35		0	0	0	2	0	0	1	1	0	2
	C. Habitat Protect aquatic habitat by reducing impacts to ecosystem health and biotic diversity in lakes, streams, and wetlands	**C.1 Habitat Protection** Program protects aquatic habitat from degradation to minimize the loss of ecosystem function and diversity.	Not directly applicable	Provides a moderate and direct benefit	Provides a substantial and direct benefit	25	100	0	0	0	0	0	0	0	1	0	1
		C.2 Habitat Restoration Program restores ecosystem function and diversity, is cost-effective, and provides multiple benefits.	Not directly applicable	Provides a moderate and direct benefit	Provides a substantial and direct benefit	25		0	0	0	0	0	0	0	1	0	0
Provide consistent, equitable standards of service to the citizens of Shoreline at a reasonable cost, within rates and budget	**D. Responsible Stewardship** Provide equitable services through cost-effective planning and management of utility assets, sound fiscal planning, and efficient operations.	**D.1 System Preservation (Asset Management)** Program supports Asset Management Program.	Not directly applicable	Provides a moderate and direct benefit	Provides a substantial and direct benefit	80	460	2	1	1	2	1	1	0	0	0	2
		D.2 Operations and Maintenance Program supports operations and maintenance needed for existing and planned assets.	Not directly applicable	Provides a moderate and direct benefit	Provides a substantial and direct benefit	20		2	1	2	2	2	1	1	0	0	1
		D.3 Financial Planning Program supports sound financial planning and/or helps the Utility qualify for alternative funding sources.	Not directly applicable	Provides a moderate and direct benefit	Provides a substantial and direct benefit	20		2	1	1	2	1	1	0	0	0	0
		D.4 Future growth Program supports future population and/or economic growth.	Not directly applicable	Provides a moderate and direct benefit	Provides a substantial and direct benefit	30		0	0	0	0	0	1	0	0	0	2
		D.5 Customer service Program improves customer service.	Not directly applicable	Provides a moderate and direct benefit	Provides a substantial and direct benefit	20		0	0	2	2	2	1	0	0	0	2
	E. Internal Resources Manage internal resources to provide adequate resources, training, and	**E.1 Workforce** Program increases/retains the capabilities of City staff.	Not directly applicable	Provides a moderate and direct benefit	Provides a substantial and direct benefit	60		1	0	0	2	0	1	1	0	0	2
Engage in transparent communication through public education and outreach	**F. Customer Service and Communications** Provide effective communication, public education, and outreach.	**F.1 Communication and Education** Program provides opportunities or supports public education, outreach, and communications.	Not directly applicable	Provides a moderate and direct benefit	Provides a substantial and direct benefit	20	40	0	0	1	2	0	1	0	2	1	2
Comply with regulatory requirements for the urban drainage system	**G. Regulatory Compliance** Meet state and federal regulatory requirements for stormwater utilities.	**G.1. Regulatory** Program addresses regulatory requirements.	Not directly applicable	Provides a moderate and direct benefit	Provides a substantial and direct benefit	200	400	0	0	0	2	0	1	2	0	2	2
						Maximum Score:	**1480**	480	300	480	1280	460	555	560	170	500	1020
								9	15	9	1	12	6	5	19	8	2

D-3 List of Programs by Management Strategy

Shoreline Surface Water Master Plan

List of Programs by Management Strategy

Program Category	Management Strategies			
	Current	Minimum	Proactive	Optimum
Operations	Administration and Management	Administration and Management	Administration and Management	Administration and Management
	Floodplain Management	Floodplain Management	Floodplain Management	Floodplain Management
	NPDES Compliance	NPDES Compliance (Min Effort Enhanced)	NPDES Compliance (Enhanced)	NPDES Compliance (Enhanced)
	Drainage Assessment	Drainage Assessment	Drainage Assessment (Enhanced)	Drainage Assessment (Enhanced)
	Water Quality Monitoring	Water Quality Monitoring	Water Quality Monitoring (Enhanced)	Water Quality Monitoring (Enhanced)
	Asset Management	Asset Management	Asset Management (Enhanced)	Asset Management (Enhanced)
	System Inspection	System Inspection	System Inspection (Enhanced)	System Inspection (Enhanced)
	Condition Assessment	Condition Assessment	Condition Assessment (Enhanced)	Condition Assessment (Enhanced)
	Private Facility Inspection	Private Facility Inspection	Private Facility Inspection/Maintenance (Enhanced)	Private Facility Inspection/Maintenance (Enhanced)
	--	Stormwater Permit (New)	Stormwater Permit (New)	Stormwater Permit (New)
Maintenance	System Maintenance	System Maintenance	System Maintenance	System Maintenance
	Small Repairs	Small Repairs	Small Repairs	Small Repairs
	Street Sweeping	Street Sweeping	Street Sweeping	Street Sweeping
	SW Pipe Replacement	SW Pipe Replacement	SW Pipe Replacement (Enhanced)	SW Pipe Replacement (Enhanced)
	Surface Water Small Projects	Surface Water Small Projects	Surface Water Small Projects (Enhanced)	Surface Water Small Projects (Enhanced)
		Catch Basin R&R (New)	Catch Basin R&R (New)	Catch Basin R&R (New)
		LID Maintenance (New)	LID Maintenance (New)	LID Maintenance (New)
		--	Pump Maintenance (New)	Pump Maintenance (New)
		--	Utility Crossing Removal (New)	Utility Crossing Removal (New)
		--	--	Improper Connection Repair (New)
Public Involvement	Soak-it-Up LID Rebate	Soak-it-Up LID Rebate	Soak-it-Up LID Rebate	Soak-it-Up LID Rebate
	Adopt-a-Drain	Adopt-a-Drain	Adopt-a-Drain	Adopt-a-Drain
	Local Source Control	Local Source Control	Local Source Control	Local Source Control
	Water Quality Public Outreach	Water Quality Public Outreach	Water Quality Public Outreach	Water Quality Public Outreach
	--	Business Inspection Source Control (Min Effort New)	Business Inspection Source Control (New)	Business Inspection Source Control (New)
	--	--	--	Thornton Creek Stewardship (New)
	--	--	--	Aquatic Habitat (New)

Note: Programs shown in blue font are enhanced existing programs or new programs.

D-4 Program Performance Measures

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Proactive Programs with Performance Measures and Ratings

KEY: Meets Expectations | Needs Improvement | Below Expectations

Red font indicates Programs that are new or enhanced for the proactive management strategy

Level of Service	LOS Targets	LOS Targets	Programs	Performance Measures	2017 Program Rating	2017 Overall Rating	2018 Target Rating	2023 Target Rating
LOS 1 Manage public health, safety and environmental risks from impaired water quality, flooding, and failed infrastructure	No verifiable health and safety issues or environmental damage caused by the stormwater services outside of risk tolerance	**A. Flooding and Erosion** No verifiable health and safety issues or environmental damage caused by flooding or erosion outside of an accepted risk tolerance **B. Water Quality** Improve the quality of stormwater discharged to impaired receiving waters to mitigate environmental damage **C. Habitat** Protect aquatic habitat by reducing impacts to ecosystem health and biotic diversity in lakes, streams, and wetlands	Drainage Assessment (Enhanced)	Percent of new drainage assessments completed within 1 year, measured annually		Below Expectations	Needs Improvements	Meets Expectations
			Water Quality Monitoring (Enhanced)	Percent of water quality samples collected in accordance with Water Quality Monitoring plan, measured annually				
			Street Sweeping	Percent of miles of street sweeping completed per schedule, measured annually				
			System Maintenance	Percent of maintenance completed in accordance with schedule or NPDES requirements, measured annually				
			Pipe Condition Assessment Program (Enhanced)	Linear feet of pipe inspected per year				
			SW Pipe Replacement Program (Enhanced)	Percent of pipe repaired as scheduled, measured annually				
			System Inspection (Enhanced)	Percent of asset inspections completed as scheduled, measured annually				
			Catch Basin Repair and Replacement (New)	Percent of catch basins repaired or replaced as scheduled (within 6 mos. for NPDES), measured annually				
			LID Maintenance (New)	Percent of LID facilities repaired within 1 Year of inspection per NPDES requirements, measured annually				
			Pump Station Maintenance (New)	Percent of pump station maintenance completed as scheduled, measured annually				
			Utility Crossing Removal (New)	Percent of identified utility crossing problems removed, measured annually				
LOS 2 Provide consistent, equitable standards of service to the citizens of Shoreline at a reasonable cost, within rates and budget	Meet the levels of service as measured by customer satisfaction and rate and revenue projections.	**D. Responsible Stewardship** Provide equitable services through cost-effective planning and management of utility assets, sound fiscal planning, and efficient operations. **E. Internal Resources** Manage internal resources to provide adequate resources, training, and	Administration and Management	Percent of full time Utility staff who meet their annual work plan goals		Needs Improvements	Meets Expectations	Meets Expectations
			Stormwater Permit (New)	Percent of permit data integrated in asset management systems within 6 months of closed permit.				
			Asset Management Program (Enhanced)	Percent of annual planned activities completed based on Asset Management Work Plan, measured annually				
			Small Repairs	Percent of identified small repairs completed within 1 year, measured annually				
			Surface Water Small Projects (Enhanced)	Percent of identified small works projects completed within 1 year, measured annually				
LOS 3 Engage in transparent communication through public education and outreach	Maintain a communication plan to inform the community on utility goals and progress	**F. Customer Service and Communications** Provide effective communication, public education, and outreach.	Soak it Up LID Rebate	Percent of rebate distributed per year		Meets Expectations	Meets Expectations	Meets Expectations
			Adopt a Drain	Percent change of program participants per year				
			Local Source Control	Percent of businesses visited biannually				
			Water Quality Public Outreach	Number of outreach events per year				
LOS 4 Comply with regulatory requirements for the urban drainage system	Meet regulatory requirements for NPDES Phase II and federal, state, and local regulations affecting surface water management	**G. Regulatory Compliance** Meet state and federal regulatory requirements for stormwater utilities.	NPDES Compliance (Enhanced)	Number of non-compliance notifications per year		Below Expectations	Meets Expectations	Meets Expectations
			Floodplain Management	Percent of Floodplain Development Permits reviewed for developments in the floodplain, measured annually				
			Private Facility Inspection and Maintenance (Enhanced)	Percent of facilities in compliance per year				
			Business Inspection Source Control (New)	Percent of businesses in compliance per year				

Proactive Management Strategy - Program Performance Measures Rating Ranges and 2017 Program Rating

Red font indicates Programs that are new or enhanced for the proactive management strategy

Level of Service	Programs	Selected Performance Measures	Meets Expectations	Needs Improvement	Below Expectations	2017 Program Rating	Measurements							
LOS 1 Manage public health, safety and environmental risks from impaired water quality, flooding, and failed infrastructure	Drainage Assessment (2018)	Percent of drainage assessment backlog remaining	10%	30%	>=30%		# of new Drainage Assessments (on an annual basis)	**Percent completed each year** (Percent complete within 12 Months)	**Percent reduction in backlog** (Percent complete that are **12** Months or older)					
	Water Quality Monitoring (2018)	Percent of water quality samples collected annually	100%	80%	< 80%		% of sampling completed **2017: 100%**	Number of standards exceeded (swimming beach) **2017: 0**	Number of resamples per year **2017: 1**	Number of beach closures **2017: 0**	Percent stream sampling sites rated "high concern" **2017:**			
	Street Sweeping	Percent of miles street sweeping completed per schedule, measured annually	90%	80%	< 80%		Number of miles swept	Tons of debris removed	Cost per lane-mile	Time spent sweeping	# of reactive work orders	% sweeping completed per schedule		
	System Maintenance (2018)	Percent of maintenance backlog remaining	10%	30%	>30%		% maintenance completed from backlog	% Proactive maintenance (Maintenance from Inspection completed within 12 months (6 months for CB)	% Reactive Maintenance (Service Requests)	Number of staff hours (used hours/budgeted hours)	cost of contractor maintenance (.95 < ME; (.95 -.80 =NE), .80 > BE)	% of service request resulting maintenance WO	Number/Percent of NPDES maintenance	Total number of maintenance WO
	Pipe Condition Assessment Program (2018)	Percent program within appropriated budget	10%	30%	>30%		% of LF pipe inspected per plan	Number of LF pipe inspected per year	Number/percent of work generated from Inspection	(Program Cost to Budget Ratio) (.95 < ME; (.95 -.80 =NE), .80 > BE)				
	SW Pipe Replacement Program (2018)	Percent program within appropriated budget	10%	30%	>30%		Percent of pipe repaired as scheduled	Percent of pipe repaired as scheduled	% of budget vs actual	Percent of pipe scheduled per asset management plan				
	System Inspection (Enhanced)	Percent of asset inspections completed as scheduled, measured annually	100	90%	< 80%		**Number/% inspected as scheduled per program or asset** (Number of ROW CBs inspected annually **2017=0**) (Number of Residential Facilities inspected **2017=31**) (Number of Regional Facilities inspected **2017=42**) (Number of Ditches Inspected **2017=676**) (Number of hot spot inspections completed **2017=27**)	**Number/% of work orders generated per program (or asset)** (Number of vactor sediment work orders generated via ROW catch basin inspections **2017=0**) (Number of repair work orders generated via ROW catch basin inspections **2017=0**) (Number of replace work orders generated via ROW catch basin inspections **2017=0**) (Number of mechanical reshape work orders generated via ditch inspections **2017=140**) (Number of work orders generated via residential inspections **2017=140**) (number of work orders generated via regional inspections **2017=28**) (Number of work orders generated via park inspections **2017=45**) (Number of work orders generated via City (Facility's Operated) inspections **2017=13**	Number/% of work orders per inspection	# hot spot inspections **2017:27**				
	Catch Basin Repair and Replacement (2018)	Percent of catch basins repaired or replaced backlog remaining	10%	30%	>30%		% of CBs repaired and replaced from backlog	**Number CB repairs/replacements completed** (% of CBs repaired) (% of CBs replaced)	**% of CBs in Compliance** (% of CBs repaired within 6 months) (% of capital CB repair/replacement completed within 1 year)	# of CB repaired/Replaced by Staff	# of CB Repaired/replaced by contractor	(Program Cost to Budget Ratio) (.95 < ME; (.95 -.80 =NE), .80 > BE)		
	LID Maintenance (2018)	Percent of LID facilities maintenance (repair) backlog remaining	10%	30%	>30%		% of backlog addressed	Number/percent maintained that require R&R	Number that failed inspection and need R&R	Number of systems that require rehab by type	% of maintenance completed per schedule			
	Pump Station Maintenance (New)	Percent of pump station maintenance completed as scheduled, measured annually	100%	80%	< 80%		Percent of uptime (90% uptime)	Number of failures	Number of reactive maintenance (<2/yr)	Number of maintenance completed within timeframe (>95%)				
	Utility Crossing Removal (2018)	Percent of identified utility crossing problems backlog remaining	10%	30%	>30%		Percent of backlog reduced	Numbers removed (5 removed per year)	number of crossings resolved as scheduled	number of new crossings				
LOS 2 Provide consistent, equitable standards of service to the citizens of Shoreline at a reasonable cost, within rates and budget	Administration and Management	Percent of full time Utility staff who meet their annual work plan goals	100%	80%	< 80%		Percent of staff work plan goals met	% of staff retention	Percent of scheduled trainings complete	#/% of workshops attended	#/% of meetings attended	% of service request closed w/30days		
	Stormwater Permit (New)	Percent of permit data integrated in asset management systems within 6 months of closed permit.	100%	80%	< 80%		number of permits	number of covenants	number of new connections	number of new assets	number of assets removed	number of new private facilities		
	Asset Management Program (Enhanced)	Percent of annual planned activities completed based on Asset Management Work Plan, measured annually	100%	80%	< 80%		Percent of AMWP items completed	Dollars saved through AM decision making	average response time for service requests	% of condition score changes	% of budget spent on construction	% of total budget spent on maintenance		
	Small Repairs (2018)	Percent of identified small repairs backlog remaining	10%	30%	>30%		Percent of backlog reduced (backlog - 1/1/2018)	# repairs/projects completed	Percent of repairs/projects completed on time (95%<ME; 95%-80% =NE; 80%>BE					
	Surface Water Small Projects (Enhanced)	Percent of identified small works projects completed within 1 year, measured annually	100%	80%	< 80%		# projects completed	Percent of projects completed as scheduled	Percent of budget vs actual	Number of projects scheduled	Percent decrease in backlog			
LOS 3 Engage in transparent communication through public education and outreach	Soak it Up LID Rebate	Percent of rebate distributed per year	80%	50%	< 50%		Number of facilities in program **2017: 30**	Percent of facilities that pass inspection **2017: 64%**	Percent of site visits that result in an application **2017: 13%**	Percent of applications result in installations **2017: 67%**	# of square footed treated annual/total **2017: 2,414/20,515**			
	Adopt a Drain	Percent change of program participants per year	>0	0	<0		Number of participants **2017: 24**	Number of drains adopted **2017: 52**	Total number of volunteer hours	% of drains adopted (vs total drains) **2017: 0.007%**	% of drain marking installed	% of drain markings replaced		
	Local Source Control	Percent of businesses visited biannually	100	90%	< 90%		Number of business visited	Number of return site visits	Number of IDDE found	Number of IDDE addressed	Number of goals achieved			
	Water Quality Public Outreach	Number of outreach events per year	8	4	>4		Number of outreach events **2017: 6**	Number of participants **2017: Est. 950**	Number of people reached **2017: 21,758 (addresses)**	Number of people surveyed **2017: 115**				
LOS 4 Comply with regulatory requirements for the urban drainage system	NPDES Compliance (2018)	Percent of regulations implemented before due date	100%	80%	< 80%		Percent of regulations implemented before due date	No. of Non Compliance notifications	Attendance at regional stormwater managers meetings	Number of IDDE investigations completed	Number of asset in non-compliance	Number of asset Inspected		
	Floodplain Management	Percent of Floodplain Development Permits reviewed for developments in the floodplain, measured annually	100%	80%	< 80%		Number of permits reviewed	# of Floodplain Development Approved	Local code and maps are updated per FEMA request					
	Private Facility Inspection and Maintenance (Enhanced)	Percent of facilities in compliance per year	95%	80%	< 80%		Number of facilities inspected **2017: 187**	Number of facilities in compliance **2017: 179**	Percent of facilities re-inspected **2017:**	Percent of facilities with covenants **2017: 25%**	Number of facilities referred to code enforcement **2017: 2**			
	Business Inspection Source Control (2018/2019)	Percent of program elements completed as scheduled	100%	80%	< 80%		Number program elements completed	Number of Program elements identified						

D-5 Project Summaries

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PROJECT SUMMARY

BC-IMP-AH01

Hidden Lake Dam Removal

Status: Ongoing

Location: Hidden Lake Dam, east of Inis Arden Way and 10th Avenue NW

Boeing Creek

Capital Cost: **$2,097,000**

Improvement

Aquatic Habitat Enhancement

Overview

Project will implement improvements located within Shoreview Park including removal of Hidden Lake Dam and waterbody. This phase is currently expected to address the flood hazard caused by sediment loading by 2020.

Improvements: Address the flood hazard caused by sediment loading prior to 2020.

Benefits: Reduce longterm maintenance costs of sediment removal, reduce long-term flood risk, implement habitat improvements, and remove one major fish passage barrier.

Site Map

Implementation

Design, Construction, and Permitting Constraints/Concerns:

Risk/Consequence of Failure:

Because sediment removal has been stopped, Hidden Lake Dam has a long-term risk of failure as it fills with sediment and the dam structure is increasingly threatened to be overwhelmed by sediment and debris from a storm event. Dam failure would threaten NW Innis Arden Way and homes to the west of Hidden Lake.

Public Outreach:

Outreach to stakeholders is an essential component of this project.

Additional Notes:

Included in 2017–22 CIP.

PROJECT COST ESTIMATE

BC-IMP-AH01

Hidden Lake Dam Removal

Status: Ongoing

LOCATION: Hidden Lake Dam, east of Inis Arden Way and 10th Avenue NW

Project Basin: Boeing Creek

Capital Cost Estimate

Item	Unit	Unit Cost	Quantity	Cost
Temprary Erosion and Sediment Control	LS	41,100.00	1.00	41,100
Water Management (Incl. Streamflow Bypass)	LS	75,000.00	1.00	75,000
Traffic Control	LS	30,000.00	1.00	30,000
Stabilized Construction Entrance	EA	2,500.00	2.00	5,000
Demolition of Current Dam Spillway	LS	8,700.00	1.00	8,700
Demolition of Lake Outlet Conveyance	LS	3,500.00	1.00	3,500
Clearing and Grubbing and Stripping and Stockpiling of Topsoil	AC	14,300.00	0.75	10,725
Common Excavation Including Haul	CY	35.00	6,800.00	238,000
Roughened Channel	LS	108,900.00	1.00	108,900
Rock/wood Revetment	LS	57,000.00	1.00	57,000
Hydroseeding	AC	5,000.00	2.00	10,000
Planting	LS	37,200.00	1.00	37,200
Bark or Wood Chip Mulch	AC	13,000.00	0.32	4,160
Bark, Hog Fuel or Wood Chip Mulch	CY	12.00	535.00	6,420
Streambed Gravel	CY	60.00	361.00	21,660
Trail Modifications	LS	10,000.00	1.00	10,000
Plant Establishment Monitoring and Maintenance	LS	60,000.00	1.00	60,000

Source: Herra's Alternative Analysis (2016)

Subtotal		727,365
Estimating and construction contingency	*50.0%*	363,683
Contractor overhead, profit, and mobilization	*13.0%*	141,836
Subtotal construction costs		**1,233,000**
Washington State sales tax (applied to all above)	*10.0%*	124,000
City Staff Time	*15.0%*	185,000
Pre-design Feasibility Study? *No*		0
Administration, engineering design, permitting	*45.0%*	555,000
Land acquisition		
Total Capital Cost		**2,097,000**

Life-cycle cost estimate:

Design Life	2020	2037	2054	2071	2088	2105	2120
Renewal				543,000			
Disposal							1,389,000
Other							

**Net present value (NPV) based on an assumed discount rate of:* *2.0%*

Design life of project:			NPV* Total
Operating (annual from commission through design life)	-	*annually*	0
Maintenance (annual from commission through design life)	*7,000*	*annually*	311,000
Renewal (anticipated major repair not funded through maintenance)			191,000
Disposal (disposal of the asset at the end of the design life)			185,000
Other costs	-		0
Total Life-cycle Cost			**2,784,000**

PROJECT SUMMARY

BC-IMP-AH02

Boeing Creek Restoration

Status: Ongoing

Location: Downstream of Hidden Lake Dam

Boeing Creek

Capital Cost: $7,256,000

Improvement

Aquatic Habitat Enhancement

Overview

The Boeing Creek Restoration Project seeks to restore fish passage along lower Boeing Creek downstream of NW Innis Arden Way, including removal of the Seattle Golf Club diversion dam and other barriers. This project would expand upon improvements implemented under the Hidden Lake Dam Removal Project to provide contiguous major fish passage, habitat, and erosion reduction improvements along lower Boeing Creek.

Improvements: Analyze feasibility to enhance fish passage along Boeing Creek between the Seattle Golf Club diversion dam and NW Innis Arden Way.

Benefits: Improve fish passage and habitat and reduce erosion potential along lower Boeing Creek.

Site Map

Implementation

Design, Construction, and Permitting Constraints/Concerns:

Risk/Consequence of Failure:

Public Outreach:

Necessary component for the project.

Additional Notes:

Included in 2017–22 CIP as Boeing Creek Restoration Project. City Council has identified Boeing Creek restoration as a priority, paired with Hidden Lake Dam removal. The cost estimate for the project does not include the culvert replacement.

PROJECT COST ESTIMATE

BC-IMP-AH02

Boeing Creek Restoration

Status: Ongoing

LOCATION: Downstream of Hidden Lake Dam

Project Basin: Boeing Creek

Capital Cost Estimate

Item	Unit	Unit Cost	Quantity	Cost
Level of Effort		2,500,000.00	1.00	2,500,000

Source: Brown and Caldwell Cost Estimate

Subtotal			2,500,000
Estimating and construction contingency		*50.0%*	1,250,000
Contractor overhead, profit, and mobilization		*13.0%*	487,500
Subtotal construction costs			**4,238,000**
Washington State sales tax (applied to all above)		*10.0%*	424,000
City Staff Time		*15.0%*	636,000
Pre-design Feasibility Study?	*Yes*	*10.0%*	50,000
Administration, engineering design, permitting		*45.0%*	1,908,000
Land acquisition			
Total Capital Cost			**7,256,000**

Life-cycle cost estimate:

Design Life	*2020*	*2037*	*2054*	*2071*	*2088*	*2105*	*2120*
Renewal				1,865,000			
Disposal							1,389,000
Other							

**Net present value (NPV) based on an assumed discount rate of: 2.0%*

Design life of project:			NPV* Total
Operating (annual from commission through design life)	-	*annually*	0
Maintenance (annual from commission through design life)	*24,000*	*annually*	1,065,000
Renewal (anticipated major repair not funded through maintenance)			653,000
Disposal (disposal of the asset at the end of the design life)			185,000
Other costs	-		0
Total Life-cycle Cost			**9,159,000**

Brown AND Caldwell

PROJECT SUMMARY

BC-IMP-FM01

Flood Reduction in Linden Avenue Neighborhood

Status: Not started

Location: Linden Ave N, Fremont Ave N, Evanston Ave N, Dayton Ave N, north of 175th Street

Boeing Creek

Capital Cost: $803,000

Improvement

Flood Mitigation

Overview

This project includes upgrading the pipe network along Linden Avenue North, Fremont Avenue North, Evanston Avenue N, and Dayton Avenue N, north of North 175th Street, and installing bio-retention facilities along Linden Avenue N and Fremont Avenue N to slow stormwater runoff from these areas, such that the system downstream does not flood. Currently, the system (which collects runoff from the Town Center along Linden Avenue N) overflows and surcharges.

Improvements: To alleviate flooding, it is recommended that the pipe network be upgraded along Linden Avenue N, Fremont Avenue N, Evanston Avenue N, and Dayton Avenue N, north of North 175th Street.

Benefits: Flooding mitigation.

Site Map

Implementation

Design, Construction, and Permitting Constraints/Concerns:

Updates would include increasing the pipe diameter from 12 inches to 18 inches and repairing one failing pipe. In addition to the proposed project, programmatic and policy changes should be considered to reduce the runoff volume generated by the Town Center. This project could be completed in conjunction with a pedestrian improvement project to construct sidewalks on one or both sides of the street between North 175th Street and North 185th Street (City 2011).

Risk/Consequence of Failure:

Public Outreach:

Additional Notes:

Project recommended as BC-CIP-4 in Boeing Creek Basin Plan. The 2015 Small Works projects addressed issues at Linden Avenue N and N 153rd Place and Linden Avenue N and N 155th Street. No current plans have been developed to address other issues.

PROJECT COST ESTIMATE

BC-IMP-FM01

Flood Reduction in Linden Avenue Neighborhood

Status: Not started

LOCATION: Linden Ave N, Fremont Ave N, Evanston Ave N, Dayton Ave N, north of 175th St.

Project Basin: Boeing Creek

Capital Cost Estimate

Item	Unit	Unit Cost	Quantity	Cost
Open-cut Storm Drain Replacement, 18 in.	LF	60.00	410.00	24,600
Storm Drain Catch Basin or Manhole	EA	4,550.00	5.00	22,750
Roadway Improvement/Pavement Patching	SY	70.00	235.00	16,450
Drainage Easements	LS	11,360.00	4.00	45,440
Bio-retention/Rain Gardens	LF	170.00	800.00	136,000
Traffic Control	LS	17,030.00	1.00	17,030

Source: Boeing Creek Basin Plan (March 2013)

Subtotal		262,270
Estimating and construction contingency	50.0%	131,135
Contractor overhead, profit, and mobilization	13.0%	51,143
Subtotal construction costs		**445,000**
Washington State sales tax (applied to all above)	10.0%	45,000
City Staff Time	15.0%	67,000
Pre-design Feasibility Study? Yes	10.0%	45,000
Administration, engineering design, permitting	45.0%	201,000
Land acquisition		
Total Capital Cost		**803,000**

Life-cycle cost estimate:

Design Life	2020	2024	2028	2032	2036	2040	2040
Renewal				71,000			
Disposal							185,000
Other							

**Net present value (NPV) based on an assumed discount rate of: 2.0%*

Design life of project:			NPV* Total
Operating (annual from commission through design life)	-	*annually*	0
Maintenance (annual from commission through design life)	*19,000*	*annually*	355,000
Renewal (anticipated major repair not funded through maintenance)			54,000
Disposal (disposal of the asset at the end of the design life)			0
Other costs			0
Total Life-cycle Cost			**1,212,000**

PROJECT SUMMARY

BC-IMP-WQ01

Westminster Triangle Bioinfiltration Facility

Status: Not started

Location: Adjacent to Westminster Triangle Park

Boeing Creek

Capital Cost: $163,000

Improvement

Water Quality Improvement

Overview

This project would involve replacing an existing ditch along North 150th Street with a formal bio-retention swale or rain garden.

Improvements: This project would involve replacing an existing ditch along North 150th Street with a formal bio-retention swale or rain garden.

Benefits: Improved roadway runoff water quality.

Site Map

Implementation

Design, Construction, and Permitting Constraints/Concerns:

Currently, a system of pipes leads water to a rock-lined ditch on the north end of the small park. Updates to the ditch would include installing underdrain pipes, filter media, filter fabric, and hydrophylic plants.

Risk/Consequence of Failure:

Public Outreach:

This project has a potential for partnership with Parks.

Additional Notes:

Project recommended as BC-CIP-9 in Boeing Creek Basin Plan (Windward 2013).

PROJECT COST ESTIMATE

BC-IMP-WQ01

Westminster Triangle Bioinfiltration Facility

Status: Not started

LOCATION: Adjacent to Westminster Triangle Park

Project Basin: Boeing Creek

Capital Cost Estimate

Item	Unit	Unit Cost	Quantity	Cost
Under-drain Pipe (6 in.)	LF	20.00	150.00	3,000
Gravel Bed Material	CY	120.00	25.00	3,000
Filter Soils	CY	30.00	35.00	1,050
Filter Fabric	SY	10.00	1,200.00	12,000
Bio-retention/Rain Garden Plants	LF	170.00	150.00	25,500
Traffic Control	LS	11,360.00	1.00	11,360

Source: Boeing Creek Basin Plan (March 2013)

Subtotal		55,910
Estimating and construction contingency	*50.0%*	27,955
Contractor overhead, profit, and mobilization	*13.0%*	10,902
Subtotal construction costs		**95,000**
Washington State sales tax (applied to all above)	*10.0%*	10,000
City Staff Time	*15.0%*	15,000
Pre-design Feasibility Study? *No*		0
Administration, engineering design, permitting	*45.0%*	43,000
Land acquisition		
Total Capital Cost		**163,000**

Life-cycle cost estimate:

Design Life	2020	2024	2028	2032	2036	2040	2040
Renewal				21,000			
Disposal							46,000
Other							

**Net present value (NPV) based on an assumed discount rate of: 2.0%*

Design life of project:			NPV* Total
Operating (annual from commission through design life)	-	*annually*	0
Maintenance (annual from commission through design life)	*6,300*	*annually*	118,000
Renewal (anticipated major repair not funded through maintenance)			16,000
Disposal (disposal of the asset at the end of the design life)			0
Other costs	-		0
Total Life-cycle Cost			**297,000**

PROJECT SUMMARY

BC-IMP-EC01

Boeing Creek Regional Stormwater Facility

Status: Pending

Location: Boeing Creek Basin

Boeing Creek

Capital Cost: $8,064,000

Improvement

Erosion Control

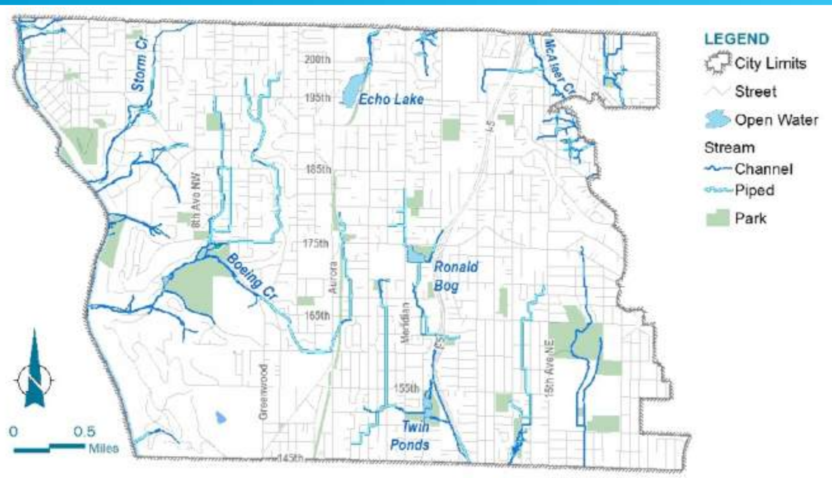
Overview

Conduct an evaluation of potential opportunities for the City to construct a regional stormwater facility funded by facility charges, connection fees for redeveloped properties, or sub-basin-specific capital facilities charges. A regional stormwater facility would give the City control over where and how the facility operates, while providing developers with reliable stormwater management on their redeveloped properties.

Improvements: The initial effort will include a feasibility study to construct a regional surface water detention facility to support redevelopment of the Aurora Square. The study would include alternatives or mechanisms to pay for the facility.

Benefits: Water quality improvement; flood mitigation.

Site Map



Implementation

Design, Construction, and Permitting Constraints/Concerns:

This project would involve using the existing Boeing Creek hydrologic model to develop potential locations and alternative strategies for regional stormwater management.

Risk/Consequence of Failure:

Public Outreach:

Additional Notes:

In City's 2017-22 CIP. The cost estimate is adapted from Aurora Square Stormwater Concept Study (KPG 2014).

PROJECT COST ESTIMATE

BC-IMP-EC01

Boeing Creek Regional Stormwater Facility

Status: Pending

LOCATION:

Project Basin: Boeing Creek

Capital Cost Estimate

Item	Unit	Unit Cost	Quantity	Cost
Pond Earthwork - Complete	CY	30.00	69,700.00	2,091,000
Control Structure	EA	10,320.00	1.00	10,320
Hydrodynamic Separator	EA	41,250.00	3.00	123,750
Flow Splitter - Vault	EA	20,630.00	1.00	20,630
Control Structure	EA	8,250.00	1.00	8,250
48" Manhole	EA	3,610.00	2.00	7,220
18" Storm Drain Pipe	LF	80.00	750.00	60,000
24" Storm Drain Pipe	LF	90.00	260.00	23,400
Landscaping - Slopes and Buffers	SF	10.00	65,000.00	650,000
Temporary Erosion Control	LS	251,620.00	1.00	251,620

Source: Aurora Square Stormwater Concept Study (October 2014)

Subtotal			3,246,190
Estimating and construction contingency		*50.0%*	1,623,095
Contractor overhead, profit, and mobilization		*13.0%*	633,007
Subtotal construction costs			**5,503,000**
Washington State sales tax (applied to all above)		*10.0%*	551,000
City Staff Time		*15.0%*	826,000
Pre-design Feasibility Study?	*Yes*	*1.5%*	83,000
Administration, engineering design, permitting		*20.0%*	1,101,000
Land acquisition			
Total Capital Cost			**8,064,000**

Life-cycle cost estimate:

Design Life	*2020*	*2029*	*2038*	*2047*	*2056*	*2065*	*2070*
Renewal				2,894,000			
Disposal							14,536,000
Other							

**Net present value (NPV) based on an assumed discount rate of:* *2.0%*

Design life of project: *50* *years*			NPV* Total
Operating (annual from commission through design life)	-	*annually*	0
Maintenance (annual from commission through design life)	*254,000*	*annually*	8,142,000
Renewal (anticipated major repair not funded through maintenance)			1,630,000
Disposal (disposal of the asset at the end of the design life)			0
Other costs	-		0
Total Life-cycle Cost			**17,836,000**

PROJECT SUMMARY

CW-IMP-AM01

Pump Station Miscellaneous Improvements

Status: Not Started

Location: Linden Avenue, Palatine, Pan Terra, Pump Station 25, Ronald Bog, and Serpentine

City-wide

Capital Cost: $732,000

Improvement

Asset Management

Overview

Six pump stations that were constructed between 2005 and 2010 have been identified for minor upgrades: Linden Avenue, Palatine, Pan Terra, Pump Station 25, Ronald Bog, and Serpentine.

Improvements: Recommended improvements vary by pump station. General upgrades include electrical, SCADA, signage, access, bollards, and redundant equipment.

Benefits: Improved pump station operations and redundancy.

Site Map

Implementation

Design, Construction, and Permitting Constraints/Concerns:

Varies by pump station, refer to Stormwater Pump Station Condition and Capacity Assessment Report for more details (Kennedy/Jenks 2016).

Risk/Consequence of Failure:

Public Outreach:

Additional Notes:

Refer to Stormwater Pump Station Condition and Capacity Assessment Report (Kennedy/Jenks 2016) for more details.

PROJECT COST ESTIMATE

CW-IMP-AM01

Pump Station Miscellaneous Improvements

Status: Not Started

LOCATION: Linden, Palatine, Pan Terra, 25, Ronald Bog, Serpentine

Project Basin: City-wide

Capital Cost Estimate

Item	Unit	Unit Cost	Quantity	Cost
Conduit Seal-Offs	LS	2,230.00	2.00	4,460
Electrical Safety (Arc Flash) Signs	LS	640.00	4.00	2,560
Add High Level Float	LS	1,350.00	3.00	4,050
SCADA	LS	2,500.00	5.00	12,500
Add Bollards	LS	10,180.00	1.00	10,180
Station Information Sign(s) and No Parking sign(s)	LS	560.00	6.00	3,360
Add Top Slab and Hatch	LS	2,730.00	2.00	5,460
Install New Catch Basin	LS	1,520.00	2.00	3,040
Upgrade Wet Well and Valve Vault Hatches	LS	1,970.00	1.00	1,970
Guard Rail	LS	9,520.00	1.00	9,520
Install Pressure Gage on Pump Discharge Piping	LS	1,270.00	2.00	2,540
Reprogram PLC/ Level Transducer/ Operations	LS	6,990.00	1.00	6,990
Add Safety Grating to Wet Well	LS	2,820.00	1.00	2,820
Steep Slope Protection (wood split-rail fence)	LS	4,440.00	1.00	4,440
Add Safety Grating to Hatches	LS	3,460.00	1.00	3,460
Regrade area to the south (upstream) to direct storm flow around hatches and toward existing CB	LS	4,100.00	1.00	4,100
Serpentine Pump Station Capacity Assessment	LS	172,000.00	1.00	172,000

Source: Shoreline Pump Station Condition and Capacity Assessment (June 2016)

Subtotal		253,450
Estimating and construction contingency	*50.0%*	126,725
Contractor overhead, profit, and mobilization	*13.0%*	49,423
Subtotal construction costs		**430,000**
Washington State sales tax (applied to all above)	*10.0%*	43,000
City Staff Time	*15.0%*	65,000
Pre-design Feasibility Study? *No*		0
Administration, engineering design, permitting	*45.0%*	194,000
Land acquisition		
Total Capital Cost		**732,000**

Life-cycle cost estimate:

Design Life	2020	2020	2020	2020	2020	2020	2020
Renewal				0			
Disposal							0
Other							

**Net present value (NPV) based on an assumed discount rate of:* 2.0%

Design life of project:	*years*	NPV* Total
Operating (annual from commission through design life)		
Maintenance (annual from commission through design life)		0
Renewal (anticipated major repair not funded through maintenance)		0
Disposal (disposal of the asset at the end of the design life)		0
Other costs		*0*
Note: Life cycle costs were not available for pump stations at the time of the analysis	**Total Life-cycle Cost**	**732,000**

PROJECT SUMMARY

CW-STU-FM02

System Capacity Modeling Study

Status: Not Started

Location: City-wide

City-wide

Capital Cost: $300,000

Study

Flood Mitigation

Overview

Hydrologic and hydraulic modeling are needed to evaluate drainage system capacity and assess the risks associated with deficiencies. This program provides new and updated modeling analyses to forecast future system demands, identify service gaps, and evaluate CIPs. The City completed a preliminary needs assessment recommending a phased approach to modeling, with priorities given to areas with known problems, future growth/development pressures, potential stormwater impacts to downstream water bodies, and/or challenges with implementing low-impact development principles.

Improvements: The City prepared the document: Framework for Hydrologic and Hydraulic Modeling Analyses, which describes recommended modeling processes, including a draft modeling plan and sample scope of work.

Benefits: Evaluating system performance, analyzing alternatives for CIPs, and identifying optimal solutions to existing problems.

Site Map

Implementation

Design, Construction, and Permitting Constraints/Concerns:

Risk/Consequence of Failure:

Public Outreach:

Additional Notes:

PROJECT COST ESTIMATE

CW-STU-FM02

System Capacity Modeling Study

Status: Not Started

LOCATION: City-wide

Project Basin: City-wide

Capital Cost Estimate

Item	Unit	Unit Cost	Quantity	Cost

Source: Brown and Caldwell Cost Estimate

Subtotal			0
Estimating and construction contingency		*0.0%*	0
Contractor overhead, profit, and mobilization		*0.0%*	0
Subtotal construction costs			**0**
Washington State sales tax (applied to all above)		*0.0%*	0
City Staff Time		*0.0%*	0
Pre-design Feasibility Study?	*Yes*	*100.0%*	300,000
Administration, engineering design, permitting		*0.0%*	0
Land acquisition			
Total Capital Cost			**300,000**

Life-cycle cost estimate:

Design Life	*2020*	*2020*	*2020*	*2020*	*2020*	*2020*	*2020*
Renewal				0			
Disposal							0
Other							

**Net present value (NPV) based on an assumed discount rate of: 2.0%*

Design life of project:		NPV* Total
Operating (annual from commission through design life)	*annually*	0
Maintenance (annual from commission through design life)	*annually*	0
Renewal (anticipated major repair not funded through maintenance)		0
Disposal (disposal of the asset at the end of the design life)		0
Other costs		0
Total Life-cycle Cost		**300,000**

PROJECT SUMMARY

CW-STU-FM03

Climate Impacts and Resiliency Study

Status: Not Started

Location: City-wide

Capital Cost: $80,000

City-wide

Study

Flood Mitigation

Overview

When planning for future projects or updating the Surface Water Master Plan, the City should consider the effects of climate change; climate change will amplify current conditions. Some areas throughout the city are already prone to flooding, so when planning improvement projects, the City must consider the increase of rainfall that the Puget Sound region is expected to have in the future. Areas in the Thornton Creek basin are already prone to flooding, so projects to improve this area should consider the effects of climate change conditions.

Improvements:

Benefits:

Site Map

Implementation

Design, Construction, and Permitting Constraints/Concerns:

Risk/Consequence of Failure:

Public Outreach:

Additional Notes:

PROJECT COST ESTIMATE

CW-STU-FM03

Climate Impacts and Resiliency Study

Status: Not Started

LOCATION: City-wide

Project Basin: City-wide

Capital Cost Estimate

Item	Unit	Unit Cost	Quantity	Cost

Source: Brown and Caldwell Cost Estimate

Subtotal			0
Estimating and construction contingency		0.0%	0
Contractor overhead, profit, and mobilization		0.0%	0
Subtotal construction costs			**0**
Washington State sales tax (applied to all above)		0.0%	0
City Staff Time		0.0%	0
Pre-design Feasibility Study?	Yes	100.0%	80,000
Administration, engineering design, permitting		0.0%	0
Land acquisition			
Total Capital Cost			**80,000**

Life-cycle cost estimate:

Design Life	2020	2020	2020	2020	2020	2020	2020
Renewal				0			
Disposal							0
Other							

**Net present value (NPV) based on an assumed discount rate of:* 2.0%

Design life of project:		NPV* Total
Operating (annual from commission through design life)	annually	0
Maintenance (annual from commission through design life)	annually	0
Renewal (anticipated major repair not funded through maintenance)		0
Disposal (disposal of the asset at the end of the design life)		0
Other costs		0
Total Life-cycle Cost		**80,000**

Brown AND Caldwell

PROJECT SUMMARY

CW-STU-WQ03

Master Plan Update

Status: Not Started

Location: City-wide

Capital Cost: $500,000

City-wide

Study

Water Quality Improvement

Overview

This project will revise and update the 2017 Surface Water Master Plan to reflect changes made by the City and Surface Water Utility, and provide a long-term management strategy to ensure continued financial viability of the Surface Water Utility. The master plan will evaluate the surface water management fees and rate structure, prioritize and incorporate the capital and operational needs identified in the 2017 plan, and direct the future activities using an asset management strategy.

Improvements:

Benefits:

Site Map

Implementation

Design, Construction, and Permitting Constraints/Concerns:

Risk/Consequence of Failure:

Public Outreach:

Additional Notes:

PROJECT COST ESTIMATE

CW-STU-WQ03

Master Plan Update

Status: Not Started

LOCATION: City-wide

Project Basin: City-wide

Capital Cost Estimate

Item	Unit	Unit Cost	Quantity	Cost

Source: Brown and Caldwell Cost Estimate

Subtotal			0
Estimating and construction contingency		*0.0%*	0
Contractor overhead, profit, and mobilization		*0.0%*	0
Subtotal construction costs			**0**
Washington State sales tax (applied to all above)		*0.0%*	0
City Staff Time		*0.0%*	0
Pre-design Feasibility Study?	*Yes*	*100.0%*	500,000
Administration, engineering design, permitting		*0.0%*	0
Land acquisition			
Total Capital Cost			**500,000**

Life-cycle cost estimate:

Design Life	*2020*	*2020*	*2020*	*2020*	*2020*	*2020*	*2020*
Renewal				0			
Disposal							0
Other							

**Net present value (NPV) based on an assumed discount rate of:* *2.0%*

Design life of project:		NPV* Total
Operating (annual from commission through design life)	*annually*	0
Maintenance (annual from commission through design life)	*annually*	0
Renewal (anticipated major repair not funded through maintenance)		0
Disposal (disposal of the asset at the end of the design life)		0
Other costs		0
Total Life-cycle Cost		**500,000**

PROJECT SUMMARY

LC-IMP-FM01

25th Avenue NE Flood Reduction

Status: Pending

Location: 25th Ave NE between Brugger's Bog Park and NE 195th St

Lyon Creek

Capital Cost: $8,226,000

Improvement

Flood Mitigation

Overview

This project addresses recurring flooding issues occuring along 25th Avenue NE. The project involves daylighting Ballinger Creek and installing fish passable box culverts at roadway and driveway crossings.

Improvements: The project will upgrade approximately 550 linear feet of the stream conveyance system along 25th Avenue NE downstream of Brugger's Bog Park.

Benefits: Increase the flood reduction service level to residents, drivers, and others along 25th Avenue NE.

Site Map

Implementation

Design, Construction, and Permitting Constraints/Concerns:

Risk/Consequence of Failure:
Continued flooding.

Public Outreach:

Additional Notes:
Included in 2017–22 CIP; Ba-CIP-1a and 1b recommended in Lyon Creek Basin Plan (City 2015).

PROJECT COST ESTIMATE

LC-IMP-FM01

25th Ave NE Flood Reduction and NE 195th St Culvert Replacement

Status: Pending

LOCATION: 25th Ave NE between Brugger's Bog Park and NE 195th St

Project Basin: Lyon Creek

Capital Cost Estimate

Item	Unit	Unit Cost	Quantity	Cost
Water Pollution/Erosion Control	LS	268,010.00	1.00	268,010
Spill Prevention, Control, and Countermeasure (SPCC) plan	LS	520.00	2.00	1,040
Traffic Control	LS	268,010.00	1.00	268,010
Potholing	EA	1,860.00	10.00	18,600
Clearing and Grubbing	SY	20.00	5,173.00	103,460
Remove Road, Curb & Gutter, and Sidewalk	SY	160.00	815.00	130,400
Temporary Stream Bypass	LS	51,450.00	2.00	102,900
Excavation Including Haul	CY	70.00	6,209.00	434,630
Embankment Construction	CY	20.00	1,706.00	34,120
Headwall	EA	61,730.00	1.00	61,730
Streambed Gravel	CY	70.00	344.00	24,080
Type 2 95-in Catch Basin	EA	10,290.00	3.00	30,870
Box culvert (139.2-in x 62.4-in)	LF	1,030.00	75.00	77,250
Schedule A 24" Storm Sewer Pipe	LF	190.00	66.00	12,540
Schedule A 72" Storm Sewer Pipe	LF	550.00	550.00	302,500
Planting and Bioengineered Restoration	SY	110.00	4,582.00	504,020
Roadway Restoration	SY	570.00	815.00	464,550
Guardrail	LF	30.00	300.00	9,000

Source: Lyon Creek Basin Plan (October 2015)

Subtotal		2,847,710
Estimating and construction contingency	*50.0%*	1,423,855
Contractor overhead, profit, and mobilization	*13.0%*	555,303
Subtotal construction costs		**4,827,000**
Washington State sales tax (applied to all above)	*10.0%*	483,000
City Staff Time	*15.0%*	725,000
Pre-design Feasibility Study? *No*		0
Administration, engineering design, permitting	*45.0%*	2,173,000
Land acquisition		18,000
Total Capital Cost		**8,226,000**

Life-cycle cost estimate:

Design Life	2020	2029	2038	2047	2056	2065	2070
Renewal				0			
Disposal							1,267,647
Other							

**Net present value (NPV) based on an assumed discount rate of: 2.0%*

Design life of project:			NPV* Total
Operating (annual from commission through design life)	-	*annually*	0
Maintenance (annual from commission through design life)	-	*annually*	0
Renewal (anticipated major repair not funded through maintenance)			0
Disposal (disposal of the asset at the end of the design life)			0
Other costs	-		0
Total Life-cycle Cost			**8,226,000**

PROJECT SUMMARY

LW-STU-FM01

26th Avenue NE Flooding and Lack of System Study

Status: Not Started

Location: 26th Avenue NE between NE 155th Street and NE 153rd Street

Puget Sound Drainages

Capital Cost: $64,000

Study

Flood Mitigation

Overview

The lack of drainage system on 26th Avenue NE between NE 155th Street and NE 153rd Street, flat grades, and high ground water contribute to flooding at 26th Avenue NW and NE 153rd Street. Neighbors use sump pumps to dewater their basements and discharge pumped groundwater to the street, contributing additional surface flow to 26th Avenue NE. This projct recommends conducting a study to include: (1) flow monitoring at catch basin where flooding occurs, (2) installation of up to 3 shallow ground water monitoring wells and monthly ground water elevation monitoring for one year, and (3) elevation survey on 26th Ave NE.

Improvements: This project involves conducting a study to evaluate the causes of flooding (including the timing and severity) and potential solutions to alleviate the problems.

Benefits: Flood mitigation.

Site Map

Implementation

Design, Construction, and Permitting Constraints/Concerns:

The functionality of the current system during storm events and the timing of sump pump discharges is not well understood. Research of previous work in the area, including sewer pipe relocations, and Shore Crest High School stormwater management would be conducted as part of the study.

Risk/Consequence of Failure:

Right-of-way flooding.

Public Outreach:

Neighbors on 26th Avenue NE need to be interviewed to identify locations of sump pumps, operating frequencies, and any other factors tl

Additional Notes:

Project recommended as PSB-Study-2 in Puget Sound Drainages Basin Plan. Site reconnaissance shows generally lacking infrastructure (few and widely spaced CB's), but no specific flooding issues. Low priority.

PROJECT COST ESTIMATE

LW-STU-FM01

26th Ave NE Flooding and Lack of System Study

Status: Not Started

LOCATION:

Project Basin: Puget Sound Drainages

Capital Cost Estimate

Item	Unit	Unit Cost	Quantity	Cost
Install shallow monitoring wells	EA	1,520.00	3.00	4,560
Topographic Survey	LS	2,520.00	1.00	2,520
Flow Monitoring Equipment	LS	5,040.00	1.00	5,040
Groundwater and flow monitoring	LS	9,670.00	1.00	9,670

Source: Puget Sound Drainages Basin Plan (December 2016)

Subtotal		21,790
Estimating and construction contingency	*50.0%*	10,895
Contractor overhead, profit, and mobilization	*13.0%*	4,249
Subtotal construction costs		**37,000**
Washington State sales tax (applied to all above)	*10.0%*	4,000
City Staff Time	*15.0%*	6,000
Pre-design Feasibility Study?	*No*	0
Administration, engineering design, permitting	*45.0%*	17,000
Land acquisition		
Total Capital Cost		**64,000**

Life-cycle cost estimate:

Design Life	*2020*	*2024*	*2028*	*2032*	*2036*	*2040*	*2040*
Renewal				9,000			
Disposal							204
Other							

**Net present value (NPV) based on an assumed discount rate of:* *2.0%*

Design life of project:			NPV* Total
Operating (annual from commission through design life)	-	*annually*	0
Maintenance (annual from commission through design life)	*3,000*	*annually*	56,000
Renewal (anticipated major repair not funded through maintenance)			7,000
Disposal (disposal of the asset at the end of the design life)			0
Other costs	-		0
Total Life-cycle Cost			**127,000**

PROJECT SUMMARY

MC-IMP-AM01

Pump Station 26

Status: Not Started

Location: 18331 10th Avenue NE

McAleer Creek

Capital Cost: $891,000

Improvement

Asset Management

Overview

A condition assessment of the City's storm pump stations was completed by Kennedy/Jenks in June 2016 in which major overhaul of Pump Station 26 was recommended because it is past its useful life.

Improvements: Demolish and rebuild station, reuse existing wetwell, add SCADA, information signs and pressure gauges, and move/replace electrical. Consider adding redundancy in the system and expanding access around the pump station.

Benefits: Extended life, improved reliability.

Site Map

Implementation

Design, Construction, and Permitting Constraints/Concerns:

Discuss upgrade to 480 V service with PSE. Replace hatch (heavy, lacks access and safety measures).

Risk/Consequence of Failure:

Public Outreach:

Additional Notes:

Refer to Stormwater Pump Station Condition and Capacity Assessement for more details (Kennedy/Jenks 2016).

PROJECT COST ESTIMATE

MC-IMP-AM01

Pump Station 26 Improvements

Status: Not Started

LOCATION: 18331 10th Ave NE, Shoreline, WA

Project Basin: McAleer Creek

Capital Cost Estimate

Item	Unit	Unit Cost	Quantity	Cost
SCADA	LS	2,500.00	1.00	2,500
New Electrical/Enclosure Demo Building/ Top Slab/ Pumps/ Valves New Top Slab and Hatch New Submersible Pumps, Valves and Valve Vault	LS	115,950.00	1.00	115,950
Sub-basin Study to Assess the Pump Capacity	LS	150,000.00	1.00	150,000

Source: Shoreline Pump Station Capacity and Condition Assessment (June 2016)

Subtotal		268,450
Estimating and construction contingency	*50.0%*	134,225
Contractor overhead, profit, and mobilization	*13.0%*	52,348
Subtotal construction costs		**456,000**
Washington State sales tax (applied to all above)	*10.0%*	46,000
City Staff Time	*15.0%*	69,000
Pre-design Feasibility Study? *Yes*	*25.0%*	114,000
Administration, engineering design, permitting	*45.0%*	206,000
Land acquisition		
Total Capital Cost		**891,000**

Life-cycle cost estimate:

Design Life	2020	2020	2020	2020	2020	2020	2020
Renewal							
Disposal							
Other							

**Net present value (NPV) based on an assumed discount rate of: 2.0%*

Design life of project:		NPV* Total
Operating (annual from commission through design life)	*annually*	0
Maintenance (annual from commission through design life)	*annually*	0
Renewal (anticipated major repair not funded through maintenance)		0
Disposal (disposal of the asset at the end of the design life)		0
Other costs		0
Note: Life cycle costs were not available for pump stations at the time of the analysis	**Total Life-cycle Cost**	**891,000**

Brown AND Caldwell

PROJECT SUMMARY

MC-IMP-EC01

NE 192nd St Ditch Modifications

Status: Not Started

Location: NE 192nd Street between 15th Avenue NE and 18th Avenue NE

McAleer Creek

Capital Cost: $202,000

Improvement

Erosion Control

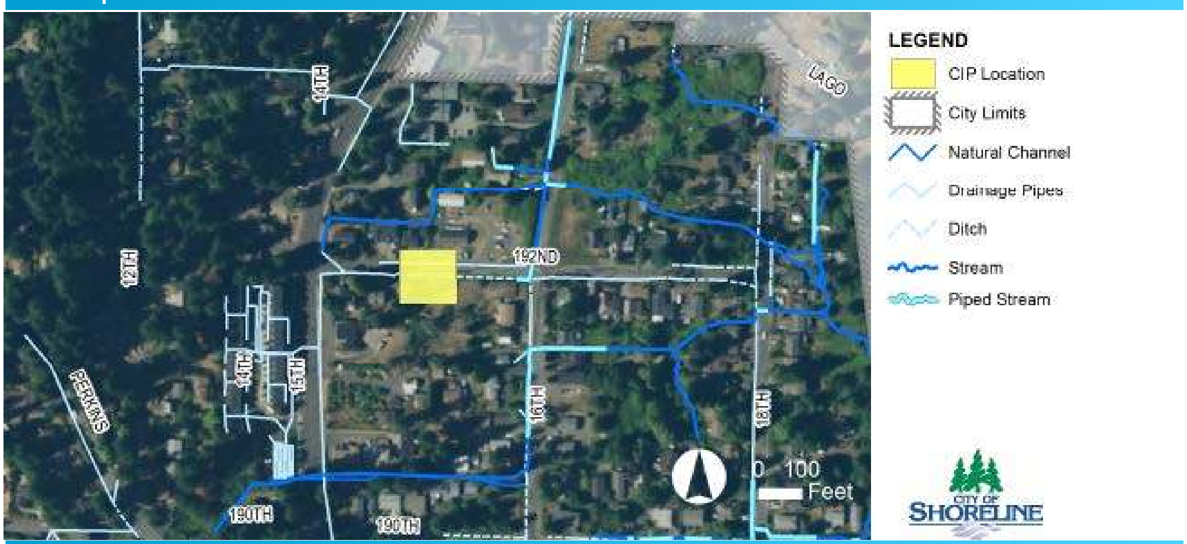
Overview

This project addresses a ditch with on-going erosion problems on the south side of NE 192nd Street. The ditch has a large contributing drainage area, is very steep, and has a history of erosion and sedimentation issues associated with high energy open conveyance systems. Previously installed energy dissipation filled in with sediment. The City recently excavated the ditch to restore the previous configuration; however, a long-term solution is needed to prevent future erosion in the ditch.

Improvements: This project involves designing an engineered, robust solution that can convey the high flows and velocities without damage to the ditch.

Benefits: Erosion control.

Site Map



Implementation

Design, Construction, and Permitting Constraints/Concerns:

Previously-installed energy dissipation features subsequently filled in with sediment. The City recently excavated the ditch to restore the previous configuration; however, a long-term solution is needed to prevent future scour and erosion in the ditch due to high flow velocities on the steep slope.

Risk/Consequence of Failure:

Public Outreach:

Additional Notes:

Project recommended as MC-CIP-3a in McAleer Creek Basin Plan (Alta Terra 2015).

PROJECT COST ESTIMATE

MC-IMP-EC01

NE 192nd St Ditch Modifications

Status: Not Started

LOCATION: NE 192nd Street between 15th Ave NE and 18th Ave NE

Project Basin: McAleer Creek

Capital Cost Estimate

Item	Unit	Unit Cost	Quantity	Cost
Water Pollution/Erosion Control	LS	3,090.00	1.00	3,090
Spill Prevention, Control, and Countermeasure (SPCC) plan	LS	520.00	1.00	520
Traffic Control	LS	5,150.00	1.00	5,150
Ditch Excavation	LF	70.00	550.00	38,500
Clean Ditch	LF	40.00	550.00	22,000

Source: Brown and Caldwell Cost Estimate

Subtotal		69,260
Estimating and construction contingency	*50.0%*	34,630
Contractor overhead, profit, and mobilization	*13.0%*	13,506
Subtotal construction costs		**118,000**
Washington State sales tax (applied to all above)	*10.0%*	12,000
City Staff Time	*15.0%*	18,000
Pre-design Feasibility Study? *No*		0
Administration, engineering design, permitting	*45.0%*	54,000
Land acquisition		
Total Capital Cost		**202,000**

Life-cycle cost estimate:

Design Life	*2020*	*2037*	*2054*	*2071*	*2088*	*2105*	*2120*
Renewal				39,000			
Disposal							167,000
Other							

**Net present value (NPV) based on an assumed discount rate of:* *2.0%*

Design life of project:			NPV* Total
Operating (annual from commission through design life)	-	*annually*	0
Maintenance (annual from commission through design life)	*8,000*	*annually*	352,000
Renewal (anticipated major repair not funded through maintenance)			14,000
Disposal (disposal of the asset at the end of the design life)			0
Other costs	-		0
Total Life-cycle Cost			**568,000**

PROJECT SUMMARY

MC-IMP-EC02

25th Avenue NE Ditch Improvements Between NE 177th and 178th Street

Status: Not Started

Location: 25th Avenue NE near NE 177th Street

McAleer Creek

Capital Cost: $2,538,000

Improvement

Erosion Control

Overview

This project involves the evaluation of integrated alternatives for managing drainage, conveyance, and road and slope stability issues within limited right-of-way on 25th Avenue NE at the City's eastern border with Lake Forest Park. The current ditch and culvert system is failing and is on the City's hot-spot list to check before, during, and after heavy rain events.

Improvements: Improve the ditch and culvert system along 25th Avenue NE, or develop alternative improvement techniques.

Benefits: Erosion control; stabilize drainage system and reduce O&M effort.

Site Map

Implementation

Design, Construction, and Permitting Constraints/Concerns:

Risk/Consequence of Failure:
Failing system and slope stability issue.

Public Outreach:

Additional Notes:
Project based on MC-CIP-12 recommended in McAleer Basin Plan (Alta Terra 2015). Cost estimates were not provided in the basin plan. Included cost estimate was developed by BC based on the project descriptions in the report.

PROJECT COST ESTIMATE

MC-IMP-EC02

25th Ave NE Ditch Improvements Between NE 177th and 178th St

Status: Not Started

LOCATION: 25th Ave NE near NE 177th St

Project Basin: McAleer Creek

Capital Cost Estimate

Item	Unit	Unit Cost	Quantity	Cost
Water Pollution/Erosion Control	LS	3,090.00	1.00	3,090
Spill Prevention, Control, and Countermeasure (SPCC) plan	LS	520.00	1.00	520
Traffic Control	LS	5,150.00	1.00	5,150
Install Culvert	EA	34,980.00	22.00	769,560
Ditch Excavation	LF	40.00	1,320.00	52,800

Source: Brown and Caldwell Cost Estimate	Subtotal		831,120
	Estimating and construction contingency	*50.0%*	415,560
	Contractor overhead, profit, and mobilization	*13.0%*	162,068
	Subtotal construction costs		**1,409,000**
	Washington State sales tax (applied to all above)	*10.0%*	141,000
	City Staff Time	*15.0%*	212,000
	Pre-design Feasibility Study? *Yes*	*10.0%*	141,000
	Administration, engineering design, permitting	*45.0%*	635,000
	Land acquisition		
	Total Capital Cost		**2,538,000**

Life-cycle cost estimate:

Design Life	2020	2029	2038	2047	2056	2065	2070
Renewal				28,000			
Disposal							799,000
Other							

**Net present value (NPV) based on an assumed discount rate of: 2.0%*

Design life of project:			**NPV* Total**
Operating (annual from commission through design life)	-	*annually*	0
Maintenance (annual from commission through design life)	*6,000*	*annually*	193,000
Renewal (anticipated major repair not funded through maintenance)			16,000
Disposal (disposal of the asset at the end of the design life)			0
Other costs	-		0
Total Life-cycle Cost			**2,747,000**

PROJECT SUMMARY

MC-IMP-FM01

NE 177th Street Drainage Improvements

Status: Not Started

Location: NE 177th Street near 25th Avenue NE

McAleer Creek

Capital Cost: $152,000

Improvement

Flood Mitigation

Overview

This project involves evaluation of existing infrastructure on NE 177th Street between 21st Place NE and 22nd Place NE to develop alternatives for new collection and conveyance infrastructure, connect to the existing stormwater system, and relieve drainage issues on private property that result from lack of formal infrastructure in this area.

Improvements: Develop options for connecting existing infrastructure within the public right-of-way to reduce impacts and provide proper downstream connections.

Benefits: Reduce flooding impacts.

Site Map

Implementation

Design, Construction, and Permitting Constraints/Concerns:

Risk/Consequence of Failure:

Flooding on private property.

Public Outreach:

Additional Notes:

Project recommended as MC-CIP-13 in McAleer Creek Basin Plan (Alta Terra 2015). Cost estimates were not provided in the basin plan. Included cost estimate was developed by BC based on the project descriptions in the report.

PROJECT COST ESTIMATE

MC-IMP-FM01

NE 177th Street Drainage Improvements

Status: Not Started

LOCATION: NE 177th Street near 25th Ave NE

Project Basin: McAleer Creek

Capital Cost Estimate

Item	Unit	Unit Cost	Quantity	Cost
Water Pollution/Erosion Control	LS	3,090.00	1.00	3,090
Spill Prevention, Control, and Countermeasure (SPCC) plan	LS	520.00	1.00	520
Traffic Control	LS	5,150.00	1.00	5,150
Ditch Excavation	LF	40.00	500.00	20,000
Clean Ditch	LF	40.00	500.00	20,000

Source: Brown and Caldwell Cost Estimate

Subtotal		48,760
Estimating and construction contingency	50.0%	24,380
Contractor overhead, profit, and mobilization	13.0%	9,508
Subtotal construction costs		**83,000**
Washington State sales tax (applied to all above)	10.0%	9,000
City Staff Time	15.0%	13,000
Pre-design Feasibility Study? Yes	10.0%	9,000
Administration, engineering design, permitting	45.0%	38,000
Land acquisition		
Total Capital Cost		**152,000**

Life-cycle cost estimate:

Design Life	2020	2037	2054	2071	2088	2105	2120
Renewal				28,000			
Disposal							152,000
Other							

**Net present value (NPV) based on an assumed discount rate of: 2.0%*

Design life of project:			NPV* Total
Operating (annual from commission through design life)	-	annually	0
Maintenance (annual from commission through design life)	6,000	annually	264,000
Renewal (anticipated major repair not funded through maintenance)			10,000
Disposal (disposal of the asset at the end of the design life)			0
Other costs	-		0
Total Life-cycle Cost			**426,000**

Brown AND Caldwell

PROJECT SUMMARY

MC-IMP-FM02

6th Avenue NE and NE 200th Street Flood Reduction Project

Status: Not Started

Location: 6th Avenue NE and NE 200th Street

Capital Cost: $384,000

McAleer Creek

Improvement

Flood Mitigation

Overview

This project reduces flooding due to inadequate capacity of the existing system in the vicinity of 6th Avenue NE and NE 200th Street.

Improvements: To increase conveyance and sediment storage capacity, replace a type 1 catch basin with a type 2 catch basin, and install a larger-diameter pipe and upsize to a 24-inch-diameter pipe to handle a 25-year flood flow rate.

Benefits: Reduce flooding impacts.

Site Map

Implementation

Design, Construction, and Permitting Constraints/Concerns:

Risk/Consequence of Failure:
Flooding on private property.

Public Outreach:

Additional Notes:
Problem partially addressed in Janurary 2015 (type 2 catch basin installed); further work is unscheduled. Project recommended as MC-CIP-1 in McAleer Creek Basin Plan (Alta Terra 2015).

PROJECT COST ESTIMATE

MC-IMP-FM02

6th Ave NE and NE 200th St Flood Reduction Project

Status: Not Started

LOCATION: 6th Ave NE and NE 200th St

Project Basin: McAleer Creek

Capital Cost Estimate

Item	Unit	Unit Cost	Quantity	Cost
Water Pollution/Erosion Control	LS	6,460.00	1.00	6,460
Spill Prevention, Control, and Countermeasure (SPCC) plan	LS	1,030.00	1.00	1,030
Traffic Control	LS	5,920.00	1.00	5,920
Potholing	EA	1,860.00	7.00	13,020
Clearing and Grubbing	SY	20.00	309.00	6,180
Connect to Existing Drainage Structure	EA	1,030.00	1.00	1,030
Trash Rack Structure	EA	5,150.00	1.00	5,150
Flow Splitter	EA	1,030.00	1.00	1,030
Excavation, including haul	CY	70.00	70.00	4,900
Schedule A 12" Storm Sewer Pipe	LF	90.00	45.00	4,050
Schedule A 24" Storm Sewer Pipe	LF	190.00	25.00	4,750
Remove Road, Curb & Gutter, and Sidewalk	SY	160.00	51.00	8,160
Roadway Restoration	SY	570.00	51.00	29,070
Planting and Bioengineered Restoration	SY	110.00	309.00	33,990

Source: McAleer Creek Basin Plan (November 2015)

Subtotal		124,740
Estimating and construction contingency	*50.0%*	62,370
Contractor overhead, profit, and mobilization	*13.0%*	24,324
Subtotal construction costs		**212,000**
Washington State sales tax (applied to all above)	*10.0%*	22,000
City Staff Time	*15.0%*	32,000
Pre-design Feasibility Study? *Yes*	*10.0%*	22,000
Administration, engineering design, permitting	*45.0%*	96,000
Land acquisition		
Total Capital Cost		**384,000**

Life-cycle cost estimate:

Design Life	2020	2037	2054	2071	2088	2105	2120
Renewal				0			
Disposal							10,000
Other							

**Net present value (NPV) based on an assumed discount rate of: 2.0%*

Design life of project:			NPV* Total
Operating (annual from commission through design life)	-	*annually*	0
Maintenance (annual from commission through design life)	-	*annually*	0
Renewal (anticipated major repair not funded through maintenance)			0
Disposal (disposal of the asset at the end of the design life)			0
Other costs	-		0
Total Life-cycle Cost			**384,000**

PROJECT SUMMARY

MC-IMP-WQ01

Bioretention at N 199th St and Wallingford Avenue NE

Status: Not Started

Location: N 199th St and Wallingford Avenue NE

Capital Cost: $524,000

McAleer Creek

Improvement

Water Quality Improvement

Overview

This project includes installing three bioretention swales on the south side of North 199th Street east of the intersection with Wallingford Avenue N to resolve the ponding issues in this area. This location was identified through the Greenworks program in the Surface Water Utility that identifies candidate locations for low impact development stormwater retrofit. These facilities would probably not involve any work on the existing storm drain other than installing new lateral connections.

Improvements: This project includes installing three bioretention swales of 1.5-foot bottom width, 1-foot depth, and 3:1 side slopes. The design also includes new CBs (Type 1) and pipes to connect to the existing storm drain line.

Benefits: Water quality improvement; improved drainage.

Site Map

Implementation

Design, Construction, and Permitting Constraints/Concerns:

Wide right-of-way along the south side of North 199th Street would allow for new bioretention on the southern edge of the right-of-way while still allowing for a parking strip along the edge of pavement. Also, potholing will be required to ensure there are no conflicts with other utilities.

Risk/Consequence of Failure:

Public Outreach:

Coordination with neighbors will be required.

Additional Notes:

Project recommended as MC-CIP-3a in McAleer Creek Basin Plan (Alta Terra 2015).

PROJECT COST ESTIMATE

MC-IMP-WQ01

Bioretention at N 199th St. and Wallingford Avenue NE

Status: Not Started

LOCATION: N 199th St and Wallingford Avenue NE

Project Basin: McAleer Creek

Capital Cost Estimate

Item	Unit	Unit Cost	Quantity	Cost
Water Pollution/Erosion Control	LS	8,540.00	1.00	8,540
Spill Prevention, Control, and Countermeasure (SPCC) plan	LS	520.00	1.00	520
Traffic Control	LS	11,940.00	1.00	11,940
Potholing	EA	1,860.00	4.00	7,440
Remove Road, Curb & Gutter, and Sidewalk	SY	160.00	245.00	39,200
Removal of Structures and Obstructions	LS	2,060.00	4.00	8,240
Excavation Including Haul	CY	70.00	216.00	15,120
Gravel Bed Material	TN	50.00	443.00	22,150
Biofiltration Soil	CY	80.00	216.00	17,280
Geosynthetic Liner	SY	10.00	123.00	1,230
Connect to Existing Drainage Structure	EA	520.00	1.00	520
Storm Drain Catch Basin or Manhole	EA	4,120.00	5.00	20,600
Schedule A 12" Storm Sewer Pipe	LF	90.00	15.00	1,350
Biofiltration Planting and Bioengineered Restoration	SY	110.00	245.00	26,950

Source: McAleer Creek Basin Plan (November 2015)

Subtotal		181,080
Estimating and construction contingency	*50.0%*	90,540
Contractor overhead, profit, and mobilization	*13.0%*	35,311
Subtotal construction costs		**307,000**
Washington State sales tax (applied to all above)	*10.0%*	31,000
City Staff Time	*15.0%*	47,000
Pre-design Feasibility Study? *No*		0
Administration, engineering design, permitting	*45.0%*	139,000
Land acquisition		
Total Capital Cost		**524,000**

Life-cycle cost estimate:

Design Life	2020	2024	2028	2032	2036	2040	2040
Renewal				68,000			
Disposal							45,000
Other							

**Net present value (NPV) based on an assumed discount rate of: 2.0%*

Design life of project:			NPV* Total
Operating (annual from commission through design life)	-	*annually*	0
Maintenance (annual from commission through design life)	*21,000*	*annually*	392,000
Renewal (anticipated major repair not funded through maintenance)			52,000
Disposal (disposal of the asset at the end of the design life)			0
Other costs	-		0
Total Life-cycle Cost			**968,000**

PROJECT SUMMARY

MC-IMP-WQ02

Bioretention at NE 192nd St and Burke Ave NE

Status: Not Started

Location: NE 192nd Street and Burke Avenue NE

McAleer Creek

Capital Cost: $320,000

Improvement

Water Quality Improvement

Overview

This project includes constructing bioretention cells at N 192nd Street, just east of Burke Avenue North. This location was identified through the Greenworks program in the Surface Water Utility that identifies candidate locations for low impact development stormwater retrofit. This project addresses surface water ponding in the area. There are multiple potential sites in front of and to either side of 1909 N 192nd Street.

Improvements: The project includes installing three bioretention swales on the south side of N 192nd Street at Burke Avenue North. The design calls for the bioretention swales to replace the existing storm drain pipes at each location.

Benefits: Water quality improvement; improved drainage.

Site Map

Implementation

Design, Construction, and Permitting Constraints/Concerns:

At 1909 N 192nd Street, there is a potential conflict between street parking and bioretention. Swales could effectively replace existing storm drain pipes within the existing footprint. The existing 12-inch concrete driveway culverts would remain between swales except where repair/replacement is required due to known poor structural condition. Potholing will be required to ensure there are no conflicts with other utilities.

Risk/Consequence of Failure:

Public Outreach:

Coordination with neighbors will be required.

Additional Notes:

Project recommended as MC-CIP-3b in McAleer Creek Basin Plan (Alta Terra 2015). Potential grant candidate.

PROJECT COST ESTIMATE

MC-IMP-WQ02

Bioretention at NE192nd St and Burke Ave NE

Status: Not Started

LOCATION: NE 192nd St and Burke Ave NE

Project Basin: McAleer Creek

Capital Cost Estimate

Item	Unit	Unit Cost	Quantity	Cost
Water Pollution/Erosion Control	LS	5,150.00	1.00	5,150
Spill Prevention, Control, and Countermeasure (SPCC) plan	LS	520.00	1.00	520
Traffic Control	LS	7,210.00	1.00	7,210
Potholing	EA	1,860.00	4.00	7,440
Remove Road, Curb & Gutter, and Sidewalk	SY	160.00	145.00	23,200
Removal of Structures and Obstructions	LS	2,060.00	3.00	6,180
Excavation Including Haul	CY	70.00	124.00	8,680
Gravel Bed Material	TN	50.00	255.00	12,750
Biofiltration Soil	CY	80.00	124.00	9,920
Geosynthetic Liner	SY	10.00	55.00	550
Storm Drain Catch Basin or Manhole	EA	4,120.00	3.00	12,360
Biofiltration Planting and Bioengineered Restoration	SY	110.00	145.00	15,950

Source: McAleer Creek Basin Plan (November 2015)

Subtotal		109,910
Estimating and construction contingency	*50.0%*	54,955
Contractor overhead, profit, and mobilization	*13.0%*	21,432
Subtotal construction costs		**187,000**
Washington State sales tax (applied to all above)	*10.0%*	19,000
City Staff Time	*15.0%*	29,000
Pre-design Feasibility Study? *No*		0
Administration, engineering design, permitting	*45.0%*	85,000
Land acquisition		
Total Capital Cost		**320,000**

Life-cycle cost estimate:

Design Life	2020	2024	2028	2032	2036	2040	2040
Renewal				42,000			
Disposal							26,000
Other							

**Net present value (NPV) based on an assumed discount rate of:* 2.0%

Design life of project:			NPV* Total
Operating (annual from commission through design life)	-	*annually*	0
Maintenance (annual from commission through design life)	*13,000*	*annually*	243,000
Renewal (anticipated major repair not funded through maintenance)			32,000
Disposal (disposal of the asset at the end of the design life)			0
Other costs	-		0
Total Life-cycle Cost			**595,000**

PROJECT SUMMARY

MC-IMP-WQ03

Echo Lake Biofiltration Swale

Status: Not Started

Location: Between Stone Avenue N and Interurban Trail

McAleer Creek

Capital Cost: $905,000

Improvement

Water Quality Improvement

Overview

Echo Lake has been identified as high priority for source control projects. Because phosphorus is a targeted pollutant of Echo Lake, the media and compost used in the swale will need to be clearly specified during design to ensure that the proposed facility improves overall water quality, including phosphorus loading. The proposed project would retrofit the existing storm drain system to provide additional water quality treatment of runoff discharging into Echo Lake by installing a biofiltration facility between Stone Avenue N and the Interurban Trail. In addition, new pipes are also proposed on N 195th Street to capture runoff with an additional pipe and catch basin to tie the existing N 196th Street system into the biofiltration swale.

Improvements: Install 300-linear-foot biofiltration swale in the green planting strip between Stone Avenue N and the Interurban Trail. Swale dimensions are 2.0 feet wide at the bottom, 1.5 feet deep, and side slopes of 3:1.

Benefits: Provide water quality treatment for runoff discharging to Echo Lake by treating nearly 1 acre of roadway runoff from N 195th Street, Stone Avenue N, and N 196th Street.

Site Map

Implementation

Design, Construction, and Permitting Constraints/Concerns:

Coordination with neighbors along Stove Avenue N may be required. Water and sewer lines cross the storm drain lines on N 195th Street and Stone Avenue N. Per GIS data, the sewer line is several feet below the existing storm drain lines; however, no elevation data for the water line are in the GIS data, so potholing will be required to determine any conflicts with the water line. The existing guardrail will need to be relocated to allow for sufficient space for the swale.

Risk/Consequence of Failure:

Public Outreach:

Additional Notes:

Project recommended in McAleer Creek Basin Plan (Alta Terra 2015). The swale will provide 97 percent filtration, meeting the current 2012 Ecology water quality standard of 91 percent. Coordination with Seattle City Light (SCL) will be required for work on the Interurban Trail. The cost estimate assumes purchasing SCL property to install, access, and maintain the swale.

PROJECT COST ESTIMATE

MC-IMP-WQ03

Echo Lake Biofiltration Swale

Status: Not Started

LOCATION: Between Stone Ave N and Interurban Trail

Project Basin: McAleer Creek

Capital Cost Estimate

Item	Unit	Unit Cost	Quantity	Cost
Water Pollution/Erosion Control	LS	11,530.00	1.00	11,530
Spill Prevention, Control, and Countermeasure (SPCC) plan	LS	520.00	1.00	520
Traffic Control	LS	16,160.00	1.00	16,160
Potholing	EA	1,860.00	3.00	5,580
Clearing and Grubbing	SY	20.00	395.00	7,900
Remove Road, Curb & Gutter, and Sidewalk	SY	160.00	12.00	1,920
Excavation Including Haul	CY	70.00	441.00	30,870
Gravel Bed Material	TN	50.00	877.00	43,850
Biofiltration Soil	CY	80.00	734.00	58,720
Geosynthetic Liner	SY	10.00	384.00	3,840
Connect to Existing Drainage Structure	EA	520.00	5.00	2,600
Storm Drain Catch Basin or Manhole	EA	4,120.00	1.00	4,120
Trash Rack structure	EA	5,150.00	1.00	5,150
Underdrain Pipe 6"	LF	30.00	300.00	9,000
Schedule A 12" Storm Sewer Pipe	LF	90.00	112.00	10,080
Extruded Curb, HMA	LF	20.00	30.00	600
Biofiltration Planting and Bioengineered Restoration	SY	110.00	395.00	43,450
Roadway Restoration	SY	570.00	12.00	6,840

Source: McAleer Creek Basin Plan (November 2015)

Subtotal		262,730
Estimating and construction contingency	*50.0%*	131,365
Contractor overhead, profit, and mobilization	*13.0%*	51,232
Subtotal construction costs		**446,000**
Washington State sales tax (applied to all above)	*10.0%*	45,000
City Staff Time	*15.0%*	67,000
Pre-design Feasibility Study? *No*		0
Administration, engineering design, permitting	*45.0%*	201,000
Land acquisition		146,000
Total Capital Cost		**905,000**

Life-cycle cost estimate:

Design Life	2020	2024	2028	2032	2036	2040	2040
Renewal				99,000			
Disposal							91,000
Other							

**Net present value (NPV) based on an assumed discount rate of: 2.0%*

Design life of project:			NPV* Total
Operating (annual from commission through design life)	-	*annually*	0
Maintenance (annual from commission through design life)	*30,000*	*annually*	560,000
Renewal (anticipated major repair not funded through maintenance)			76,000
Disposal (disposal of the asset at the end of the design life)			0
Other costs	-		0
Total Life-cycle Cost			**1,541,000**

PROJECT SUMMARY

PS-IMP-AM01

Heron Creek Culvert Crossing at Springdale Court NW

Status: Not Started

Location: Heron Creek culvert at Springdale Court NW

Puget Sound Drainages

Capital Cost: $855,000

Improvement

Asset Management

Overview

The Heron Creek culvert crossing at Springdale Court is broken and in danger of collapsing because it is in such poor condition, and the retaining wall at the outfall of the culvert is failing. The retaining wall is currently being held in place with a 2-inch wide by-4-inch tall timber propped up against a nearby tree. This project proposes replacing the existing 18-inch-diameter reinforced concrete culvert with a new fish passable culvert. If fish passage is determined to be unnecessary during permit negotiations, an alternative culvert may be proposed.

Improvements: Replace the existing 18-inch diameter culvert with a new fish-passable culvert of 12 feet inside width.

Benefits: Replacement of failing infrastructure; fish passage improvements.

Site Map

Implementation

Design, Construction, and Permitting Constraints/Concerns:

Environmental permits, includign a hydraulic project approval (HPA), State Environmental Policy Act (SEPA) determination, and Army Corps of Engineers Section 404 Permit will likely be required as this culvert conveys stream flow.

Risk/Consequence of Failure:

Culvert failure/collapse.

Public Outreach:

Necessary because infrastructure is located on private property.

Additional Notes:

Project recommended as PSB-CIP-13 in the Puget Sound Drainage Basin Plan (Alta Terra 2016). Possible coordination with Springdale Court NW and Ridgefield Road Drainage Improvement project.

PROJECT COST ESTIMATE

PS-IMP-AM01

Heron Creek Culvert Crossing at Springdale Ct. NW

Status: Not Started

LOCATION: Heron Creek culvert at Springdale Ct. NW

Project Basin: Puget Sound Drainages

Capital Cost Estimate

Item	Unit	Unit Cost	Quantity	Cost
Water Pollution/Erosion Control	LS	13,510.00	1.00	13,510
Spill Prevention, Control, and Countermeasure (SPCC) plan	LS	510.00	1.00	510
Stormwater Pollution Prevention Plan (SWPPP)	LS	310.00	1.00	310
Traffic Control Arterial Streets	LS	6,050.00	1.00	6,050
Excavation Including Haul	CY	40.00	299.00	11,960
Shoring or Extra Excavation Class B	SF	10.00	1,008.00	10,080
Potholing	EA	1,210.00	2.00	2,420
Fish Pass Culvert with Wingwalls and Footings	LF	2,930.00	56.00	164,080
Temporary Stream Bypass	LS	50,360.00	1.00	50,360
Streambed Gravel	CY	60.00	70.00	4,200
Biofiltration Planting and Bioengineered Restoration	SY	80.00	27.00	2,160
Roadway Restoration	SY	270.00	112.00	30,240

Source: Puget Sound Drainages Basin Plan (December 2016)

Subtotal		295,880
Estimating and construction contingency	*50.0%*	147,940
Contractor overhead, profit, and mobilization	*13.0%*	57,697
Subtotal construction costs		**502,000**
Washington State sales tax (applied to all above)	*10.0%*	51,000
City Staff Time	*15.0%*	76,000
Pre-design Feasibility Study?	*No*	0
Administration, engineering design, permitting	*45.0%*	226,000
Land acquisition		
Total Capital Cost		**855,000**

Life-cycle cost estimate:

Design Life	2020	2029	2038	2047	2056	2065	2070
Renewal				0			
Disposal							62,000
Other							

**Net present value (NPV) based on an assumed discount rate of:* 2.0%

Design life of project:			**NPV* Total**
Operating (annual from commission through design life)	-	*annually*	0
Maintenance (annual from commission through design life)	-	*annually*	0
Renewal (anticipated major repair not funded through maintenance)			0
Disposal (disposal of the asset at the end of the design life)			0
Other costs	-		0
Total Life-cycle Cost			**855,000**

PROJECT SUMMARY

PS-IMP-EC01

Stabilize NW 16th Place Storm Drainage in Reserve M

Status: Not Started

Location: NW 16th Place in Reserve M

Puget Sound Drainages

Capital Cost: $500,000

Improvement

Erosion Control

Overview

The stormwater outfall pipe in the Innis Arden Reserves natural area (Reserve M) has failed and is contributing to erosion on the hillslope. The existing 12-inch-diameter corrugated plastic stormwater pipe has failed in multiple locations, resulting in a deep gully forming in the hillside adjacent to Ronald Sewer District's emergency overflow pipe at Lift Station 4 on 16th Avenue NW. The hillside is saturated and unstable with large slope failure occurring in March–April 2016. This project proposes the construction of an HDPE tight line to convey stormwater (and groundwater) flows from 16th Place NW to Puget Sound to reduce erosion.

Improvements: Remove SP-1864 and install 500 feet of 12-inch-diameter HDPE pipe with pipe anchors every 75 feet along the slope. A diffuser tee and/or energy dissipation structure is recommended at the outfall.

Benefits: Manage erosion control and improve slope stability.

Site Map

Implementation

Design, Construction, and Permitting Constraints/Concerns:

Future study of the upstream contributing area is recommended to identify improvements to reduce flow to the outfall at 16th Avenue NW. The HDPE pipe could be placed parallel to the existing emergency sewer overflow pipe that appears to be in a currently stable position on the hillslope. Traffic control will be required for the installation of new infrastructure. Critical areas permitting will be necessary for this project. Coordination with neighbors is required. Geotechnical evaluation will be required for this site.

Risk/Consequence of Failure:

Continued hillslope erosion, additional slope failures.

Public Outreach:

Additional Notes:

Project recommended as PSB-CIP-12 in Puget Sound Drainages Basin Plan (Alta Terra 2016). Coordination with Parks is identified as a potential significant issue per the City.

PROJECT COST ESTIMATE

PS-IMP-EC01

Stabilize NW 16th Place Storm Drainage in Reserve M

Status: Not Started

LOCATION: NW 16th Pl in Reserve M

Project Basin: Puget Sound Drainages

Capital Cost Estimate

Item	Unit	Unit Cost	Quantity	Cost
Water Pollution/Erosion Control	LS	7,240.00	1.00	7,240
Spill Prevention, Control, and Countermeasure (SPCC) plan	LS	510.00	1.00	510
Stormwater Pollution Prevention Plan (SWPPP)	LS	310.00	1.00	310
Traffic Control	LS	4,030.00	1.00	4,030
Removal of Structures and Obstructions	LS	2,020.00	1.00	2,020
Schedule A 12" Storm Sewer Pipe	LF	180.00	500.00	90,000
Pipe Anchors	EA	3,280.00	7.00	22,960
Quarry Spalls	CY	360.00	7.00	2,520
Planting and Bioengineered Restoration	SY	50.00	667.00	33,350

Source: Puget Sound Drainages Basin Plan (December 2016)

Subtotal		162,940
Estimating and construction contingency	*50.0%*	81,470
Contractor overhead, profit, and mobilization	*13.0%*	31,773
Subtotal construction costs		**277,000**
Washington State sales tax (applied to all above)	*10.0%*	28,000
City Staff Time	*15.0%*	42,000
Pre-design Feasibility Study? *Yes*	*10.0%*	28,000
Administration, engineering design, permitting	*45.0%*	125,000
Land acquisition		
Total Capital Cost		**500,000**

Life-cycle cost estimate:

Design Life	*2020*	*2037*	*2054*	*2071*	*2088*	*2105*	*2120*
Renewal				0			
Disposal							152,000
Other							

**Net present value (NPV) based on an assumed discount rate of: 2.0%*

Design life of project:			NPV* Total
Operating (annual from commission through design life)	-	*annually*	0
Maintenance (annual from commission through design life)	-	*annually*	0
Renewal (anticipated major repair not funded through maintenance)			0
Disposal (disposal of the asset at the end of the design life)			0
Other costs	-		0
Total Life-cycle Cost			**500,000**

PROJECT SUMMARY

PS-IMP-EC02

NW 194th Place and 25th Avenue NW Ditch Erosion

Status: Not Started

Location: NW 194th Place and 25th Avenue NW

Capital Cost: $150,000

Puget Sound Drainages

Improvement

Erosion Control

Overview

The ditch on 25th Avenue NW is severely eroded. This segment of the drainage system is very steep and mostly piped. Flow from the piped section upstream enters the ditch at high velocities, causing erosion. The proposed project includes installing a new pipe along 25th Avenue NW, northwest of NW 194th Place. Ditch DI-135 is eroded and located at the toe of a steel slope; erosion has been an ongoing problem at this location.

Improvements: Install a new pipe along 25th Avenue NW, northwest of NW 194th Place. The existing ditch slope is approximately 9 to 12 percent.

Benefits: Mitigate erosion issue; improve drainage infrastructure.

Site Map

Implementation

Design, Construction, and Permitting Constraints/Concerns:

Removing existing pipe SP-6352 and SP-7265, connecting CB-1565 and CB-10449 by replacing DI-135 with 127 feet of 18-inch-diameter stormwater pipe. Traffic control will be required for the installation of new infrastructure.

Risk/Consequence of Failure:

Continued ditch erosion.

Public Outreach:

Coordination with neighbors required.

Additional Notes:

Project recommended as PSB-CIP-15b in the Puget Sound Drainages Basin Plan (Alta Terra 2016). Possible Small Works project.

PROJECT COST ESTIMATE

PS-IMP-EC02

NW 194th Place and 25th Ave NW Ditch Erosion

Status: Not Started

LOCATION: NW 194th Place and 25th Ave NW

Project Basin: Puget Sound Drainages

Capital Cost Estimate

Item	Unit	Unit Cost	Quantity	Cost
Water Pollution/Erosion Control	LS	2,160.00	1.00	2,160
Spill Prevention, Control, and Countermeasure (SPCC) plan	LS	510.00	1.00	510
Stormwater Pollution Prevention Plan (SWPPP)	LS	310.00	1.00	310
Traffic Control	LS	4,030.00	1.00	4,030
Excavation Including Haul	CY	40.00	75.00	3,000
Shoring or Extra Excavation Class B	SF	10.00	508.00	5,080
Potholing	EA	1,210.00	1.00	1,210
Schedule A 18" Storm Sewer Pipe	LF	230.00	127.00	29,210
Planting and Bioengineered Restoration	SY	50.00	113.00	5,650

Source: Puget Sound Drainages Basin Plan (December 2016)

Subtotal		51,160
Estimating and construction contingency	50.0%	25,580
Contractor overhead, profit, and mobilization	13.0%	9,976
Subtotal construction costs		**87,000**
Washington State sales tax (applied to all above)	10.0%	9,000
City Staff Time	15.0%	14,000
Pre-design Feasibility Study?	No	0
Administration, engineering design, permitting	45.0%	40,000
Land acquisition		
Total Capital Cost		**150,000**

Life-cycle cost estimate:

Design Life	2020	2037	2054	2071	2088	2105	2120
Renewal				0			
Disposal							39,000
Other							

**Net present value (NPV) based on an assumed discount rate of: 2.0%*

Design life of project:			NPV* Total
Operating (annual from commission through design life)	-	annually	0
Maintenance (annual from commission through design life)	-	annually	0
Renewal (anticipated major repair not funded through maintenance)			0
Disposal (disposal of the asset at the end of the design life)			0
Other costs	-		0
Total Life-cycle Cost			**150,000**

PROJECT SUMMARY

PS-IMP-FM01

NW 195th Place and Richmond Beach Drive Flooding

Status: Not Started

Location: NW 195th Place and Richmond Beach Drive

Puget Sound Drainages

Capital Cost: $747,000

Improvement

Flood Mitigation

Overview

Frequent flooding is reported at the intersection of NW 195th Place and Richmond Beach Drive NW when water surcharges from the grate of manhole MH-274 during wet weather. This project involves replacing the undersized 18-inch-diameter system along Richmond Beach Drive with a new 24-inch-diameter pipe, and replacing three existing stormwater structures. The new structure replacing MH-274 will have a solid locking lid to prevent stormwater from rising above the structure rim. A conservative rational method analysis of the basin tributary to the outfall indicates that the outfall may also be undersized. Additional hydrologic and hydraulic analysis is necessary to verify the proposed solution as well as the capacity of the existing outfalls to Puget Sound.

Improvements: Replace the 18-inch-diameter system along Richmond Beach Drive with 24-inch-diameter pipes and replace three existing stormwater structures.

Benefits: Flood mitigation.

Site Map

Implementation

Design, Construction, and Permitting Constraints/Concerns:

Project includes replacing undersized piping and three existing stormwater structures. Additional modeling analysis is necessary to verify proposed solution and capacity.

Risk/Consequence of Failure:

Right-of-way flooding.

Public Outreach:

Additional Notes:

Project recommended as PSB-CIP-10 in the Puget Sound Drainages Basin Plan (Alta Terra 2016).

PROJECT COST ESTIMATE

PS-IMP-FM01

NW 195th Place and Richmond Beach Drive Flooding

Status: Not Started

LOCATION: NW 195th Place and Richmond Beach Drive

Project Basin: Puget Sound Drainages

Capital Cost Estimate

Item	Unit	Unit Cost	Quantity	Cost
Water Pollution/Erosion Control	LS	11,400.00	1.00	11,400
Spill Prevention, Control, and Countermeasure (SPCC) plan	LS	510.00	1.00	510
Stormwater Pollution Prevention Plan (SWPPP)	LS	310.00	1.00	310
Traffic Control Arterial Streets	LS	6,050.00	1.00	6,050
Remove Road, Curb & Gutter, and Sidewalk	SY	160.00	251.00	40,160
Excavation Including Haul	CY	40.00	223.00	8,920
Shoring or Extra Excavation Class B	SF	10.00	1,508.00	15,080
Potholing	EA	1,210.00	2.00	2,420
Schedule A 24" Storm Sewer Pipe	LF	250.00	377.00	94,250
Roadway Restoration	SY	270.00	251.00	67,770
Storm Drain Catch Basin or Manhole	EA	4,030.00	3.00	12,090

Source: Puget Sound Drainages Basin Plan (December 2016)

Subtotal		258,960
Estimating and construction contingency	*50.0%*	129,480
Contractor overhead, profit, and mobilization	*13.0%*	50,497
Subtotal construction costs		**439,000**
Washington State sales tax (applied to all above)	*10.0%*	44,000
City Staff Time	*15.0%*	66,000
Pre-design Feasibility Study?	*No*	0
Administration, engineering design, permitting	*45.0%*	198,000
Land acquisition		
Total Capital Cost		**747,000**

Life-cycle cost estimate:

Design Life	2020	2037	2054	2071	2088	2105	2120
Renewal				0			
Disposal							115,000
Other							

**Net present value (NPV) based on an assumed discount rate of:* *2.0%*

Design life of project:			NPV* Total
Operating (annual from commission through design life)	-	*annually*	0
Maintenance (annual from commission through design life)	-	*annually*	0
Renewal (anticipated major repair not funded through maintenance)			0
Disposal (disposal of the asset at the end of the design life)			0
Other costs	-		0
Total Life-cycle Cost			**747,000**

PROJECT SUMMARY

PS-IMP-FM02

NW 196th Place and 21st Avevue NW Infrastructure Improvements

Status: Not Started

Location: NW 196th Place and 21st Avenue NW near Richmond Beach Library

Puget Sound Drainages

Capital Cost: $313,000

Improvement

Flood Mitigation

Overview

An existing pipe and catch basin located at the northeast corner of the intersection of NW 196th Place and 21st Avenue NW (near the entrance to the Richmond Beach Library) do not connect to a downstream storm drain system. During rain events, flow enters the pipe and catch basin but eventually overtops the catch basin rim and sheet flows to the downstream catch basin located in the right-of-way of NW 196th Street at 21st Avenue NW. This is especially problematic in the cold winter months when ice can form on the roadway. This project involves capping and abandoning the ineffective pipe and connecting existing catch basins with new pipe and two new catch basins, so that the system functions more effectively.

Improvements: Project involves capping and abandoning pipe SP-14525, and connecting CB-10001 to CB-3834 with 161 linear feet of new 12-inch-diameter pipe and two new catch basins.

Benefits: Flood mitigation.

Site Map

LEGEND
CIP Location
Drainage Pipes
Ditch

Implementation

Design, Construction, and Permitting Constraints/Concerns:

Traffic control will be required for the installation of new infrastructure. Access to the Richmond Beach Library needs to be addressed during construction. Prior to final design, the site should be visited during a rainfall event to verify that flow enters the existing catch basins, and whether any additional upstream improvements are needed.

Risk/Consequence of Failure:

Right-of-way flooding.

Public Outreach:

Likely needed with adjacent library and park.

Additional Notes:

Project recommended as PSB-CIP-11 in the Puget Sound Drainages Basin Plan (Alta Terra 2016).

PROJECT COST ESTIMATE

PS-IMP-FM02

NW 196th Pl and 21st Ave NW Improvement Project

Status: Not Started

LOCATION: NW 196th Place and 21st Avenue NW near Richmond Beach Library

Project Basin: Puget Sound Drainages

Capital Cost Estimate

Item	Unit	Unit Cost	Quantity	Cost
Water Pollution/Erosion Control	LS	4,880.00	1.00	4,880
Spill Prevention, Control, and Countermeasure (SPCC) plan	LS	510.00	1.00	510
Stormwater Pollution Prevention Plan (SWPPP)	LS	310.00	1.00	310
Traffic Control Arterial Streets	LS	6,050.00	1.00	6,050
Excavation Including Haul	CY	40.00	95.00	3,800
Shoring or Extra Excavation Class B	SF	10.00	165.00	1,650
Potholing	EA	1,210.00	2.00	2,420
Remove Road, Curb & Gutter, and Sidewalk	SY	160.00	107.00	17,120
Schedule A 12" Storm Sewer Pipe	LF	180.00	161.00	28,980
Roadway Restoration	SY	270.00	107.00	28,890
Connect to Existing Drainage Structure	SY	1,520.00	2.00	3,040
Storm Drain Catch Basin or Manhole	EA	3,730.00	2.00	7,460
Cement Conc. Traffic Curb and Gutter	LF	90.00	30.00	2,700

Source: Puget Sound Drainages Basin Plan (December 2016)

Subtotal		107,810
Estimating and construction contingency	*50.0%*	53,905
Contractor overhead, profit, and mobilization	*13.0%*	21,023
Subtotal construction costs		**183,000**
Washington State sales tax (applied to all above)	*10.0%*	19,000
City Staff Time	*15.0%*	28,000
Pre-design Feasibility Study? *No*		0
Administration, engineering design, permitting	*45.0%*	83,000
Land acquisition		
Total Capital Cost		**313,000**

Life-cycle cost estimate:

Design Life	2020	2037	2054	2071	2088	2105	2120
Renewal				0			
Disposal							20,000
Other							

**Net present value (NPV) based on an assumed discount rate of: 2.0%*

Design life of project:			NPV* Total
Operating (annual from commission through design life)	-	*annually*	0
Maintenance (annual from commission through design life)	-	*annually*	0
Renewal (anticipated major repair not funded through maintenance)			0
Disposal (disposal of the asset at the end of the design life)			0
Other costs	-		0
Total Life-cycle Cost			**313,000**

PROJECT SUMMARY

PS-IMP-FM03

18th Avenue NW and NW 204th Drainage System Connection

Status: Not Started

Location: 18th Avenue NW near NW 204th Street, 16th Place NW

Capital Cost: $261,000

Puget Sound Drainages

Improvement

Flood Mitigation

Overview

The drainage system on the east side of 18th Avenue NW at NW 204th Street has no downstream connection. This project involves reshaping the ditches and installing a new pipe and one catch basin to collect flows from the upstream system on 16th Place NW. Additionally, a new catch basin and pipe will be installed at 18th Avenue NW and NW 204th Street to convey flows from upstream to an existing system on the west side of 18th Avenue NW.

Improvements: Reshape ditches, install a new pipe and catch basin to collect upstream flows from 16th Place NW, 18th Avenue NW, and NW 204th Street to convey flows from upstream to an existing system on the west side of 18th Avenue NW.

Benefits: Improve an area lacking drainage infrastructure.

Site Map

Implementation

Design, Construction, and Permitting Constraints/Concerns:

Reshape ditches DI-732 and DI-1708 and install 60 feet of 12-inch-diameter pipe and one catch basin to collect flows from pipe SP-9856 upstream of ditch DI-732. Additionally, install a new catch basin and 84 feet of 12-inch-diameter pipe at 18th Avenue NW and NW 204th Street to convey flows from upstream to an existing system on the west side of 18th Avenue NW. Traffic control will be required for the installation of new infrastructure. Capacity of the downstream system should be confirmed during design.

Risk/Consequence of Failure:

Public Outreach:

Coordination with neighbors is required.

Additional Notes:

Project recommended as PSB-CIP-14 in Puget Sound Drainages Basin Plan (Alta Terra 2016).

PROJECT COST ESTIMATE

PS-IMP-FM03

18th Avenue NW and NW 204th Drainage System Connection

Status: Not Started

LOCATION: 18th Avenue NW near NW 204th Street, 16th Pl NW

Project Basin: Puget Sound Drainages

Capital Cost Estimate

Item	Unit	Unit Cost	Quantity	Cost
Water Pollution/Erosion Control	LS	3,680.00	1.00	3,680
Spill Prevention, Control, and Countermeasure (SPCC) plan	LS	510.00	1.00	510
Stormwater Pollution Prevention Plan (SWPPP)	LS	310.00	1.00	310
Traffic Control	LS	4,030.00	1.00	4,030
Excavation Including Haul	CY	40.00	85.00	3,400
Reshape Ditch	LF	20.00	155.00	3,100
Shoring or Extra Excavation Class B	SF	10.00	576.00	5,760
Potholing	EA	1,210.00	4.00	4,840
Schedule A 12" Storm Sewer Pipe	LF	180.00	144.00	25,920
Roadway Restoration	SY	270.00	96.00	25,920
Storm Drain Catch Basin or Manhole	EA	3,730.00	2.00	7,460

Source: Puget Sound Drainages Basin Plan (December 2016)

Subtotal		84,930
Estimating and construction contingency	*50.0%*	42,465
Contractor overhead, profit, and mobilization	*13.0%*	16,561
Subtotal construction costs		**144,000**
Washington State sales tax (applied to all above)	*10.0%*	15,000
City Staff Time	*15.0%*	22,000
Pre-design Feasibility Study? *Yes*	*10.0%*	15,000
Administration, engineering design, permitting	*45.0%*	65,000
Land acquisition		
Total Capital Cost		**261,000**

Life-cycle cost estimate:

Design Life	2020	2037	2054	2071	2088	2105	2120
Renewal				17,000			
Disposal							18,000
Other							

**Net present value (NPV) based on an assumed discount rate of: 2.0%*

Design life of project:			NPV* Total
Operating (annual from commission through design life)	-	*annually*	0
Maintenance (annual from commission through design life)	*4,000*	*annually*	176,000
Renewal (anticipated major repair not funded through maintenance)			6,000
Disposal (disposal of the asset at the end of the design life)			0
Other costs	-		0
Total Life-cycle Cost			**443,000**

PROJECT SUMMARY

PS-IMP-FM04

NW 180th and 8th Avenue Ditch with Unknown Connection

Status: Not Started

Location: NW 180th Street and 8th Avenue NW

Puget Sound Drainages

Capital Cost: $68,000

Improvement

Flood Mitigation

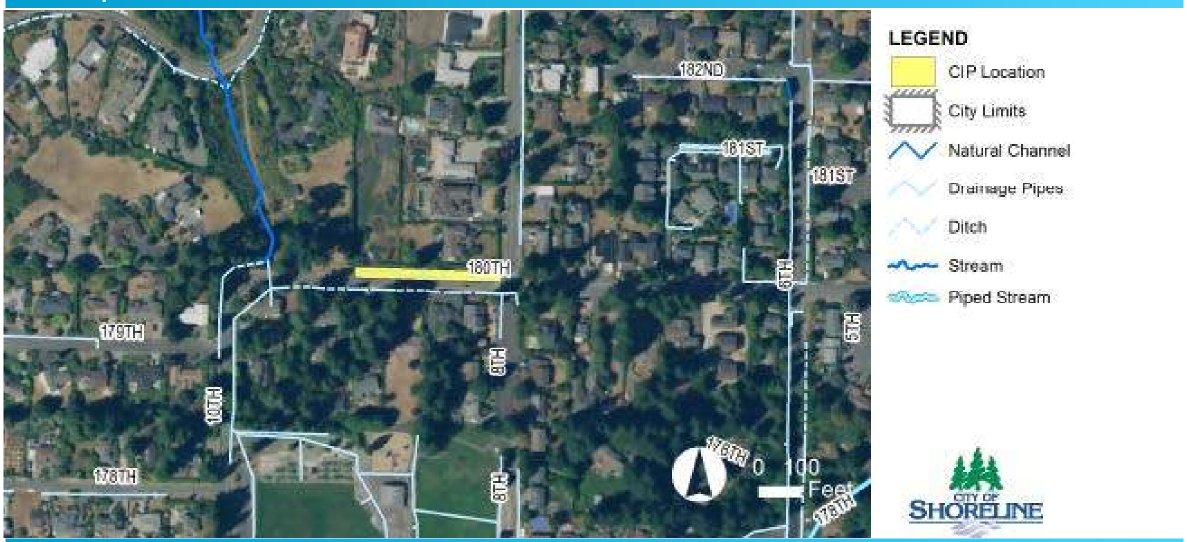
Overview

The existing drainage system on NW 180th Street does not adequately convey flow downstream because the ditches and pipes are not well defined or well connected. This proposed project includes adding connections to existing pipes and reshaping ditches at NW 180th Street, just west of 8th Avenue NW. The ditch on the north side of NW 180th Street is undefined and does not adequately direct flow to the downstream pipe system that outfalls to the stream at 800 NW 180th Street.

Improvements: This project proposes reshaping ditch (DI-1485), installing a catch basin at the end of the ditch, and another catch basin to connect the downstream 12-inch pipes (eliminating an existing short ditch).

Benefits: Improved drainage in an area lacking adequate infrastructure.

Site Map



Implementation

Design, Construction, and Permitting Constraints/Concerns:
Traffic control will be required for the installation of new infrastructure.

Risk/Consequence of Failure:

Public Outreach:
Coordination with neighbors is required.

Additional Notes:
Based on PSB-CIP-15a in the Puget Sound Drainages Basin Plan (Alta Terra 2016). Possible small works project.

PROJECT COST ESTIMATE

PS-IMP-FM04

NW 180th and 8th Avenue Ditch with Unknown Connection

Status: Not Started

LOCATION: NW 180th Street and 8th Avenue NW

Project Basin: Puget Sound Drainages

Capital Cost Estimate

Item	Unit	Unit Cost	Quantity	Cost
Water Pollution/Erosion Control	LS	1,030.00	1.00	1,030
Spill Prevention, Control, and Countermeasure (SPCC) plan	LS	510.00	1.00	510
Stormwater Pollution Prevention Plan (SWPPP)	LS	310.00	1.00	310
Traffic Control	LS	4,030.00	1.00	4,030
Reshape Ditch	LF	20.00	220.00	4,400
Excavation Including Haul	CY	40.00	7.00	280
Shoring or Extra Excavation Class B	SF	10.00	48.00	480
Potholing	EA	1,210.00	2.00	2,420
Schedule A 12" Storm Sewer Pipe	LF	180.00	12.00	2,160
Storm Drain Catch Basin or Manhole	EA	3,730.00	2.00	7,460

Source: Puget Sound Drainages Basin Plan (December 2016)

Subtotal		23,080
Estimating and construction contingency	*50.0%*	11,540
Contractor overhead, profit, and mobilization	*13.0%*	4,501
Subtotal construction costs		**40,000**
Washington State sales tax (applied to all above)	*10.0%*	4,000
City Staff Time	*15.0%*	6,000
Pre-design Feasibility Study? *No*		0
Administration, engineering design, permitting	*45.0%*	18,000
Land acquisition		
Total Capital Cost		**68,000**

Life-cycle cost estimate:

Design Life	2020	2037	2054	2071	2088	2105	2120
Renewal				14,000			
Disposal							67,000
Other							

**Net present value (NPV) based on an assumed discount rate of: 2.0%*

Design life of project:			NPV* Total
Operating (annual from commission through design life)	-	*annually*	0
Maintenance (annual from commission through design life)	*3,000*	*annually*	132,000
Renewal (anticipated major repair not funded through maintenance)			5,000
Disposal (disposal of the asset at the end of the design life)			0
Other costs	-		0
Total Life-cycle Cost			**205,000**

PROJECT SUMMARY

PS-IMP-FM05

NW 197th Place and 15th Avenue NW Flooding

Status: Not Started

Location: NW 197th Place and 15th Avenue NW

Puget Sound Drainages

Capital Cost: $119,000

Improvement

Flood Mitigation

Overview

During heavy rainfall, the residence located at 19719 15th Avenue NW floods when surface water from City right-of-way flows down its driveway. The homeowner requested a berm be installed in front of the property. City crews investigated but did not install a berm because of concern that flows would be transferred to neighboring properties. Currently, there is no surface water infrastructure on the west side of 15th Avenue NW at this location. There is an existing asphalt berm in front the home to the north (19727 15th Avenue NW). This project involves extending the asphalt berm in front of 19727 15th Avenue NW to the south side of the driveway for 19719 15th Avenue NW and installing a new catch basin at the south end of the berm to collect flows.

Improvements: Install a catch basin at the south end of an existing berm, and extend the berm around its rim to collect flows. Install a 12-inch-diameter pipe from this new catch basin and connect to the existing pipe on 15th Avenue NW.

Benefits: Flood mitigation.

Site Map

Implementation

Design, Construction, and Permitting Constraints/Concerns:

Extend the asphalt berm in front of 19727 15th Avenue NW to the south side of the driveway for 19719 15th Avenue NW. CB-12326 was not located during field visits, and based on video inspection data, an 8-inch-diameter stormwater tap break-in is located at the approximate location CB-12326 is shown on the map. Install a new catch basin at this 8-inch-diameter tap break-in, and connect the new 12-inch-diameter pipe and the existing 8-inch-diameter pipe to the existing 12-inch-diameter stormwater system.

Risk/Consequence of Failure:

Localized garage flooding.

Public Outreach:

Coordination with neighbors required.

Additional Notes:

Project recommended as PSB-CIP-16 in the Puget Sound Drainages Basin Plan (Alta Terra 2016). Possible Small Works project.

PROJECT COST ESTIMATE

PS-IMP-FM05

NW 197th Pl and 15th Ave NW Flooding

Status: Not Started

LOCATION: NW 197th Pl and 15th Ave NW

Project Basin: Puget Sound Drainages

Capital Cost Estimate

Item	Unit	Unit Cost	Quantity	Cost
Water Pollution/Erosion Control	LS	1,700.00	1.00	1,700
Spill Prevention, Control, and Countermeasure (SPCC) plan	LS	510.00	1.00	510
Stormwater Pollution Prevention Plan (SWPPP)	LS	310.00	1.00	310
Traffic Control	LS	4,030.00	1.00	4,030
Excavation Including Haul	CY	40.00	21.00	840
Shoring or Extra Excavation Class B	SF	10.00	140.00	1,400
Potholing	EA	1,210.00	1.00	1,210
Schedule A 12" Storm Sewer Pipe	LF	180.00	35.00	6,300
Hot Mix Asphalt (HMA) Berm	LF	20.00	70.00	1,400
Roadway Restoration	SY	270.00	47.00	12,690
Storm Drain Catch Basin or Manhole	EA	3,730.00	2.00	7,460

Source: Puget Sound Drainages Basin Plan (December 2016)

Subtotal		37,850
Estimating and construction contingency	50.0%	18,925
Contractor overhead, profit, and mobilization	13.0%	7,381
Subtotal construction costs		**65,000**
Washington State sales tax (applied to all above)	10.0%	7,000
City Staff Time	15.0%	10,000
Pre-design Feasibility Study? Yes	10.0%	7,000
Administration, engineering design, permitting	45.0%	30,000
Land acquisition		
Total Capital Cost		**119,000**

Life-cycle cost estimate:

Design Life	2020	2024	2028	2032	2036	2040	2040
Renewal				0			
Disposal							15,000
Other							

**Net present value (NPV) based on an assumed discount rate of: 2.0%*

Design life of project:			NPV* Total
Operating (annual from commission through design life)	-	annually	0
Maintenance (annual from commission through design life)	8,000	annually	150,000
Renewal (anticipated major repair not funded through maintenance)			0
Disposal (disposal of the asset at the end of the design life)			0
Other costs	-		0
Total Life-cycle Cost			**269,000**

Brown AND Caldwell

PROJECT SUMMARY

PS-IMP-FM06

Springdale Ct. NW and Ridgefield Rd. Drainage Improvements

Status: Not Started

Location: Springdale Court NW and Ridgefield Road NW

Puget Sound Drainages

Capital Cost: $2,058,000

Improvement

Flood Mitigation

Overview

To address flooding of the residences in the area, the project is proposed in three phases:
Phase 1: Replacement of broken pipes and rehabilitation of the ditch system on Ridgefield Road NW.
Phase 2: Replacement of existing pipes with larger-diameter pipes to convey higher flows on Springdale Court NW, and modification of ditches and replacement of connecting structures that are in poor condition.
Phase 3: Installation of new stormwater pipes and connections on Ridgefield Road NW to convey upstream stormwater flows to the Ridgefield/Springdale drainage system and reduce flows to pipes on private property.

Improvements: Replace broken pipes and rehabilitate ditch system, replace existing pipes with larger-diameter pipes, modify ditches, and replace connecting structures that are in poor condition.

Benefits: Flood mitigation.

Site Map

Implementation

Design, Construction, and Permitting Constraints/Concerns:

Risk/Consequence of Failure:
Continued residential flooding.

Public Outreach:
Nexus of private and public property will require coordination with property owners.

Additional Notes:
Based on several options presented in PSB-CIP-8 of the Puget Sound Drainages Basin Plan (Alta Terra 2016). Options include flow bypasses or diversions, upstream peak flow attenuation techniques (e.g., LID), and negotiated easements for open-channel flow. May be optimal to combine with PS-IMP-AM01 Heron Creek Culvetr Crossing at Springdale Ct NW.

PROJECT COST ESTIMATE

PS-IMP-FM06

Springdale Ct. NW and Ridgefield Rd. Drainage Improvement

Status: Not Started

LOCATION: Springdale Ct. NW and Ridgefield Rd

Project Basin: Puget Sound Drainages

Capital Cost Estimate

Item	Unit	Unit Cost	Quantity	Cost
Water Pollution/Erosion Control	LS	30,470.00	1.00	30,470
Spill Prevention, Control, and Countermeasure (SPCC) plan	LS	1,520.00	1.00	1,520
Stormwater Pollution Prevention Plan (SWPPP)	LS	910.00	1.00	910
Traffic Control	LS	12,090.00	1.00	12,090
Excavation Including Haul	CY	40.00	630.00	25,200
Shoring or Extra Excavation Class B	SF	10.00	4,260.00	42,600
Potholing	EA	1,210.00	16.00	19,360
Remove Road, Curb & Gutter, and Sidewalk	SY	160.00	474.00	75,840
Schedule A 12" Storm Sewer Pipe	LF	180.00	356.00	64,080
Schedule A 24" Storm Sewer Pipe	LF	250.00	709.00	177,250
Connect to Existing Drainage Structure	EA	1,520.00	4.00	6,080
Reshape Ditch	LF	20.00	195.00	3,900
Roadway Restoration	SY	300.00	710.00	213,000
Storm Drain Catch Basin or Manhole	EA	3,730.00	11.00	41,030

Source: Puget Sound Drainages Basin Plan (December 2016)

Subtotal		713,330
Estimating and construction contingency	*50.0%*	356,665
Contractor overhead, profit, and mobilization	*13.0%*	139,099
Subtotal construction costs		**1,210,000**
Washington State sales tax (applied to all above)	*10.0%*	121,000
City Staff Time	*15.0%*	182,000
Pre-design Feasibility Study?	*No*	0
Administration, engineering design, permitting	*45.0%*	545,000
Land acquisition		
Total Capital Cost		**2,058,000**

Life-cycle cost estimate:

Design Life	2020	2037	2054	2071	2088	2105	2120
Renewal				0			
Disposal							129,000
Other							

**Net present value (NPV) based on an assumed discount rate of:* *2.0%*

Design life of project:			NPV* Total
Operating (annual from commission through design life)	-	*annually*	0
Maintenance (annual from commission through design life)	-	*annually*	0
Renewal (anticipated major repair not funded through maintenance)			0
Disposal (disposal of the asset at the end of the design life)			0
Other costs	-		0
Total Life-cycle Cost			**2,058,000**

PROJECT SUMMARY

PS-IMP-FM07

Lack of System and Ponding on 20th Avenue NW

Status: Not Started

Location: 20th Avenue NW near Richmond Beach Saltwater Park

Puget Sound Drainages

Capital Cost: $1,458,000

Improvement

Flood Mitigation

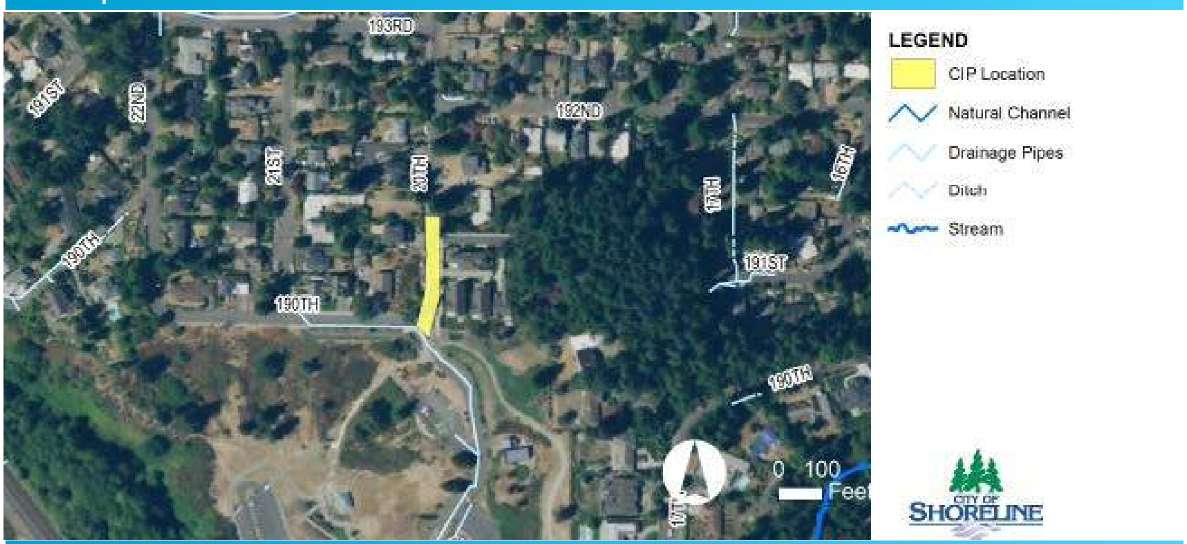
Overview

Flat slopes and lack of drainage infrastructure on 20th Avenue NW between NW 190th Street and NW 193rd Street contributes to ponding. This CIP includes constructing bioretention cells/rain gardens along 20th Avenue NW to reduce ponding by collecting and infiltrating flows. Additional bioretention cells/rain gardens could be added along NW 192nd Street and NW 193rd Street, but are not currently included in the cost estimate. Project addresses City Works service requests 341 and 2250.

Improvements: Construct bioretention areas/rain gardens along 20th Avenue NW to reduce ponding by collecting and infiltrating flows.

Benefits: Mitigate localized flooding of right-of-way.

Site Map



Implementation

Design, Construction, and Permitting Constraints/Concerns:

Bioretention swales are proposed on the east side of 20th Avenue NW, each located in a planter strip. Stormwater and pedestrian improvement projects should be coordinated. The design also includes six new catch basins and pipes to connect to the existing storm system on NW 190th Street. Traffic control is needed for installing bioretention swales. Geotechnical explorations are needed to verify infiltration rates. Potholing will be required to ensure that there are no conflicts with other utilities.

Risk/Consequence of Failure:

Right-of-way flooding.

Public Outreach:

Coordination with neighbors required.

Additional Notes:

Project recommended as PSB-CIP-9 in the Puget Sound Drainages Basin Plan (Alta Terra 2016).

PROJECT COST ESTIMATE

PS-IMP-FM07

Lack of System and Ponding on 20th Avenue NW

Status: Not Started

LOCATION: 20th Avenue NW near Richmond Beach Saltwater Park

Project Basin: Puget Sound Drainages

Capital Cost Estimate

Item	Unit	Unit Cost	Quantity	Cost
Water Pollution/Erosion Control	LS	21,320.00	1.00	21,320
Spill Prevention, Control, and Countermeasure (SPCC) plan	LS	510.00	1.00	510
Stormwater Pollution Prevention Plan (SWPPP)	LS	310.00	1.00	310
Traffic Control	LS	27,860.00	1.00	27,860
Excavation Including Haul	CY	40.00	308.00	12,320
Shoring or Extra Excavation Class B	SF	10.00	1,228.00	12,280
Gravel Bed Material	TN	40.00	151.00	6,040
Biofiltration Soil	CY	80.00	84.00	6,720
Geosynthetic Liner	SY	10.00	312.00	3,120
Potholing	EA	1,210.00	4.00	4,840
Removal of Structures and Obstructions	EA	2,020.00	2.00	4,040
Remove Road, Curb & Gutter, and Sidewalk	SY	160.00	381.00	60,960
Schedule A 12" Storm Sewer Pipe	LF	180.00	307.00	55,260
Storm Drain Catch Basin or Manhole	EA	4,030.00	6.00	24,180
Connect to Existing Drainage Structure	EA	1,520.00	2.00	3,040
Cement Conc. Traffic Curb and Gutter with Curb Cuts	LF	110.00	550.00	60,500
Roadway Restoration	SY	300.00	136.00	40,800
Hot Mix Asphalt (HMA) Cl. 1/2 in. PG 64-22	SY	70.00	1,587.00	111,090
Biofiltration Planting and Bioengineered Restoration	SY	90.00	244.00	21,960

Source: Puget Sound Drainages Basin Plan (December 2016)

Subtotal			477,150
Estimating and construction contingency		*50.0%*	238,575
Contractor overhead, profit, and mobilization		*13.0%*	93,044
Subtotal construction costs			**809,000**
Washington State sales tax (applied to all above)		*10.0%*	81,000
City Staff Time		*15.0%*	122,000
Pre-design Feasibility Study?	*Yes*	*10.0%*	81,000
Administration, engineering design, permitting		*45.0%*	365,000
Land acquisition			
Total Capital Cost			**1,458,000**

Life-cycle cost estimate:

Design Life	2020	2024	2028	2032	2036	2040	2040
Renewal				178,000			
Disposal							63,000
Other							

**Net present value (NPV) based on an assumed discount rate of:* *2.0%*

Design life of project:			NPV* Total
Operating (annual from commission through design life)	-	*annually*	0
Maintenance (annual from commission through design life)	*54,000*	*annually*	1,008,000
Renewal (anticipated major repair not funded through maintenance)			135,000
Disposal (disposal of the asset at the end of the design life)			0
Other costs	-		0
Total Life-cycle Cost			**2,601,000**

PROJECT SUMMARY

SC-IMP-AM01

Stormwater Upgrades NW 196th Street

Status: Not Started

Location: 5th Avenue NW between NW 195th Street and NW 196th Street

Storm Creek

Capital Cost: $146,000

Improvement

Asset Management

Overview

This project includes replacing the pipe beneath the intersection of NW 196th Street and 5th Avenue NW along with providing a new stormwater conveyance system along 5th Avenue between 195th and 196th. There is currently no formal stormwater system to convey runoff from 197th Street, 196th Street, and 5th Avenue downstream.

Improvements: Replace the pipe underneath the intersection of Northwest 196th Street and 5th Avenue Northwest, and provide a new stormwater conveyance system along 5th Avenue between 196th Street and 197th Street.

Benefits: This project would provide formal stormwater infrastructure where none currently exists, and where the condition assessment indicated a pipe in need of replacement.

Site Map

Implementation

Design, Construction, and Permitting Constraints/Concerns:

520 linear feet of 12-inch-diameter storm drain, two stormwater structures, and roadway restoration.

Risk/Consequence of Failure:

Public Outreach:

Additional Notes:

Project recommended in Storm Creek Basin Plan (Windward 2013).

PROJECT COST ESTIMATE

SC-IMP-AM01

Stormwater Upgrades NW 196th Street

Status: Not Started

LOCATION: 5th Ave NW between NW 195th St. and NW 196th St.

Project Basin: Storm Creek

Capital Cost Estimate

Item	Unit	Unit Cost	Quantity	Cost
Open Cut Storm Drain New or Replaced (PVC, 12-in diameter pipe)	LF	40.00	520.00	20,800
Storm Drain Catch Basin or Manhole	LS	4,550.00	2.00	9,100
Roadway Improvement/ Pavement Patching	SY	70.00	250.00	17,500
Traffic Control	LS	2,280.00	1.00	2,280

Source: Storm Creek Basin Plan (March 2013)

Subtotal		49,680
Estimating and construction contingency	50.0%	24,840
Contractor overhead, profit, and mobilization	13.0%	9,688
Subtotal construction costs		**85,000**
Washington State sales tax (applied to all above)	10.0%	9,000
City Staff Time	15.0%	13,000
Pre-design Feasibility Study?	No	0
Administration, engineering design, permitting	45.0%	39,000
Land acquisition		
Total Capital Cost		**146,000**

Life-cycle cost estimate:

Design Life	2020	2037	2054	2071	2088	2105	2120
Renewal				0			
Disposal							158,000
Other							

**Net present value (NPV) based on an assumed discount rate of: 2.0%*

Design life of project:			NPV* Total
Operating (annual from commission through design life)	-	annually	0
Maintenance (annual from commission through design life)	-	annually	0
Renewal (anticipated major repair not funded through maintenance)	-		0
Disposal (disposal of the asset at the end of the design life)			0
Other costs	-		0
Total Life-cycle Cost			**146,000**

PROJECT SUMMARY

SC-IMP-WQ01

Convert Stormwater Conveyance Ditches to Bioinfiltration Facilities

Status: Not Started

Location: Ditches along 8th Avenue NW and 10th Avenue NW

Storm Creek

Capital Cost: $1,178,000

Improvement

Water Quality Improvement

Overview

his project involves converting roadside drainage ditches into biofiltration facilities. There are several roads in the Storm Creek basin, including 8th Avenue NW and 10th Avenue NW, where drainage is conveyed beneath driveways by a series of ditches and cross culverts. These roads are relatively flat and have existing issues with ditch filling and/or flooding. These areas may be appropriate for conversion into roadside biofiltration facilities, which would provide water quality and quantity benefits.

Improvements: Convert roadside ditches in flat areas that have existing issues with ditch filling and or flooding into roadside biofiltration facilities.

Benefits: Reduced flow to downstream stormwater infrastructure and Storm Creek and improved water quality.

Site Map

Implementation

Design, Construction, and Permitting Constraints/Concerns:

Further investigation is required to determine how roadside biofiltration swales would function at the locations that could benefit from this modification.

Risk/Consequence of Failure:

Public Outreach:

Necessary for work affecting driveways.

Additional Notes:

Project recommended as ST-CIP-2 in Storm Creek Basin Plan (Windward 2013). It would be important to get the approval of adjacent property owners for this project to be successful.

PROJECT COST ESTIMATE

SC-IMP-WQ01

Convert Stormwater Conveyance Ditches to Bio-infiltration Facilities

Status: Not Started

LOCATION: Ditches along 8th Avenue NW and 10th Avenue NW   Project Basin: Storm Creek

Capital Cost Estimate

Item	Unit	Unit Cost	Quantity	Cost
Conversion of Ditches into Bio-infiltration Swales	LF	230.00	1,775.00	408,250

Source: Storm Creek Basin Plan (March 2013) Subtotal		408,250
Estimating and construction contingency	*50.0%*	204,125
Contractor overhead, profit, and mobilization	*13.0%*	79,609
Subtotal construction costs		**692,000**
Washington State sales tax (applied to all above)	*10.0%*	70,000
City Staff Time	*15.0%*	104,000
Pre-design Feasibility Study? *No*		0
Administration, engineering design, permitting	*45.0%*	312,000
Land acquisition		
Total Capital Cost		**1,178,000**

Life-cycle cost estimate:

Design Life	*2020*	*2024*	*2028*	*2032*	*2036*	*2040*	*2040*
Renewal				153,000			
Disposal							537,000
Other							

**Net present value (NPV) based on an assumed discount rate of:* *2.0%*

Design life of project:			NPV* Total
Operating (annual from commission through design life)	-	*annually*	0
Maintenance (annual from commission through design life)	*46,000*	*annually*	859,000
Renewal (anticipated major repair not funded through maintenance)			116,000
Disposal (disposal of the asset at the end of the design life)			0
Other costs	-		0
Total Life-cycle Cost			**2,153,000**

PROJECT SUMMARY

SC-STU-EC01

Storm Creek Erosion Management Study

Status: Not Started

Location: Storm Creek Basin

Storm Creek

Capital Cost: $80,000

Study

Erosion Control

Overview

This project will investigate solutions to manage ongoing erosion issues within lower Storm Creek.

Improvements: Evaluate options to manage erosion within lower Storm Creek.

Benefits: Manage erosion within lower Storm Creek.

Site Map

Implementation

Design, Construction, and Permitting Constraints/Concerns:

Risk/Consequence of Failure:

Public Outreach:

Additional Notes:

Loosely combines ST-Study-2 and ST-Study-3 from the Storm Creek Basin Plan, which sought to evaluate approaches to reduce peak flows in Storm Creek.

PROJECT COST ESTIMATE

SC-STU-EC01

Storm Creek Erosion Management Feasibility Study

Status: Not Started

LOCATION: City-wide **Project Basin: Storm Creek**

Capital Cost Estimate

Item	Unit	Unit Cost	Quantity	Cost

Source: Brown and Caldwell Cost Estimate

Subtotal			0
Estimating and construction contingency		*0.0%*	0
Contractor overhead, profit, and mobilization		*0.0%*	0
Subtotal construction costs			**0**
Washington State sales tax (applied to all above)		*0.0%*	0
City Staff Time		*0.0%*	0
Pre-design Feasibility Study?	*Yes*	*10.0%*	80,000
Administration, engineering design, permitting		*0.0%*	0
Land acquisition			
Total Capital Cost			**80,000**

Life-cycle cost estimate:

Design Life	*2020*	*2024*	*2028*	*2032*	*2036*	*2040*	*2040*
Renewal				0			
Disposal							0
Other							

**Net present value (NPV) based on an assumed discount rate of:* *2.0%*

Design life of project:			NPV* Total
Operating (annual from commission through design life)	-	*annually*	0
Maintenance (annual from commission through design life)	-	*annually*	0
Renewal (anticipated major repair not funded through maintenance)			0
Disposal (disposal of the asset at the end of the design life)			0
Other costs	-		0
Total Life-cycle Cost			**80,000**

Brown AND Caldwell

PROJECT SUMMARY

TC-IMP-AH01

Hamlin Creek Daylighting

Status: Not Started

Location: Hamlin Creek: Fircrest Campus and S of Fircrest Campus along 20th Avenue NE

Thornton Creek Basin

Capital Cost: $1,611,000

Improvement

Aquatic Habitat Enhancement

Overview

Hamlin Creek has a high proportion of piped stream length and little vegetative cover along ditched portions extending southwater from Fircrest Campus along 20th Avenue NE. The project would seek daylighting of Hamlin Creek on state-owned Fircrest property as part of the state's master planning process, and stream channel improvements on the City-owned ditch sections south of campus. This would increase the habitat and stream function along Hamlin Creek.

Improvements: Construct better defined stream channel by adding large woody debris, gravel, and stabilize banks. Plant the native riparian vegetation and daylight sections of upper Hamlin Creek which are now conveyed mostly in piped systems.

Benefits: On-site habitat improvements for terrestrial and amphibious wildlife; downstream water quality and quantity benefits for fish and other aquatic wildlife in Thornton Creek farther downstream in perennial reaches.

Site Map

Implementation

Design, Construction, and Permitting Constraints/Concerns:

Project would involve the daylighting of sections of Hamlin Creek on state property as part of the master planning process for the Fircrest Campus. As such, a cost estimate will likely eventually be developed as part of that process, and implementation would be financed as part of the redevelopment of the campus and so should not require funding from the City of Shoreline.

Risk/Consequence of Failure:

Public Outreach:

Additional Notes:

Project recommended as ThCr-AQ10 in Thornton Creek Basin Plan (R.W. Beck 2009).

PROJECT COST ESTIMATE

TC-IMP-AH01

Hamlin Creek Daylighting

Status: Not Started

LOCATION: Hamlin Creek: Fircrest Campus and S of Fircrest Campus along 20th

Project Basin: Thornton Creek

Capital Cost Estimate

Item	Unit	Unit Cost	Quantity	Cost
Clearing and Grubbing	AC	4,020.00	2.00	8,040
Access	LS	12,170.00	1.00	12,170
Traffic Control	LS	12,170.00	1.00	12,170
Erosion and Sedimentation Control	LS	12,170.00	1.00	12,170
Control of Water	LS	9,740.00	1.00	9,740
Excavation for Stream Daylighting	CY	10.00	800.00	8,000
Utilities and Infrastructure - Driveways, Culverts, Storm Drains, Water Sewer,	LS	121,670.00	1.00	121,670
Log Structure Placement	EA	1,100.00	20.00	22,000
Substrate Placement/ Channel Formation	CY	70.00	120.00	8,400
Hand Removal of Non-Native Vegetation	SF	10.00	15,000.00	150,000
Topsoil Supplementation	CY	60.00	100.00	6,000
Native Revegetation	SF	10.00	15,000.00	150,000
Interpretive Signage	EA	1,530.00	2.00	3,060
Miscellaneous Items	LS	24,340.00	1.00	24,340

Source: Thornton Creek Basin Plan (November 2009):

Subtotal		547,760
Estimating and construction contingency	50.0%	273,880
Contractor overhead, profit, and mobilization	13.0%	106,813
Subtotal construction costs		**929,000**
Washington State sales tax (applied to all above)	10.0%	93,000
City Staff Time	15.0%	140,000
Pre-design Feasibility Study?	No	0
Administration, engineering design, permitting	45.0%	419,000
Land acquisition		30,000
Total Capital Cost		**1,611,000**

Life-cycle cost estimate:

Design Life	2020	2037	2054	2071	2088	2105	2120
Renewal				409,000			
Disposal							164,000
Other							

**Net present value (NPV) based on an assumed discount rate of: 2.0%*

Design life of project:			NPV* Total
Operating (annual from commission through design life)	-	annually	0
Maintenance (annual from commission through design life)	6,000	annually	264,000
Renewal (anticipated major repair not funded through maintenance)			144,000
Disposal (disposal of the asset at the end of the design life)			0
Other costs	-		0
Total Life-cycle Cost			**2,019,000**

PROJECT SUMMARY

TC-IMP-AH02

Thornton Creek Course-Grained Sediment Improvements

Status: Not Started

Location: Thornton Creek

Thornton Creek Basin

Capital Cost: $55,000

Improvement

Aquatic Habitat Enhancement

Overview

Much of the Thornton Creek watershed lacks the instream structure supplied by course grained floodplain sediment. To reap the stream/habitat enhancements afforded by a system with a sufficient amount of coarse grained sediment, a number steps are suggested. These include: 1) Reduce bank armoring and streambed grade controls where feasible, 2) Allow stream access to floodplain gravel through channel migration, 3) Provide in-stream structure to catch and accumulate sediment, and 4) Introduce additional gravel supply to sections of the stream that are sediment-starved and/or at locations where such gravel would be effectively distributed downstream.

Improvements: This project includes building infrastructures to manage floodplain sediments.

Benefits: Stream/ habitat enhancement; neighborhood aesthetic.

Site Map

Implementation

Design, Construction, and Permitting Constraints/Concerns:

It should be noted that lower-gradient, headwater stream segments such as those that flow through marshy areas would not naturally be lined with such coarse-grained sediments (gravel) and it would not be appropriate to artificially supply gravel to those areas. In-stream improvements would require permits from the Corps, Ecology, WDFW, and the City of Shoreline.

Risk/Consequence of Failure:

Public Outreach:

Additional Notes:

Project recommended as ThCr-AQ11 in Thornton Creek Basin Plan (R.W. Beck 2009).

PROJECT COST ESTIMATE

TC-IMP-AH02

Thornton Creek Course-Grained Sediment Improvements

Status: Not Started

LOCATION: Thornton Creek

Project Basin: Thornton Creek

Capital Cost Estimate

Item	Unit	Unit Cost	Quantity	Cost
Access	LS	6,090.00	1.00	6,090
Traffic Control	LS	610.00	1.00	610
Substrate Placement/ Channel Formation	CY	70.00	100.00	7,000
Miscellaneous Items	LS	1,220.00	1.00	1,220

Source: Thornton Creek Basin Plan (November 2009):

Subtotal		14,920
Estimating and construction contingency	*50.0%*	7,460
Contractor overhead, profit, and mobilization	*13.0%*	2,909
Subtotal construction costs		**26,000**
Washington State sales tax (applied to all above)	*10.0%*	3,000
City Staff Time	*15.0%*	4,000
Pre-design Feasibility Study?	*No*	0
Administration, engineering design, permitting	*45.0%*	12,000
Land acquisition		10,000
Total Capital Cost		**55,000**

Life-cycle cost estimate:

Design Life	2020	2037	2054	2071	2088	2105	2120
Renewal				12,000			
Disposal							21,000
Other							

**Net present value (NPV) based on an assumed discount rate of:* *2.0%*

Design life of project:			NPV* Total
Operating (annual from commission through design life)	-	*annually*	0
Maintenance (annual from commission through design life)	*1,000*	*annually*	44,000
Renewal (anticipated major repair not funded through maintenance)			5,000
Disposal (disposal of the asset at the end of the design life)			0
Other costs	-		0
Total Life-cycle Cost			**104,000**

PROJECT SUMMARY

TC-IMP-AH03

Enhance Ronald Bog Wetland Fringe Areas

Status: Not Started

Location: Ronald Bog Park and adjacent wetlands area

Thornton Creek Basin

Capital Cost: $2,826,000

Improvement

Aquatic Habitat Enhancement

Overview

Wetland and buffer areas along the east edge of the park are infested with invasive Himalayan blackberry, lack a diverse native plant assemblage, and habitat structures. The project as envisioned would include excavation as needed to provide wetland hydrology to approximately an additional acre of area that is now upland or only marginal wetland; enhance and restore the inlet stream channel as fish and wildlife habitat, including the placement of log structures; remove existing non-native vegetation including Himalayan blackberry, knotweed, and nightshade; supplement topsoils; and implement a native revegetation plan.

Improvements: Excavate to enhance wetland hydrology; enhance and restore the inlet stream channel, including placement of log structures; remove existing non-native vegetation; supplement topsoils; and implement a native revegetation plan.

Benefits: Wetland/habitat enhancement.

Site Map

Implementation

Design, Construction, and Permitting Constraints/Concerns:

Enhancement of wetland fringe areas around Ronald Bog, including extensive excavation and stream channel improvements, would require permits from the Corps, Ecology, WDFW, and the City of Shoreline.

Risk/Consequence of Failure:

Public Outreach:

Additional Notes:

Project recommended as ThCr-AQ2 in Thornton Creek Basin Plan (R.W. Beck 2009).

PROJECT COST ESTIMATE

TC-IMP-AH03

Enhance Ronald Bog Wetland Fringe Areas

Status: Not Started

LOCATION: Ronald Bog Park, adjacent wetlands

Project Basin: Thornton Creek

Capital Cost Estimate

Item	Unit	Unit Cost	Quantity	Cost
Clearing and Grubbing	AC	4,020.00	1.00	4,020
Access	LS	1,220.00	1.00	1,220
Traffic Control	LS	610.00	1.00	610
Erosion and Sedimentation Control	LS	3,650.00	1.00	3,650
Control of Water	LS	3,650.00	1.00	3,650
Excavation Including Haul	CY	20.00	1,500.00	30,000
Log Structure Placement	EA	1,100.00	10.00	11,000
Substrate Placement/ Channel Formation	CY	70.00	60.00	4,200
Hand Removal of Non-Native Vegetation	SF	0.35	50,000.00	17,500
Topsoil Supplementation	CY	60.00	150.00	9,000
Native Revegetation	SF	10.00	85,000.00	850,000
Irrigation	SF	0.40	85,000.00	34,000
Interpretive Signage	EA	1,530.00	3.00	4,590
Miscellaneous Items	LS	6,090.00	1.00	6,090

Source: Thornton Creek Basin Plan (November 2009):

Subtotal		979,530
Estimating and construction contingency	*50.0%*	489,765
Contractor overhead, profit, and mobilization	*13.0%*	191,008
Subtotal construction costs		**1,661,000**
Washington State sales tax (applied to all above)	*10.0%*	167,000
City Staff Time	*15.0%*	250,000
Pre-design Feasibility Study? *No*		0
Administration, engineering design, permitting	*45.0%*	748,000
Land acquisition		
Total Capital Cost		**2,826,000**

Life-cycle cost estimate:

Design Life	2020	2037	2054	2071	2088	2105	2120
Renewal				334,000			
Disposal							307,000
Other							

**Net present value (NPV) based on an assumed discount rate of:* 2.0%

Design life of project:			NPV* Total
Operating (annual from commission through design life)	-	*annually*	0
Maintenance (annual from commission through design life)	*165,000*	*annually*	7,254,000
Renewal (anticipated major repair not funded through maintenance)			117,000
Disposal (disposal of the asset at the end of the design life)			0
Other costs	-		0
Total Life-cycle Cost			**10,197,000**

PROJECT SUMMARY

TC-IMP-AM01

Pump Station 30 Upgrades

Status: Not Started

Location: NE 170th and 15th Avenue NE

Thornton Creek Basin

Capital Cost: $339,000

Improvement

Asset Management

Overview

A condition assessment of the City's storm pump stations was completed by Kennedy/Jenks in June 2016 in which major overhaul of Pump Station 30 was recommended because this pump station is past its useful life. Consider adding redundancy in the system and expanding access around the pump station.

Improvements: Demolish and rebuild station, reuse existing wetwell, add SCADA, and add info signs. Kennedy/Jenks recommended contacting Puget Sound Energy to upgrade the electrical service/transformer when the station is upgraded.

Benefits: Extended life and improved reliability.

Site Map

Implementation

Design, Construction, and Permitting Constraints/Concerns:
Discuss upgrade to 480 V service with PSE. Replace hatch (heavy, lacks access and safety measures).

Risk/Consequence of Failure:

Public Outreach:

Additional Notes:
See Stormwater Pump Station Condition and Capacity Assessement for more details (Kennedy/Jenks 2016).

PROJECT COST ESTIMATE

TC-IMP-AM01

Pump Station 30 upgrades

Status: Not Started

LOCATION: NE 170th and 15th Ave NE

Project Basin: Thornton Creek

Capital Cost Estimate

Item	Unit	Unit Cost	Quantity	Cost
SCADA	LS	2,500.00	1.00	2,500
New Electrical/ Enclosure Demo Building/ Top Slab/ Pumps/ Valves New Top Slab and Hatch Gabion Wall (to increase O&M work area around existing wet well) New Submersible Pumps, Valves and Valve Vault	LS	114,650.00	1.00	114,650

Source: Shoreline Pump Station Condition and Capacity Assessment (June 2016)

Subtotal		117,150
Estimating and construction contingency	*50.0%*	58,575
Contractor overhead, profit, and mobilization	*13.0%*	22,844
Subtotal construction costs		**199,000**
Washington State sales tax (applied to all above)	*10.0%*	20,000
City Staff Time	*15.0%*	30,000
Pre-design Feasibility Study?	*No*	0
Administration, engineering design, permitting	*45.0%*	90,000
Land acquisition		
Total Capital Cost		**339,000**

Life-cycle cost estimate:

Design Life	2020	2029	2038	2047	2056	2065	2070
Renewal				0			
Disposal							0
Other							

**Net present value (NPV) based on an assumed discount rate of: 2.0%*

Design life of project:		NPV* Total
Operating (annual from commission through design life)	*annually*	0
Maintenance (annual from commission through design life)	*annually*	0
Renewal (anticipated major repair not funded through maintenance)		0
Disposal (disposal of the asset at the end of the design life)		0
Other costs		0
Note: Life cycle costs were not available for pump stations at the time of the analysis	**Total Life-cycle Cost**	**339,000**

PROJECT SUMMARY

TC-IMP-FM01

12th Avenue NE Infiltration Pond Retrofits

Status: Not Started

Location: 12th Avenue NE between NE 170th Street and NE 175th Street

Thornton Creek Basin

Capital Cost: $677,000

Improvement

Flood Mitigation

Overview

Solve the flooding problems associated with a 25-year event by installing a trench infiltration system and making improvements to the existing infiltration facility. The solution includes installing an overflow structure on 12th Avenue NE where the existing storm drainage discharges into backyards between NE 170th and NE 175th streets and 11th and 12th avenues NE. The overflow structure would maintain water quality flows along the existing path; however, high flows would be diverted into an infiltration trench that would extend south along 12th Avenue NE. This overflow structure could be oversized to act as a sediment trap to capture sediment prior to discharging flow to the infiltration trench. An infiltration trench is proposed to take advantage of the outwash soils in the area.

Improvements: Install trench infiltration system, overflow structure, and sediment trap to address flooding problems.

Benefits: Flood reduction/prevention.

Site Map

Implementation

Design, Construction, and Permitting Constraints/Concerns:
Clean out the bottom of the existing infiltration facility to remove sediment buildup and reestablish grading.

Risk/Consequence of Failure:
Residential flooding from NE 170th Street to NE 175th Street between 13th Avenue NE and 12th Avenue NE (17021, 17029, and 17042 11th avenues NE).

Public Outreach:
Likely advisable/needed for neighboring affected residents.

Additional Notes:
Project recommended as ThCr-F2 in the Thornton Creek Basin Plan (R.W. Beck 2009). This project corresponds to Alternative 2.

PROJECT COST ESTIMATE

TC-IMP-FM01

12th Ave NE Infiltration Pond Retrofits

Status: Not Started

LOCATION: 12th Ave NE between NE 170th St and NE 175th St

Project Basin: Thornton Creek

Capital Cost Estimate

Item	Unit	Unit Cost	Quantity	Cost
Clearing and Grubbing	LS	2,440.00	1.00	2,440
Excavation Including Haul	CY	20.00	133.00	2,660
18" Diameter Smooth Interior Wall Corrugated Polyethylene	LF	70.00	1,160.00	81,200
Washed Drain Rock	TN	40.00	804.00	32,160
Catch Basin Type 2 48"	EA	3,580.00	2.00	7,160
Catch Basin Type 2 54"	EA	4,600.00	4.00	18,400
Flow Control Structure, 54-in	EA	7,430.00	1.00	7,430
Asphalt Concrete Pavement Patching	TN	130.00	161.00	20,930
Control of Water	LS	18,250.00	1.00	18,250
Traffic Control	LS	9,740.00	1.00	9,740
Temporary Erosion and Sediment Control	LS	14,600.00	1.00	14,600
Miscellaneous Items	LS	6,090.00	1.00	6,090

Source: Thornton Creek Basin Plan (November 2009):

Subtotal		221,060
Estimating and construction contingency	*50.0%*	110,530
Contractor overhead, profit, and mobilization	*13.0%*	43,107
Subtotal construction costs		**375,000**
Washington State sales tax (applied to all above)	*10.0%*	38,000
City Staff Time	*15.0%*	57,000
Pre-design Feasibility Study? *Yes*	*10.0%*	38,000
Administration, engineering design, permitting	*45.0%*	169,000
Land acquisition		
Total Capital Cost		**677,000**

Life-cycle cost estimate:

Design Life	*2020*	*2024*	*2028*	*2032*	*2036*	*2040*	*2040*
Renewal				124,000			
Disposal							28,000
Other							

**Net present value (NPV) based on an assumed discount rate of:* *2.0%*

Design life of project:			NPV* Total
Operating (annual from commission through design life)	-	*annually*	0
Maintenance (annual from commission through design life)	*17,000*	*annually*	318,000
Renewal (anticipated major repair not funded through maintenance)			94,000
Disposal (disposal of the asset at the end of the design life)			0
Other costs	-		0
Total Life-cycle Cost			**1,089,000**

PROJECT SUMMARY

TC-IMP-FM03

Culvert Improvements Near 14849 12th Avenue NE

Status: Not Started

Location: 14849 & 15021 12th Ave NE

Thornton Creek Basin

Capital Cost: $347,000

Improvement

Flood Mitigation

Overview

Littles Creek experiences localized flooding between two residences. The creek exits a culvert and turns west 90 degrees between the two proporties toward the Paramount Park Open Space. The project proposes to excavate the channel to improve conveyance capacity with a sump to trap sediment. The recommended solution for this flooding problem is to excavate the channel to improve capacity, using the recommendations in Alternative 2 of the Preliminary Study of Flooding Problems at 14849 12th Avenue NE (Otak 2001).

Improvements: As part of this project, rock walls will be maintained and constructed. Also, a 20x8x5 cubic feet deep sump is proposed at the exit of the culvert at 12th Avenue NE to allow for sedimentation.

Benefits: Flood reduction/prevention, stream/habitat restoration and enhancement. Improvement of neighborhood aesthetic.

Site Map

Implementation

Design, Construction, and Permitting Constraints/Concerns:

Littles Creek is likely to be considered a Type IV stream by the City of Shoreline. Type IV streams require a standard buffer width of 35 feet. Alterations (including dredging) to Type IV streams are not authorized by the City of Shoreline and thus a Critical Areas Special Use Permit exception would likely be required to allow for the proposed dredging.

Risk/Consequence of Failure:

Localized residential flooding.

Public Outreach:

Additional Notes:

Project recommended as ThCr-F4 in Thornton Creek Basin Plan (R.W. Beck 2009).

PROJECT COST ESTIMATE

TC-IMP-FM03

Culvert Improvements Near 14849 12th Avenue NE

Status: Not Started

LOCATION: 14849 & 15021 12th Ave NE

Project Basin: Thornton Creek

Capital Cost Estimate

Item	Unit	Unit Cost	Quantity	Cost
Clearing and Grubbing	AC	4,020.00	0.15	603
Excavation Including Haul	CY	20.00	200.00	4,000
Temporary Stream Diversion	LS	30,420.00	1.00	30,420
Streambed Gravel	CY	70.00	150.00	10,500
Riparian Planting	AC	60,840.00	0.31	18,860
Boulders	AC	70.00	56.00	3,920
Traffic Control	LS	14,600.00	1.00	14,600
Temporary Erosion and Sediment Control	LS	24,340.00	1.00	24,340
Miscellaneous Items	LS	12,170.00	1.00	12,170

Source: Thornton Creek Basin Plan (November 2009):

Subtotal		119,413
Estimating and construction contingency	*50.0%*	59,707
Contractor overhead, profit, and mobilization	*13.0%*	23,286
Subtotal construction costs		**203,000**
Washington State sales tax (applied to all above)	*10.0%*	21,000
City Staff Time	*15.0%*	31,000
Pre-design Feasibility Study?	*No*	0
Administration, engineering design, permitting	*45.0%*	92,000
Land acquisition		
Total Capital Cost		**347,000**

Life-cycle cost estimate:

Design Life	2020	2037	2054	2071	2088	2105	2120
Renewal				90,000			
Disposal							41,000
Other							

**Net present value (NPV) based on an assumed discount rate of: 2.0%*

Design life of project:			NPV* Total
Operating (annual from commission through design life)	-	*annually*	0
Maintenance (annual from commission through design life)	*2,000*	*annually*	88,000
Renewal (anticipated major repair not funded through maintenance)			32,000
Disposal (disposal of the asset at the end of the design life)			0
Other costs	-		0
Total Life-cycle Cost			**467,000**

PROJECT SUMMARY

TC-IMP-FM04

10th Avenue NE Stormwater Improvements

Status: Pending

Location: 10th Avenue NE between NE 175th Street and NE 165 Street

Thornton Creek Basin

Capital Cost: $1,788,000

Improvement

Flood Mitigation

Overview

This project will improve water quality and drainage capacity along 10th Avenue NE between NE 165th Street and NE 175th Street, a headwater area for Little's Creek. The improvements will address a ditch-and-culvert and piped storm drain system that runs approximately one 0.5-mile along 10th Avenue NE between NE 175th Street and NE 165th Street. Average slope from 175th to 165th is flat (less than 1 percent), portions of the existing system are negatively sloped, and pipes are typically undersized. System capacity is regularly exceeded, leading to flooding of the 10th Ave NE roadway, shoulder, dirveways, and some downslope private properties to the east.

Improvements: Convert up to 1,000 linear feet of conveyance to bioretention and infiltration facilities to convey runoff from 21 acres in addition to high flows from a heavily developed 65-acre contributing area of the North City businesss district.

Benefits: Flood mitigation; water quality improvement.

Site Map

Implementation

Design, Construction, and Permitting Constraints/Concerns:

Initially secured $250k for pre-construction activities through Ecology, which was delayed. Upon re-application for an Ecology grant in 2016, funding was made available in the upcoming budget. Confirmation of this funding will become clearer in late 2017.

Risk/Consequence of Failure:

Public Outreach:

Additional Notes:

Project based on the Thornton Creek Basin Plan (R.W. Beck 2009) that recommended larger-scale detention and conveyance improvements, which were not programmed for implementation because of expected high costs (City 2009). Upon further surveying of the area in 2014, alternative recommendations were made to improve drainage by adding infiltration and/or bioretention features.

PROJECT COST ESTIMATE

TC-IMP-FM04

10th Ave NE Stormwater Improvements

Status: Pending

LOCATION: 10th Ave NE between NE 175th St and NE 165 St

Project Basin: Thornton Creek

Capital Cost Estimate

Item	Unit	Unit Cost	Quantity	Cost
24" Diameter Smooth Interior Wall Corrugated Polyethylene	LF	100.00	2,872.00	287,200
Catch Basin Type 2 48"	EA	3,580.00	15.00	53,700
Roadside Planting/ Landscaping	SY	40.00	3,191.00	127,640
Asphalt Concrete Pavement Patching	TN	130.00	464.00	60,320
Control of Water	LS	18,250.00	1.00	18,250
Traffic Control	LS	18,250.00	1.00	18,250
Temporary Erosion and Sediment Control	LS	12,170.00	1.00	12,170
Miscellaneous Items	LS	12,170.00	1.00	12,170
Plant Establishment Monitoring and Management/Maintenance	LS	30,000.00	1.00	30,000

Source: Thornton Creek Basin Plan (November 2009):

Subtotal		619,700
Estimating and construction contingency	*50.0%*	309,850
Contractor overhead, profit, and mobilization	*13.0%*	120,842
Subtotal construction costs		**1,051,000**
Washington State sales tax (applied to all above)	*10.0%*	106,000
City Staff Time	*15.0%*	158,000
Pre-design Feasibility Study?	*No*	0
Administration, engineering design, permitting	*45.0%*	473,000
Land acquisition		
Total Capital Cost		**1,788,000**

Life-cycle cost estimate:

Design Life	2020	2037	2054	2071	2088	2105	2120
Renewal				0			
Disposal							869,000
Other							

**Net present value (NPV) based on an assumed discount rate of: 2.0%*

Design life of project:			NPV* Total
Operating (annual from commission through design life)	-	*annually*	0
Maintenance (annual from commission through design life)	-	*annually*	0
Renewal (anticipated major repair not funded through maintenance)			0
Disposal (disposal of the asset at the end of the design life)			0
Other costs	-		0
Total Life-cycle Cost			**1,788,000**

PROJECT SUMMARY

TC-IMP-FM05

NE 148th Street Infiltration Facilities

Status: Ongoing

Location: NE 148th Street between 12th Avenue and 15th Avenue NE

Thornton Creek Basin

Capital Cost: $393,000

Improvement

Flood Mitigation

Overview

Storm drainage infrastructure on NE 148th Street between 12th Avenue and 15th Avenue NE currently consists of a single catch basin located on the south side of the street, approximately 200 feet west of 15th Avenue NE. This catch basin apparently has no outlet, dispersing inflows by infiltration alone, and is easily overwhelmed by runoff. The existing storm drainage configuration leads to frequent ponding within large areas on both sides of NE 148th Street. This project will use an innovative approach using LID stormwater facilities to improve drainage and reduce flooding, while also protecting Little's Creek from urban runoff.

Improvements: Construct LID facilities, such as bioretention surfaces, in conjunction with gravel or asphalt surfaces to allow continued use of shoulder parking in selected areas.

Benefits: Flood mitigation; water quality improvement.

Site Map

Implementation

Design, Construction, and Permitting Constraints/Concerns:

Initially secured $290k for pre-construction activities through Ecology, which was delayed. Upon re-application for an Ecology grant in 2016, funding was made available in the upcoming budget. Confirmation of this funding will become clearer in late 2017.

Risk/Consequence of Failure:

Public Outreach:

Additional Notes:

Design on hold pending Washington State Department of Ecology grant funding. Design is approximately 95 percent complete, so once funding is secured the project should be construction-ready shortly thereafter. Cost estimates are based on 90 percent design estimate completed by SvR Design in 2014).

PROJECT COST ESTIMATE

TC-IMP-FM05

NE 148th Street Infiltration Facilities

Status: Ongoing

LOCATION: NE 148th St between 12th and 15th Ave NE

Project Basin: Thornton Creek

Capital Cost Estimate

Item	Unit	Unit Cost	Quantity	Cost
Construction Surveying, Mobilization, and Utility Conflicts	LS	45,197.00	1.00	45,197
Unforeseen Private Property Interface Issues	LS	7,500.00	1.00	7,500
Project Temorary Traffic Control and Clearing and Grubbing	LS	7,800.00	1.00	7,800
Removal of Structure and Obstruction	LS	21,900.00	1.00	21,900
Ditch Excavation Including Haul	CY	20.00	1,106.00	22,120
Crushed Surfacing Top Course	TN	30.00	15.20	456
Asphalt Treated Base and HMA Cl. B	LS	7,507.00	1.00	7,507
Permeable Gravel Paving System and Base Course	LS	23,263.00	1.00	23,263
8" DI Storm Sewer Pipe	LF	80.00	56.00	4,480
Catch Basin Type 1 with frame and grate	EA	2,000.00	8.00	16,000
Modular Stacking, Infiltration System	LS	138,408.00	1.00	138,408
Maintenance Ports - Modular Stacking, Infiltration System	EA	500.00	24.00	12,000
Erosion/Water Pollution Control and SPCC	LS	7,500.00	1.00	7,500
Bioretention Soil Mix and Arborist Wood Chips Mulch	LS	6,543.00	1.00	6,543
PSIPE (5gal, 2 gal, 1 gal, and 10 in tubes or 4" pots)	LS	14,052.00	1.00	14,052
Subgrade Prep. For Planting Areas and Tree Protection Fence	LS	12,625.00	1.00	12,625
Asphalt Thickened Edge	LF	10.00	556.00	5,560
Mailbox Support	EA	400.00	1.00	400
Gravel Backfill for Drains	CY	67.00	22.40	1,501
1/4" Minus Crushed Surfacing	CY	67.00	28.00	1,876

Source: SvR Design Company (2014)

Subtotal		356,688
Estimating and construction contingency	*10.0%*	35,669
Contractor overhead, profit, and mobilization	*0.0%*	0
Subtotal construction costs		**393,000**
Washington State sales tax (applied to all above)	*0.0%*	0
City Staff Time	*0.0%*	0
Pre-design Feasibility Study?	*No*	0
Administration, engineering design, permitting	*0.0%*	0
Land acquisition		
Total Capital Cost		**393,000**

Life-cycle cost estimate:

Design Life	2020	2024	2028	2032	2036	2040	2040
Renewal				79,000			
Disposal							226,000
Other							

**Net present value (NPV) based on an assumed discount rate of: 2.0%*

Design life of project:			NPV* Total
Operating (annual from commission through design life)	-	*annually*	0
Maintenance (annual from commission through design life)	*24,000*	*annually*	448,000
Renewal (anticipated major repair not funded through maintenance)			60,000
Disposal (disposal of the asset at the end of the design life)			0
Other costs	-		0
Total Life-cycle Cost			**901,000**

D-6 Project Prioritization

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Level of Service (LOS)			Prioritization					
Expectations	Targets	Performance Measures	Criteria	Scoring: 0	Scoring: 1	Scoring: 2	Weighting Factor	Maximum Scores
Manage public health, safety and environmental risks from impaired water quality, flooding, and failed infrastructure	**A. Flooding and Erosion** No verifiable health and safety issues or environmental damage caused by flooding or erosion outside of an accepted risk tolerance	**A.1 System Capacity** The capacity of the drainage system to capture, convey, store and discharge (or infiltrate) runoff should be sufficient to prevent flooding more often than the standard risk tolerance for the affected properties.	a. Does the project improve the capacity of the drainage system?	Provides no improvement to the capacity of the drainage system	Provides appreciable and incremental improvement to the capacity of the drainage system, but not enough to reduce the flood risk to the standard for affected properties	Improves the capacity of the drainage system to meet standards for flood risk for all affected properties	40	320
			b. What is the scale of the problem addressed by the improvement?	Small: no structures impacted, localized within the right-of-way	Moderate: significant right-of-way impacts and/or 1-2 impacted structures	Extensive: critical road right-of-way and/or more than 2 structures affected	20	
		A.2 Hazard Reduction Urban drainage conditions that cause observed and recurring public safety hazards should be eliminated.	Does the project address an apparent public safety hazard such as severe flooding of inhabited structures or flooding that affects critical facilities?	Does not address an apparent public safety hazard	Addresses a public safety hazard that is minor to moderate in frequency or severity.	Addresses a public safety hazard that is considered severe.	60	
		A.3 Erosion Control Water conveyed through public infrastructure and/or within the public right of way (i.e., ditches and streams) should not cause	Does the project address an erosion problem due to public stormwater conveyance?	Does not address an erosion problem that threatens property or infrastructure	Stabilizes or mitigates an existing erosion problem, minor or limited threat to property or infrastructure	Stabilizes or mitigates an erosion problem that is an imminent or substantial threat to property or infrastructure	40	
	B. Water Quality Improve the quality of stormwater discharged to impaired receiving waters to mitigate environmental damage	**B.1 Stormwater Treatment** Stormwater runoff from pollutant-generating surfaces should be treated in accordance with applicable regulatory standards.	Does the project treat stormwater runoff from pollutant-generating surfaces, and address the cause of water quality impairments?	< 0.5 acres of pollutant-generating surface treated in accordance with regulatory standards	Greater than 0.5 acres, but less than 2 acres of pollutant-generating surface treated in accordance with regulatory standards	Greater than 2 acres of pollutant-generating surface treated in accordance with regulatory standards	40	160
		B.2 Low Impact Development (LID) LID principles are encouraged and should be used where feasible	Does the project incorporate LID techniques?	No	Project implements some typical LID techniques.	Project implements extensive and/or advanced LID techniques.	5	
		B.3 Impaired Water Impacts Stormwater impacts to impaired water bodies should be reduced where cost-efficient opportunities are present.	Does the project identify or take advantage of a cost-efficient opportunity to improve water quality?	No known related cost-efficient opportunities	Provides appreciable and incremental improvement to water quality with relatively minor additional cost to a planned project	Provides a substantial improvement to water quality with relatively minor additional cost to a planned project	35	
	C. Habitat Protect aquatic habitat by reducing impacts to ecosystem health and biotic diversity in lakes, streams, and wetlands	**C.1 Habitat Protection** Existing aquatic habitat should be protected from degradation to minimize the loss of ecosystem function and diversity.	a. Does the project prevent or mitigate stream degradation?	No	Yes, moderately (e.g., <500 linear feet of stream channel)	Yes, substantially (e.g., >500 linear feet of stream channel)	25	100
			b. Does the project prevent or mitigate the loss of wetland areas?	Does not protect wetlands	Protects less than 0.5 acres of wetland	Protects greater than 0.5 acres of wetland		
			c. Does the project prevent or mitigate impacts to lakes or shoreline habitat?	Does not protect lakes or shoreline habitat	Provides moderate protection for lakes or shoreline habitat	Provides substantial protection for lakes or shoreline habitat		
		C.2 Habitat Restoration Ecosystem function and diversity should be improved in natural areas where cost-effective, multi-objective opportunities are present.	a. Does the project benefit ecosystem function or diversity?	Does not provide any benefit to ecosystem function or diversity	Provides moderate benefit to ecosystem function or diversity	Provides substantial benefit to to ecosystem function or diversity	25	
			b. Does the project restore aquatic habitat?	Does not restore aquatic habitat	Provides a moderate benefit to aquatic habitat	Restores critical habitat and provides a substantial benefit to target species		
			c. Does the project benefit target species?	Provides little to no benefit to target species	Provides a moderate benefit to target species	Provides a substantial benefit to target species		
Provide consistent, equitable standards of service to the citizens of Shoreline at a reasonable cost, within rates and budget	**D. Responsible Stewardship** Provide equitable services through cost-effective planning and management of utility assets, sound fiscal planning, and efficient operations.	**D.1 System Preservation (Asset Management)** Provide reliable service by maximizing the useful life of assets and reducing life-cycle costs.	a. Does the project repair or replace deficient infrastructure, based on Risk Priority Score (combination of condition and critical location) ratings?	Risk Priority Score of "Low Priority" or "Regular Monitoring"	Risk Priority Score of "Frequent Monitoring"	Risk Priority Score of "First Priority" or "Second Priority"	100	460
			b. Does this activity support the Asset Management Work Plan?	Does not support Asset Management program	"Long-term" priority identified in Asset Management Work Plan	"Immediate" or "Near-Term" priority identified in Asset Management Work Plan	40	
		D.2 Operations and Maintenance Manage costs required to operate, maintain, and administer utility assets.	Does the project reduce or avoid O&M and administration costs required for a known problem?	Limited reduction or increase in effort/costs	Moderate reduction in effort/costs; mitigate an O&M hotspot	Substantial reduction in effort/costs; eliminate an O&M hotspot	20	
		D.3 Financial Planning Practice sound financial planning by seeking alternative funding sources to augment City utility funds.	Does the project provide an alternative funding opportunity (e.g., federal, state, or other funding source outside the stormwater utility)?	None present	Alternative funding opportunity for less than 25% total project budget	Alternative funding opportunity for greater than 25% total project budget	20	
		D.4 Future growth Plan for system capacity upgrades to accommodate future population and/or economic growth.	Does the project address future growth needs or improve areas lacking stormwater infrastructure?	No benefit	Moderate benefit	Substantial benefit	30	
		D.5 Customer service Within the utility's scope of responsibility, respond to customer requests and identified service issues.	Does the project address the area of an observed customer service issue?	No	Yes, minor service issue	Yes, major service issue	20	
Engage in transparent communication through public education and outreach	**E. Customer Service and Communications** Provide effective communication, public education, and outreach.	**E.1 Communication and Education** Incorporate public education, outreach, and communications opportunities.	Will the project enhance public understanding of surface water issues and/or utility services?	Meets basic expectations for public outreach	Significant public education and/or involvement; stakeholder groups are engaged	Public education and/or involvement is a major component of the project; stakeholder groups are highly engaged	20	40
Comply with regulatory requirements for the urban drainage system	**F. Regulatory Compliance** Meet state and federal regulatory requirements for stormwater utilities.	**F.1. Regulatory** Comply with applicable regulatory requirements.	Will the project address a current or future regulatory deficiency?	No	Addresses or mitigates risk of future deficiency 4 or more years after implementation	Addresses or mitigates risk of deficiency within the next 1 to 4 years (current or imminent deficiencies should be flagged as an immediate priority)	200	400
							Maximum Score:	1480

Brown AND Caldwell

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Appendix E: Approach to Performing Hydrologic and Hydraulic Modeling Analyses TM

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Technical Memorandum

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Prepared for: City of Shoreline

Project title: Shoreline Surface Water Master Plan

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List of Abbreviations

BC	Brown and Caldwell
B-IBI	benthic index of biotic integrity
CIP	capital improvement program
City	City of Shoreline
DEM	Digital elevation model
EPA	U.S. Environmental Protection Agency
EPA-SWMM	U.S. Environmental Protection Agency's Stormwater Management Model
FCSG	FCS Group
ft^2	square foot/feet
GIS	geographic information system
GSI	green stormwater infrastructure
HEC-RAS	Hydrologic Engineering Center's River Analysis System
H&H	hydrologic and hydraulic
HS	hot spot
HSPF	Hydrological Simulation Program-Fortran
KPI	key performance indicator
LID	low-impact development
LiDAR	light detection and ranging
LOS	level of service
Master Plan	Surface Water Master Plan
MS4	municipal separate storm sewer system
NPDES	National Pollutant Discharge Elimination System
O&M	operations and maintenance
QA/QC	quality assurance/quality control
SCS	Soil Conservation Service
SUB	subarea
TMDL	total maximum daily load
TRANS	transportation
Utility	Surface Water Utility
WWHM3	Western Washington Hydrology Model Version 3

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Section 1: Introduction

Brown and Caldwell (BC) and FCS Group (FCSG) are working with the City of Shoreline (City) to prepare an updated Surface Water Master Plan (Master Plan) for the Surface Water Utility (Utility) that will address drainage and water quality issues associated with growth, increasing regulations, and aging infrastructure. The Master Plan will guide Utility activities for the next 5 to 10 years and will include recommendations for capital improvement projects, policies, programs, and a financial plan for long-term asset management.

One of the initial planning tasks was to develop updated levels of service (LOS) that align the services provided by the Utility with customer expectations, and that are consistent with City policies and community goals. BC and FCSG worked with the City through a series of workshops, meetings, and public-outreach activities to prepare draft LOS and targets (Table 1).

Table 1. Draft LOS and Targets for Master Plan

Number	LOS	Target
1	Manage public health, safety, and environmental risks from impaired water quality, flooding, and failed infrastructure	No verifiable health and safety issues or environmental damage caused by the stormwater services outside of risk tolerance
2	Provide consistent, equitable standards of service to the citizens of Shoreline at a reasonable cost, within rates and budget	Meet the levels of service as measured by customer satisfaction and rate and revenue projections
3	Comply with regulatory requirements for the urban drainage system	Meet or exceed regulatory requirements for NPDES Phase II and federal, state, and local regulations affecting surface water management
4	Engage in transparent communication through public education and outreach	Maintain a communication plan to inform the community on utility goals and progress

LOS 1 focuses on how the City's drainage system will function and perform over time by defining acceptable levels of risk. The Utility should take action or conduct activities to understand and mitigate those risks, and then continually assess progress through key performance indicators (KPIs). While preparing the draft LOS, BC and FCSG worked with City staff on developing an initial set of activities for achieving LOS 1. These activities, associated risks, and KPIs will be continually refined throughout the development of the Master Plan. A modified list of these activities for LOS 1 is presented here:

- Track occurrences of problems relating to flooding, erosion, water quality, and/or failed infrastructure
- Enforce regulatory requirements for construction and new development
- Maintain an operation and maintenance (O&M) strategy to provide reliable and continuous service
- Forecast future system demand requirements
- Identify and complete projects to address system deficiencies and meet future growth needs
- Maintain a capital improvement program (CIP) to implement projects over time
- Prioritize improvements based on potential to mitigate risks and minimize triple-bottom-line costs
- Implement related plans adopted by the City Council such as the Urban Forest Strategic Management Plan
- Monitor ongoing system performance in alignment with goals of the City's Master Plan
- Plan resources to respond to emergencies within a specified response time

At this initial stage, the costs associated with performing these activities and achieving the LOS targets, or the rates and resources needed to maintain them, are unknown. Engineering analyses are needed to evaluate selected risk tolerances, identify gaps or system deficiencies, evaluate potential solutions, estimate life-cycle costs, and prioritize the recommended actions for implementation.

After projects and programs are developed a financial planning study will be completed to assess rate impacts and inform decision makers as to whether the preliminary LOS targets and risk tolerances are achievable given available resources. If LOS targets cannot be met because of resource limitations, there is business justification to either decrease the LOS or increase resource capabilities to meet the higher level of service (Figure 1).

LOS 1 involves mitigation of risks, such as incurring flood damages, service interruptions, or regulatory violations. Risks associated with conveyance deficiencies and impaired stormwater are typically evaluated using hydrologic models that simulate rainfall-runoff processes and hydraulic models that simulate the conveyance of runoff through the drainage system (collectively referred to as "H&H models"). As the City works to evaluate LOS and risks associated with the underperformance of its drainage system, new and updated modeling analyses will be needed.

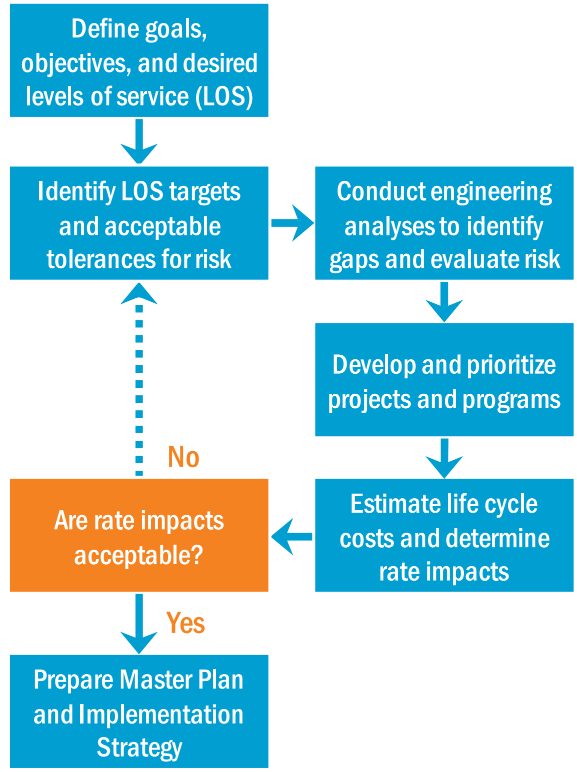

Figure 1. LOS-based Utility planning process

The purpose of this technical memorandum is to develop an approach to performing H&H analyses, including recommendations for prioritizing future data collection and modeling efforts. The following specific objectives were achieved:

- Determine the City's H&H modeling needs by examining known projects and problems, analyzing areas that could potentially be impacted by future development, and other conditions that may affect stormwater management such as water quality concerns and low-impact development (LID) feasibility constraints
- Identify data gaps by reviewing available data and previous modeling efforts including work completed for the City's basin planning efforts and geodatabases from the City's geographic information system (GIS)
- Develop a recommended approach to H&H modeling that includes prioritized data collection, model selection, and appropriate modeling methods

Section 2: Needs Assessment

While H&H models are essential tools for stormwater managers, they should not be developed without a clear need and understood purpose. Models are tools used to inform decisions, and thus should be constructed specifically to address the questions at hand. Therefore, the first step in developing a modeling approach is to examine the problem and determine how it is best evaluated within the context of the planning process. The following sections discuss potential needs for H&H modeling including evaluating known problem areas to develop capital improvement projects, planning for new infrastructure to accommodate future growth/development, evaluating impacts to downstream water bodies in the city and neighboring jurisdictions, and examining issues related to LID feasibility.

2.1 Known Problems and Projects

BC spoke with City staff and reviewed existing information to compile a list of problems and projects that will likely require H&H modeling to identify solutions, evaluate the alternative scenarios, and size project components to ensure design criteria are met in accordance with acceptable risk[1]. Identified problems and projects include the following:

- **Recommendations from basin plans:** Over the past 7 years, the City has completed detailed basin plans for each of the city's major watersheds. Recommendations from these basin plans have been incorporated into the City's CIP spreadsheet. BC reviewed the City's current CIP spreadsheet and identified projects that remain to be completed. BC also added projects from the recently completed *Puget Sound Drainages Basin Plan* (AltaTerra 2016).
- **Potential drainage hot spots:** The City's surface water GIS database includes features identified as "hot spots," which appear to be legacy problems identified by King County as potentially problematic. BC reviewed the "hot spots" data and identified problems that relate to flooding or conveyance deficiencies.
- **Additional areas of interest:** BC identified other locations of interest based on conversations with City staff. These pertain primarily to areas were new development is expected, or locations were transportation projects could create opportunities for stormwater improvements.

Figure 2 shows the locations of the identified problems and projects; each is categorized by the general issue of concern. Table 2 lists these problems and projects and provides a brief description. Note that the identifiers in Figure 2 and Table 2 match those of the basin plans, except for newly identified items. Hot spots are denoted with "HS" and transportation projects are denoted with "TRANS."

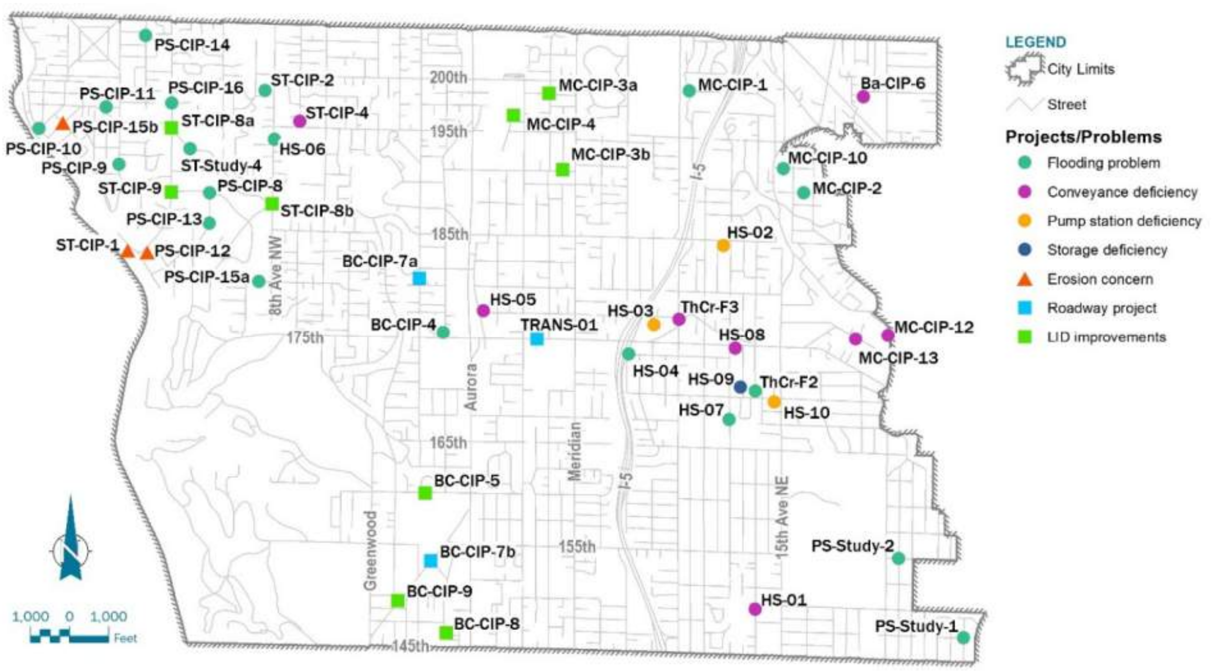

Figure 2. Problem and project locations identified as potentially needing H&H analyses

[1] For example, the City's current *Engineering Development Manual* refers to the King County *Surface Water Design Manual* for conveyance system specifications (City 2012a; King County 2016). New drainage systems may overtop for runoff events that exceed the 25-year design capacity, provided the overflow from a 100-year runoff event does not create or aggravate a severe flooding problem or severe erosion problem downstream.

Table 2. Project and Problem Locations Identified as Potentially Needing H&H Analyses

Identifier	Name	Basin	Issue
Ba-CIP-6	Remove Improper Storm Drain Connections	Lyon Creek	Conveyance deficiencies: structural
BC-CIP-4	Flood Reduction in Linden Avenue Neighborhood	Boeing Creek	Flooding
BC-CIP-5	Stormwater Improvements for N 160th Street Transportation Improvement Project	Boeing Creek	Water quality improvements (LID) with roadway project
BC-CIP-7a	Stormwater Improvements for Fremont Avenue N Transportation Improvement Project	Boeing Creek	Storm drainage improvements with roadway project
BC-CIP-7b	Stormwater Improvements for Westminster Way Transportation Improvement Project	Boeing Creek	Storm drainage improvements with roadway project
BC-CIP-8	Construct Bio-infiltration Swales adjacent to Interurban Trail	Boeing Creek	Water quality improvements (LID)
BC-CIP-9	Construct Bio-infiltration Swale in Right-of-way Adjacent to Westminster Triangle Park	Boeing Creek	Water quality improvements (LID)
MC-CIP-1	6th Avenue NE and NE 200th Street Flood Reduction	McAleer Creek	Flooding
MC-CIP-2	NE 190th Street Stormwater Management Swale	McAleer Creek	Flooding
MC-CIP-3a	Bioretention N 199th and Wallingford Avenue N	McAleer Creek	Water quality improvements (LID)
MC-CIP-3b	Bioretention at N 192nd Street and Burke Avenue NE	McAleer Creek	Water quality improvements (LID)
MC-CIP-4	Echo Lake Biofiltration Swale	McAleer Creek	Water quality improvements (LID)
MC-CIP-10	NE 192nd Street Ditch Improvements	McAleer Creek	Flooding
MC-CIP-12	25th Avenue NE Drainage Improvements	McAleer Creek	Conveyance deficiencies: capacity and structural
MC-CIP-13	NE 177th Street Drainage Improvements	McAleer Creek	Conveyance deficiencies: capacity and structural
PS-CIP-8	Springdale Ct. NW and Ridgefield Road Drainage Improvements	Puget Sound Drainages	Flooding
PS-CIP-9	Lack of System and Ponding on 20th Avenue NW	Puget Sound Drainages	Flooding
PS-CIP-10	NW 195th Place and Richmond Beach Drive Flooding	Puget Sound Drainages	Flooding
PS-CIP-11	NW 196th Place and 21st Avenue NW near Richmond Beach Library	Puget Sound Drainages	Flooding
PS-CIP-12	Stabilize NW 16th Place Storm Drainage in Reserve M	Puget Sound Drainages	Erosion threat to infrastructure
PS-CIP-13	Heron Creek Culvert Crossing at Springdale Ct.	Puget Sound Drainages	Flooding
PS-CIP-14	18th Avenue NW and NW 204th Drainage System Connection	Puget Sound Drainages	Flooding

Table 2. Project and Problem Locations Identified as Potentially Needing H&H Analyses

Identifier	Name	Basin	Issue
PS-CIP-15a	NW 180th and 8th Avenue Ditch with Unknown Connection	Puget Sound Drainages	Flooding
PS-CIP-15b	NW 194th Place and 25th Ave NW Ditch Erosion	Puget Sound Drainages	Erosion threat to infrastructure
PS-CIP-16	NW 197th and 15th Ave NW Flooding	Puget Sound Drainages	Flooding
PS-Study-1	Conduct Options Analysis at 32nd Ave NE and NE 147th St	Puget Sound Drainages	Flooding
PS-Study-2	26th Avenue NE Flooding and Lack of System	Puget Sound Drainages	Flooding
ST-CIP-1	Tightline Storm Creek	Storm Creek	Erosion threat to infrastructure
ST-CIP-2	Convert Stormwater Conveyance Ditches to Bio-infiltration Facilities	Storm Creek	Flooding and water quality improvements (LID)
ST-CIP-4	NW 196th Street Drainage Improvements	Storm Creek	Conveyance deficiencies: structural
ST-CIP-8a	Water Quality Improvements in Conjunction with Traffic Roundabouts: 15th Avenue NW and Richmond Beach Road	Storm Creek	Water quality improvements (LID) with roadway project
ST-CIP-8b	Water Quality Improvements in Conjunction with Traffic Roundabouts: 8th Avenue NW and Richmond Beach Road	Storm Creek	Water quality improvements (LID) with roadway project
ST-CIP-9	Utilize LID Techniques for Sidewalk Improvements: 15th Avenue NW in the 188th Street Vicinity	Storm Creek	Water quality improvements (LID) with sidewalk project
ST-Study-4	Flooding Assessment at Richmond Breach Road, East of 14th Place NW	Storm Creek	Simulated flooding
ThCr-F2	12th Avenue NE and 11th Avenue NE between NE 175th Street and NE 170th St Flood Reduction	Thornton Creek	Flooding
ThCr-F3	NE 175th Street/NE 178th Street at Serpentine Place near 5th Avenue NE Drainage Improvements	Thornton Creek	Conveyance deficiencies: capacity
HS-01	NE 150th and 12th Avenue NE Drainage Improvements	Thornton Creek	Conveyance deficiencies: capacity
HS-02	Pump Station 26 Improvements	McAleer Creek	Pump station deficiency: capacity
HS-03	Pump Station 25 Improvements	Thornton Creek	Pump station deficiency: flooding
HS-04	NE 174th and 1st Avenue Flood Reduction	Thornton Creek	Flooding
HS-05	N 178th and Midvale Drainage Improvements	Boeing Creek	Conveyance deficiencies: capacity
HS-06	8th Avenue N Drainage Improvements	Storm Creek	Flooding
HS-07	10th Avenue NE Flood Reduction	Thornton Creek	Flooding
HS-08	NE 175th Street Drainage Improvements	Thornton Creek	Conveyance deficiencies: capacity

Table 2. Project and Problem Locations Identified as Potentially Needing H&H Analyses

Identifier	Name	Basin	Issue
HS-09	Ghezzi Pond Improvements	Thornton Creek	Storage deficiencies
HS-10	Pump Station 30 Improvements	Thornton Creek	Pump station deficiency: capacity
TRANS-01	Stormwater Improvements for 175th Street Corridor Transportation Improvement Project	Thornton Creek	Storm drainage improvements with roadway project

2.2 Future Development

The Phase II Western Washington Municipal Stormwater Permit (also known as Municipal Separate Storm Sewer System [MS4] Permit) requires onsite stormwater management and flow control measures for new development and redevelopment activities that replace or add hard surfaces. Minimum Requirements 5 and 7 are intended to provide stormwater treatment and reduce downstream discharges that could cause channel erosion or other adverse impacts. Flow charts for determining minimum requirements are provided in Attachment A. Basic requirements are summarized below:

- **Minimum Requirement 5, "Onsite Stormwater Management,"** contains an LID performance standard that applies to projects that result in greater than 2,000 square feet (ft^2) of new plus replaced hard surfaces or disturb at least 7,000 ft^2 of land. The requirement reads as follows:

  > *Stormwater discharges shall match developed discharge durations to pre-developed durations for the range of pre-developed discharge rates from 8% of the 2-year peak flow to 50% of the 2-year peak flow. Refer to the Standard Flow Control Requirement section in Minimum Requirement #7 for information about the assignment of the pre-developed condition. Project sites that must also meet minimum requirement #7 shall match flow durations between 8% of the 2-year flow through the full 50-year flow.*

- **Minimum Requirement 7:** "Flow Control," contains a flow control requirement that applies to projects that result in greater than 5,000 ft^2 of new plus replaced hard surfaces, convert ¾ acres or more of vegetation to lawn/landscaped areas, or convert 2.5 acres or more of native vegetation to pasture. The requirement reads as follows:

  > *Stormwater discharges shall match developed discharge durations to pre-developed durations for the range of pre-developed discharge rates from 50% of the 2-year peak flow up to the full 50-year peak flow. The pre-developed condition to be matched shall be a forested land cover unless [specific conditions are met.*

These requirements will substantially mitigate the increases in stormwater runoff associated with new and re-developed areas. However, some small projects may not trigger Mitigation Requirement 7, and some very small projects may not even trigger Mitigation Requirement 5, which means runoff rates could increase especially for very large events. Regardless of onsite mitigation requirements, new developments and redeveloped areas could still require modifications to the City's drainage system to accommodate new service connections from underdrains or overflow structures, improve existing infrastructure, or manage runoff from right-of-way improvements. Given these uncertainties, and the questions that inevitably arise with development and land use changes, H&H modeling should be performed to evaluate future service needs, particularly in areas where development densities are expected to increase. As will be discussed in Section 3.1, hydrologic calculations used in the environmental impact statements for the 185th Street Station subarea and 145th Street Station subareas are insufficient for evaluating specific conveyance capacity issues. The following subsections examine areas of the city with significant potential for redevelopment with increased development densities.

2.2.1 Subarea Plans

The City's *Comprehensive Plan* describes several subarea plans, which are detailed land use plans for smaller geographic areas within the city (City 2012b). These areas can encompass neighborhoods, corridors, or other types of special districts with strategic development goals. These subareas are often expected to experience increased development densities and substantial growth in the coming years. Figure 3 shows the approximate areas covered by the subarea plans referenced in the *Comprehensive Plan*.

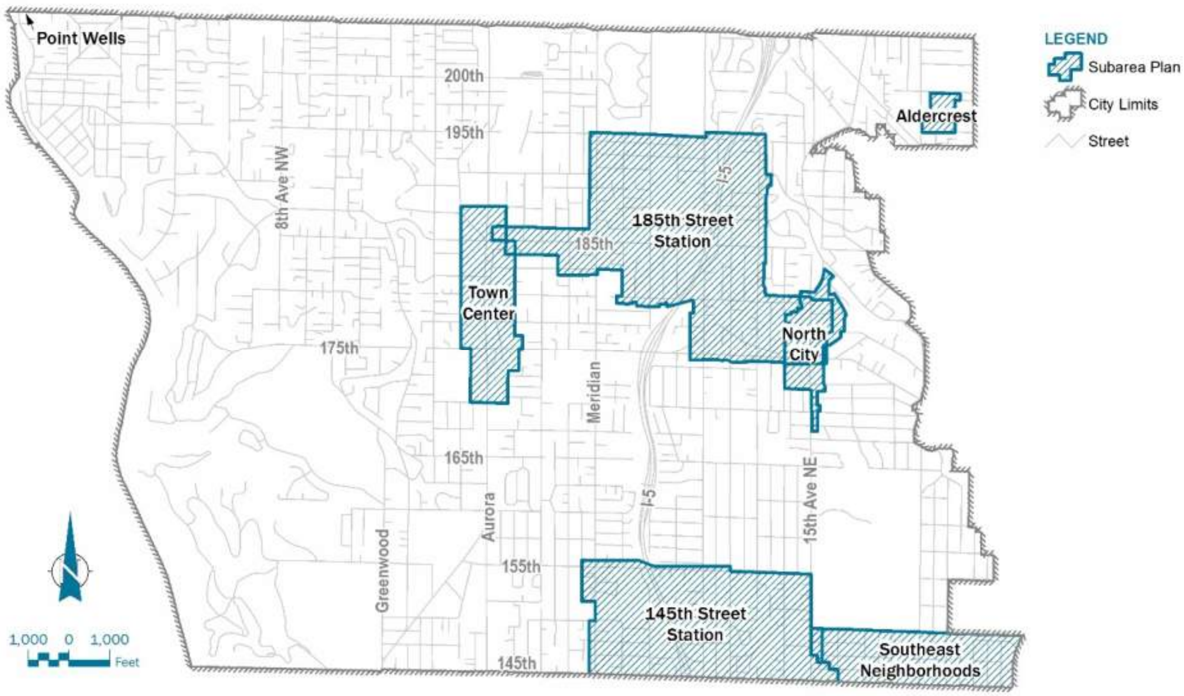

Figure 3. Areas affected by subarea plans as referenced in the *Comprehensive Plan*

2.2.2 Increased Imperviousness

BC performed geospatial analyses to map imperviousness for existing and future conditions. Existing impervious surface areas were based on the City's current GIS data, which include delineated surfaces for transportation (feature title *ImperviousTrans2012*), buildings (feature title *Buildings2012*), and other surfaces such as parking lots and sidewalks (feature title *ImperviousOther2012*). Future imperviousness was estimated based on modified zoning data. The baseline zoning data were obtained from the City's current GIS. Modifications were made in the 145th Street Station and 185th Street Station subareas to reflect the current online mapping by the City for those areas (Shoreline 2016). In addition, water bodies and parks were overlaid to isolate those areas as separate categories. Each zoning category was assumed to be built out to the maximum allowable hardscape percentage as defined by the City's current Development Code (Table 3).

Table 3. Future Imperviousness Percentages Based on Zoning

Zoning category		Estimated percentage of total impervious area
Abbrev.	Description	
R4	Residential, 4 units per acre	45%
R6	Residential, 6 units per acre	50%
R8	Residential, 8 units per acre	65%
R12	Residential, 12 units per acre	75%
R18	Residential, 18 units per acre	85%
R24	Residential, 24 units per acre	85%
R48	Residential, 48 units per acre	90%
MUR-35	Mixed-use residential (35' height based on R-18 zoning)	85%
MUR-45	Mixed-use residential (45' height based on R-48 zoning)	90%
MUR-70	Mixed-use residential (70' height)	90%
NB	Neighborhood business	85%
CB	Community business	85%
MB	Mixed business	95%
TC	Town center (1, 2, 3, or 4)	95%
PA 3	Planned Area 3	85%
CZ	Contract zone	90%
C	Campus	60%
ROW	Right-of-way	90%
Water	Major water bodies	0%
Park	Parks	15%

Note: Imperviousness percentages were based on maximum hardscape allowed by City Development Code (Code Publishing Company 2016) with the exceptions of right-of-way, parks, and water bodies. Impervious percentages for those categories were assumed based on work done for the Thornton Creek and Boeing Creek basin plans.

Existing impervious surface percentages were subtracted from future impervious surface percentages to obtain a potential increase in imperviousness on a parcel-by-parcel basis. An overview of the results is shown in Figure 4. As expected, the 145th Street and 185th Street Station subareas stand out as clusters with the greatest potential for increased impervious areas. H&H modeling of these areas would provide a tool for evaluating future drainage needs under current development regulations, or under various management scenarios such as constructing regional stormwater facilities or developing modified flow control requirements through basin planning.

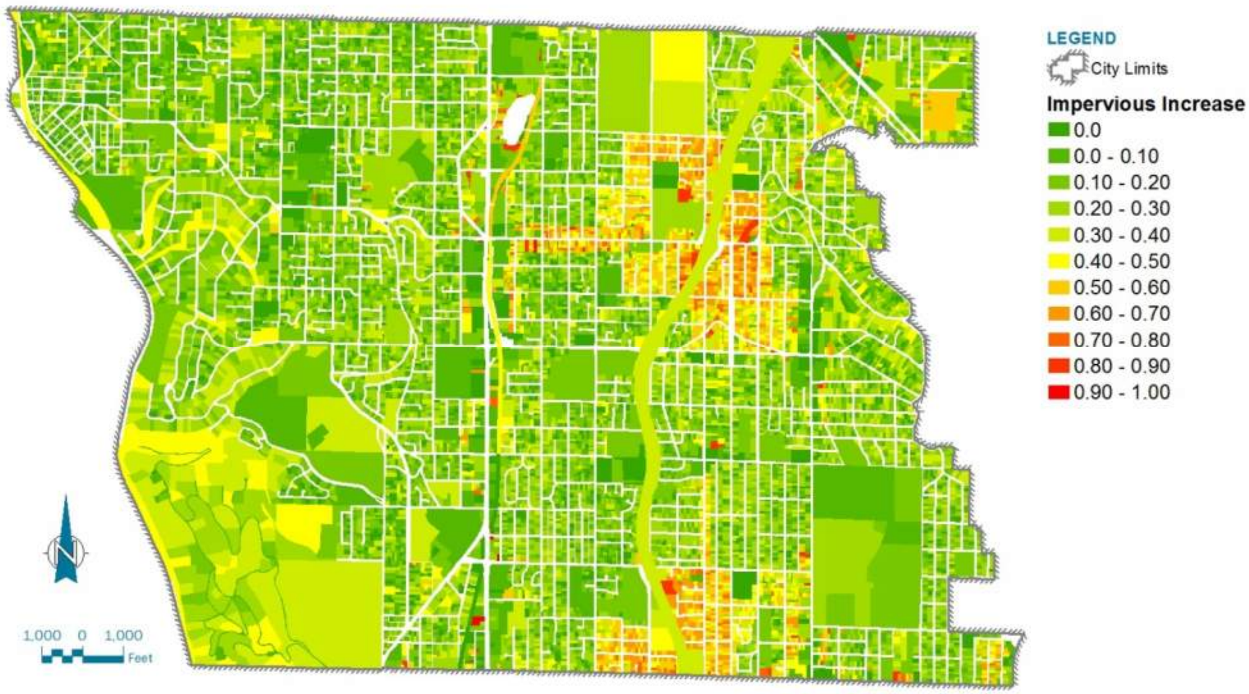

Figure 4. Potential increase in imperviousness percentages by parcel at fully developed condition

2.3 Downstream Receiving Waters

The current Phase II permit does not generally require retrofitting to treat or control runoff from previously developed areas. In contrast, the Washington State Phase I municipal stormwater permit (Phase I Permit), which applies to large jurisdictions (populations greater than 100,000), requires the permittee to develop a structural control program to reduce stormwater impacts from existing developed areas as well as future development. It is possible that a similar requirement could be added to the next Phase II permit, which is expected to be issued in 2018.

Although the current Phase II permit does not explicitly require treatment or flow control for runoff from existing development, it does require compliance with any total maximum daily loads (TMDLs) established for water bodies that receive municipal stormwater runoff. Phase II permittees whose stormwater drains to TMDL water bodies might need to implement regional projects, distributed BMPs, and/or green stormwater infrastructure (GSI) to reduce stormwater pollutant loads from existing development.

The Washington State Department of Ecology (Ecology) performs a statewide water quality assessment every 2 to 4 years to identify water bodies that do not meet state water quality standards. Water bodies that do not meet standards are placed on the Clean Water Act Section 303(d) list. Ecology develops TMDLs for the water bodies on the 303(d) list to bring them into compliance with water quality standards. TMDLs typically apply to the watershed areas that contribute flow to the 303(d)-listed reaches.

Although McAleer Creek is the only water body within Shoreline on the current 303(d) list, several watersheds within the city contribute flow to downstream 303(d)-listed water bodies. Figure 5 shows the areas potentially affected by TMDLs for 303(d)-listed water bodies.

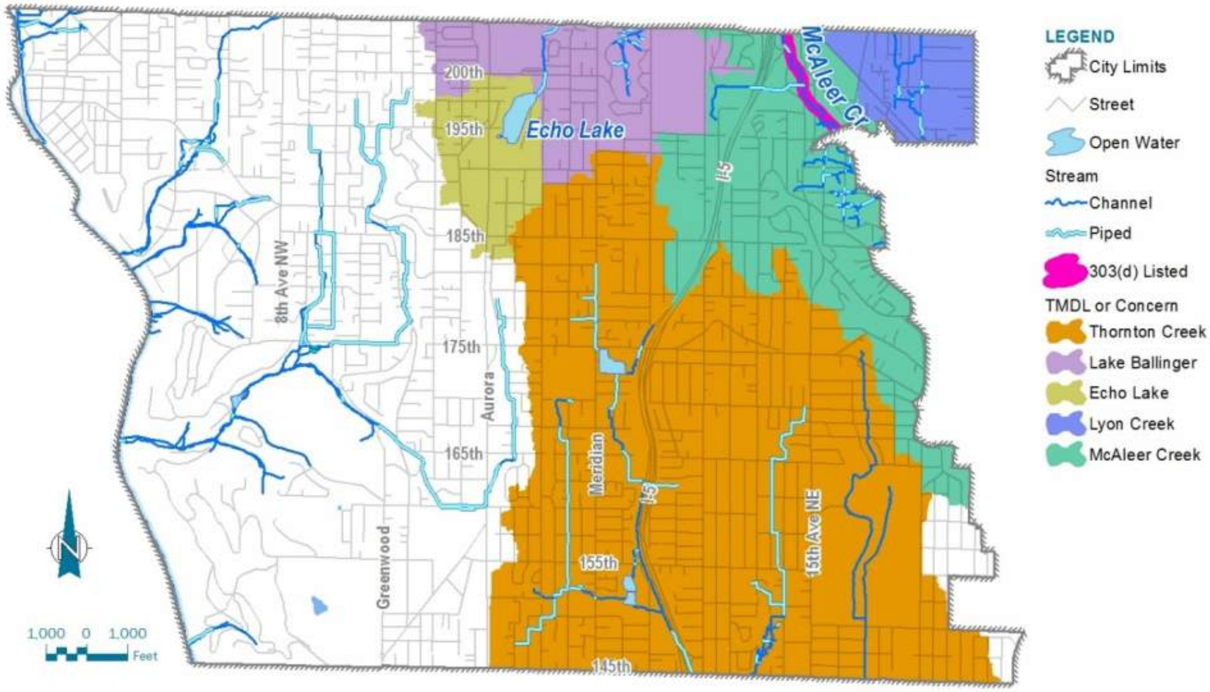

Figure 5. Areas potentially affected by TMDL or "waters of concern"

McAleer Creek is on the 303(d) list for fecal coliform bacteria, dissolved oxygen, water temperature, and low benthic index of biotic integrity (B-IBI) scores. Ecology has established a TMDL to limit phosphorus discharges to Lake Ballinger, which receives drainage from a portion of Shoreline. Reaches of Thornton Creek downstream of Shoreline are on the 303(d) list for bacteria, dissolved oxygen, and water temperature. Echo Lake is listed under "waters of concern" because of elevated fecal coliform bacteria concentrations.

TMDLs for water bodies downstream of Shoreline could trigger pollutant load reduction requirements for stormwater discharges in Shoreline. TMDL requirements become a special condition of the next Phase II permit after the TMDL has been developed by Ecology and approved by the U.S. Environmental Protection Agency (EPA). The TMDL could require treatment or removal of stormwater runoff from existing developed areas that drain to the affected water bodies. In such cases, H&H modeling would likely be needed to evaluate alternatives for implementation planning.

2.4 Low-Impact Development Infeasibility

Onsite stormwater management and flow control requirements as described in the previous section can be costly and challenging to implement in high-density urban areas. Three of the biggest constraints affecting feasibility are geotechnical concerns (i.e., erosion or landslide potential), insufficient infiltration capacity of underlying soils, and high groundwater.

BC performed a preliminary evaluation of LID feasibility by mapping areas of concern. Specifically, BC used the City's GIS data to map areas delineated as "erosion" or "landslide" geotechnical concerns and areas mapped as predominantly till soils, which generally have poor infiltration capacity. Areas with high groundwater concerns were not considered for this preliminary evaluation because city-wide mapping of high groundwater is not readily available. As shown in Figure 6, more than 16 percent of the city is mapped as having geotechnical constraints and more than 60 percent is mapped as till soils. H&H modeling could be used to evaluate stormwater management alternatives in these areas such as constructing regional stormwater facilities.

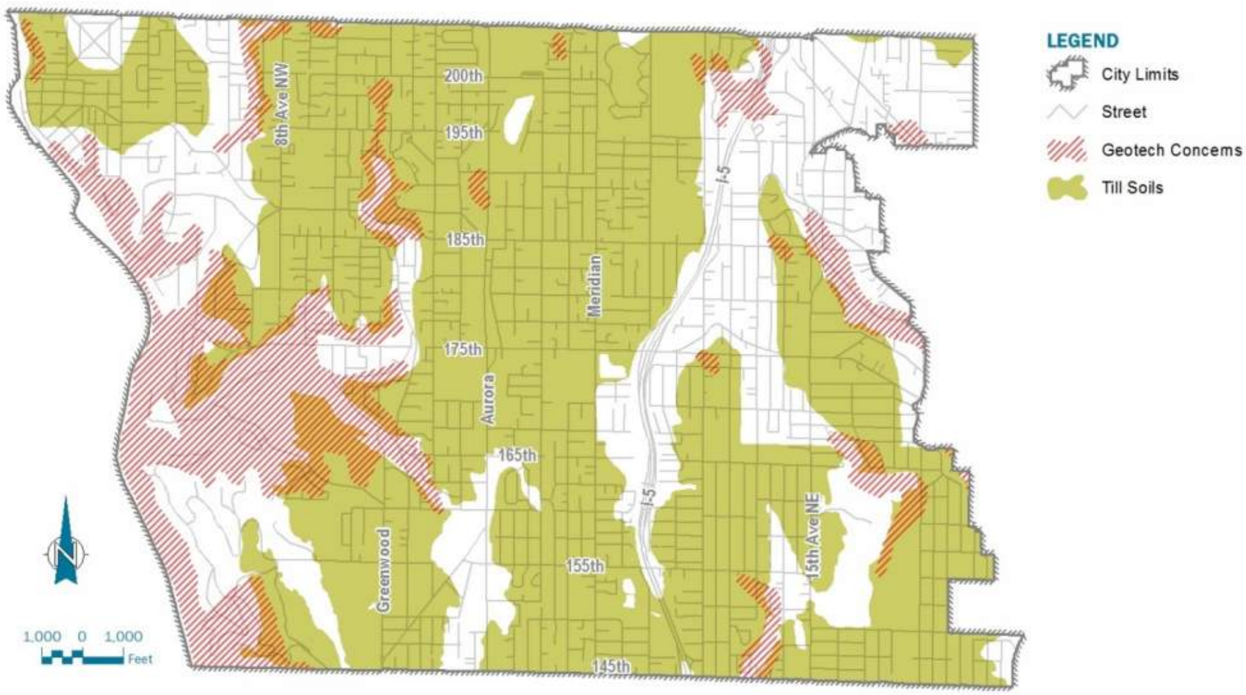

Figure 6. Mapping of possible constraints to LID

Geotechnical concerns based on "erosion" and "landslide" mapping contained in the City's GIS Geology database.

Section 3: Data Review

BC collected and reviewed data that could be used to develop drainage system models. Two key sources of information are the modeling files from previous basin planning efforts and the City's current GIS data for stormwater facilities and infrastructure. Section 4.1 provides a summary of the modeling performed for each of the basin plans. Section 4.2 summarizes the GIS data review.

3.1 Previous Modeling

H&H modeling analyses were performed to support planning efforts in the Boeing Creek, Lyon Creek, McAleer Creek, Storm Creek, and Thornton Creek basins (modeling was not performed for the Puget Sound Drainages Basin Plan). Limited surface water modeling was also performed for the environmental impact statements for the 145th Street Station and 185th Street Station subareas. The following bullets briefly summarize the modeling completed for each of these reports:

- **Thornton Creek Watershed Plan (2009):** A Hydrological Simulation Program-FORTRAN (HSPF) model was developed for the north branch of Thornton Creek from the Ronald Bog area in the north to southern edge of the city. The model was calibrated to recorded water surface elevations at Ronald Bog. An XP-SWMM computer model was also developed to evaluate the Serpentine Pump Station and the flooding problem in Littles Creek on 10th Avenue NE near NE 175th Street. A floodplain mapping study for Thornton Creek was being conducted concurrently with the basin planning effort. A Hydrologic Engineering Center's River Analysis System (HEC-RAS) model was created to simulate the hydraulic characteristics of the study reach downstream of Ronald Bog. The model was used to compute water surface profiles corresponding to the 10-, 50-, 100-, and 500-year floods; flood inundation limits for the 100- and 500-year events; and the floodway boundary for the 100-year flood.

- **Boeing Creek Basin Plan (Windward 2013):** A model of the Boeing Creek watershed was developed using the U.S. Environmental Protection Agency's Stormwater Management Model (EPA-SWMM). The model was used to simulate historical and current stream flows, and to perform limited hydraulic modeling along the main channel and along selected pipes for 25- and 100-year discharges. Most of the storm pipe network was not modeled. Future conditions were not modeled because the basin was assumed to be built out (i.e., fully developed).
- **Storm Creek Basin Plan (Windward 2013):** Similar to Boeing Creek, the EPA-SWMM model was used to simulate existing stream flows and conveyance of the 25-year design event. Additionally, the model was used to identify the area inundated during a 100-year recurrence interval flow event for the City's critical areas code. Hydraulic modeling was focused on the main channel from the mouth up through the Syre Wetland and a few selected pipes. Most of the tributary drainage networks were not modeled. The Western Washington Hydrology Model Version 3 (WWHM3) was used to assess site-specific detention and infiltration opportunities.
- **Lyon Creek Basin Plan (AltaTerra 2015):** An existing hydrologic model for the Lyon Creek watershed was used to simulate flows in the Ballinger Creek subbasin, which mostly covers the portion of the Lyon Creek basin that falls within Shoreline city limits. The hydrologic model was developed and calibrated by Hammond Collier Wade Livingstone using HSPF in 1999 for the City of Lake Forest Park. Otak updated the model in 2009 by extending the precipitation through 2007 and updating stormwater facility inputs. A separate hydraulic model was developed using the HEC-RAS program. The HEC-RAS model was used to simulate steady-state water surface profiles along the main channel of Ballinger Creek to evaluate culvert capacity under 25- and 100-year flood conditions. Tributary drainage networks were not modeled.
- **McAleer Creek Basin Plan (AltaTerra 2015):** Hammond Collier Wade Livingstone developed and calibrated an HSPF in 1999 for the City of Lake Forest Park. Otak updated the model in 2009 by extending the precipitation through 2007 and adding a more-detailed subbasin for Lake Ballinger based on work by Clear Creek Solutions (2008). This modified HSPF model was used to calculate discharge frequency for McAleer Creek. A HEC-RAS model was developed and used to simulate steady-state water surface profiles along the main channel of McAleer Creek to evaluate culvert capacity and map flood inundation for 25- and 100-year flood conditions. Tributary drainage networks were not modeled.
- **Draft Environmental Impact Statements for the 185th Street Station Subarea and 145th Street Station Subarea (City 2014, 2015):** The surface water conveyance system was analyzed by using the Rational Method to calculate unmitigated peak discharges—no hydraulic capacity modeling was performed. The Rational Method uses runoff coefficients, an assumed rainfall intensity for the 25-year design event, and the estimated drainage area. In evaluating potential impacts, the reports note the following:

  Using the rational method provides a conservative estimate of the peak flows for each alternative. These flows were used as a comparison representing the percent increase for unmitigated flow due to the increased impervious area associated with the planned action alternatives. Medium- and large-sized redevelopment likely would trigger flow control mitigation requirements that would decrease net runoff from the redeveloped sites.

  Any potential net increase in post-development peak flows would need to be accommodated by the downstream conveyance system. Such an increase in net peak flows would likely require downstream implementation of flow control. In portions of the subarea without established conveyance systems, new conveyance system improvements would likely be needed as development occurs.

While some of the input data from previous modeling work will be useful for future modeling efforts, the usefulness varies depending on the technical approaches, modeling programs, level of detail, and assumptions. Surveyed data inputs such as channel cross-sections, pipe sizes and elevations, and bridge/culvert dimensions will be very useful for future hydraulic modeling along those reaches where it is available.

The HSPF models developed for the eastern basins (Lyon, McAleer, and Thornton) could provide a basis for long-term continuous-simulation modeling, and could even be expanded to other areas of the city. The HSPF models have been updated over time; however, calibration appears be somewhat limited. The hydrologic component of the EPA-SWMM models developed for Boeing and Storm creeks are less likely to be used for future modeling because they use the Soil Conservation Service (SCS) runoff curve number and drying time parameters to do continuous simulations, which provide limited parameter flexibility and could make model calibration difficult.

3.2 Geospatial Data

BC downloaded the City's GIS data in July 2016 in the format of five ArcGIS-compatible geodatabases: *Land*, *Parks*, *Street*, *SurfaceWater*, and *Topography*. GIS data for stormwater facilities and infrastructure are contained in the *SurfaceWater* geodatabase. The City has indicated that its inventory of stormwater assets and spatial mapping is largely complete, though specific asset data and attributes continue to be collected over time. Table 4 provides a summary of key stormwater drainage assets contained in the *SurfaceWater* geodatabase.

Table 4. Summary of Drainage Assets in the *SurfaceWater* Geodatabase

Parameter	Value
Total length of natural drainage channels	29 miles
Total length of drainage ditches	30 miles
Total number of stormwater pipes	15,663
Total number of manholes	981
Total number of pipe inlets	146
Total number of catch basins	11,715
Total number of culverts	10[a]
Total number of ponds	62
Total number of vaults	143
Total number of pump stations	9

a. Many culverts appear to be classified as pipes.

BC performed a preliminary review of the surface water asset data to assess completeness with respect to input data needed to build new drainage model—using pipe data as the primary indicator. Principal conveyance elements and network connectivity appear to be generally complete; however, there are gaps in key attributes such as pipe size, material, and invert elevations. Approximately 86 percent of the pipes have diameters (Figure 7), but only about 15 percent include invert elevations (Figure 8). Invert elevations can be inferred from pipe depths subtracted from rim elevations or ground surface elevations; however, only about 30 percent of pipes have depth information and no rim elevations are available. Table 5 provides a summary of the review of pipe attributes.

Table 5. Summary of Pipe Attributes in *SurfaceWater* Geodatabase	
Parameter	Value
Number of stormwater pipes (all sizes)	15,663
Percentage of stormwater pipes with diameter	86
Percentage of stormwater pipes with material	73
Percentage of stormwater pipes with install year	38
Percentage of stormwater pipes with downstream depth	30
Percentage of stormwater pipes with downstream elevation	15
Percentage of stormwater pipes with upstream depth	30
Percentage of stormwater pipes with upstream elevation	14
Percentage of stormwater pipes with shape	11

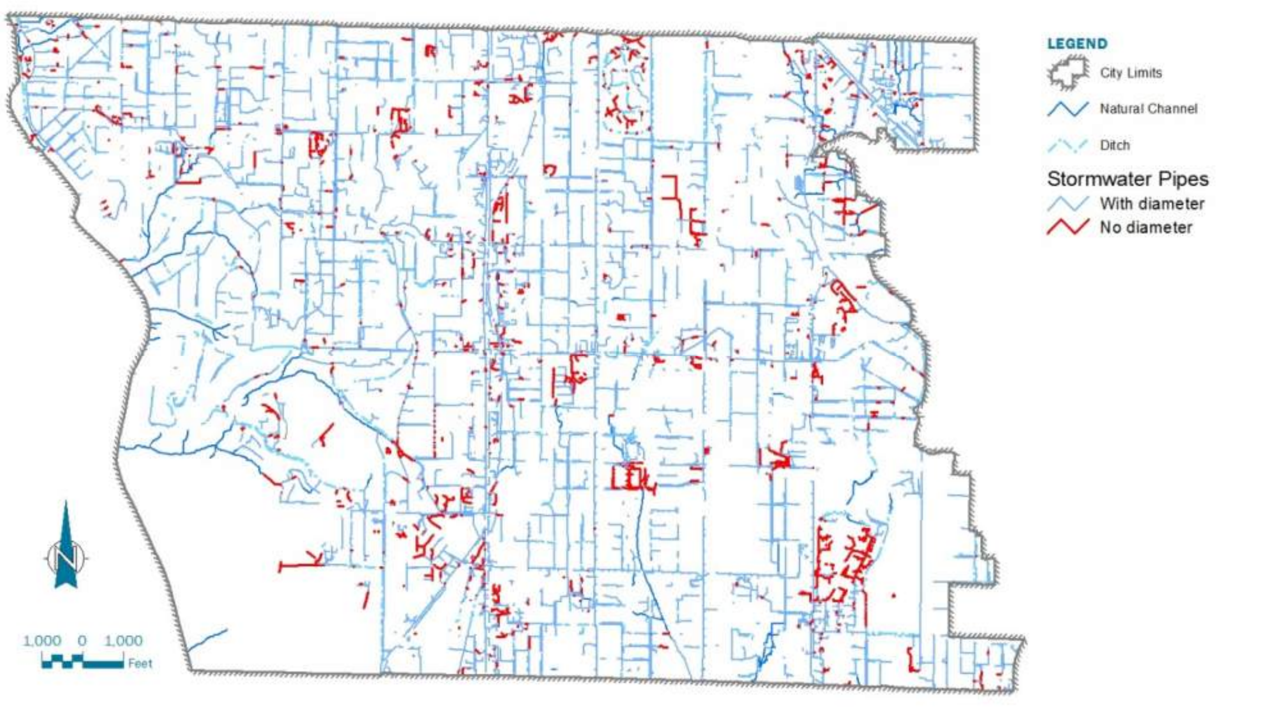

Figure 7. Distribution of pipes with no data for the diameter attribute in the *SurfaceWater* geodatabase

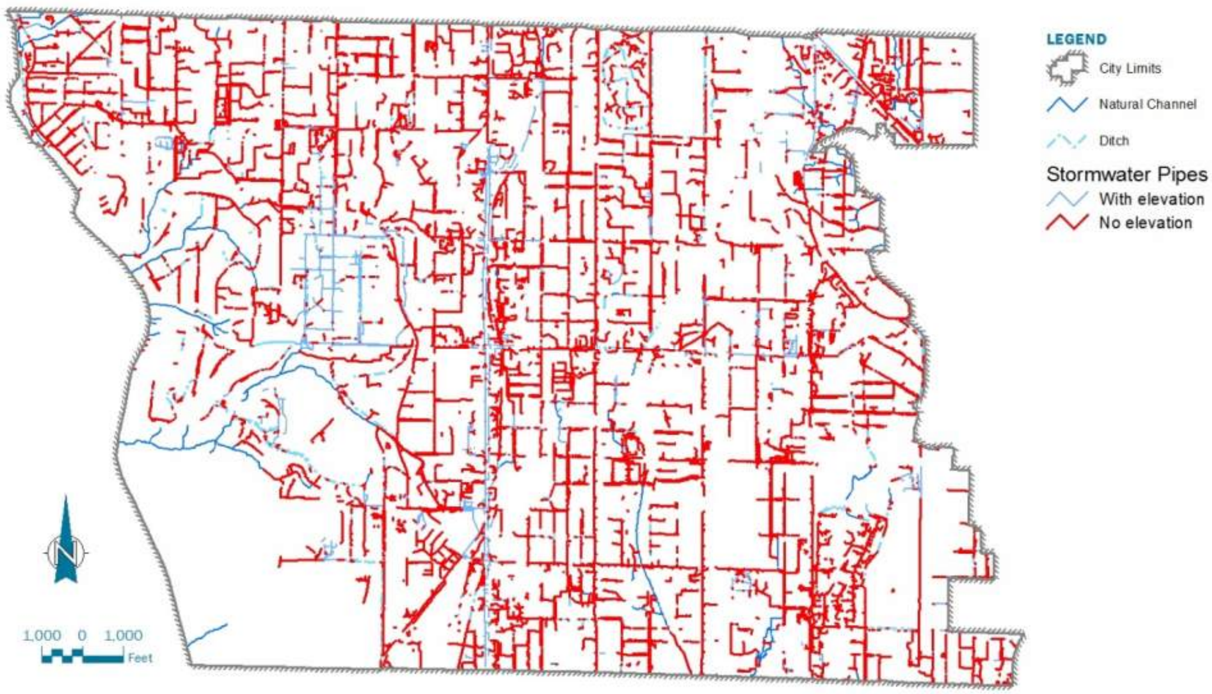

Figure 8. Distribution of pipes with no data for the downstream elevation attribute in the *SurfaceWater* geodatabase

Figures 7 and 8 suggest that gaps in pipe attribute data are widespread and not systematically concentrated in any discernable areas. Additional infrastructure data will be need to be collected before detailed models can be developed for any sizable area of the city.

Section 4: Recommended Approach

BC recommends a phased and prioritized approach to H&H modeling, focusing foremost on data collection and then on model development. Data collection activities can be performed independently from model development and can also provide near-term benefits to asset management and O&M activities. Model development should be performed according to priorities, tailored to specific needs, and refined over time.

The following sections describe the recommended approach. Section 4.1 establishes subbasin priorities and then groups areas into phases. Section 4.2 discusses the data and attributes to be collected for use in model building. Section 4.3 describes a framework for model development.

4.1 Subbasin Priorities

Digital mapping of subbasin areas was not available for most of the basin planning areas, and basin boundaries in existing GIS files did not always account for pipes and ditches shown in the City's GIS database. Therefore, BC created new subbasin delineations prior to determining subbasin priorities. These delineations were developed by first performing automated delineations using a digital elevation model (DEM) obtained from the Puget Sound LiDAR Consortium (PSLC 2006). Automated delineations were then adjusted where stormwater infrastructure crossed subbasin boundaries. New subbasin identifiers were assigned using recognizable names with numbering sequenced from upstream to downstream. Figure 9 shows the subbasins and the direction of stormwater discharge at the outlet.

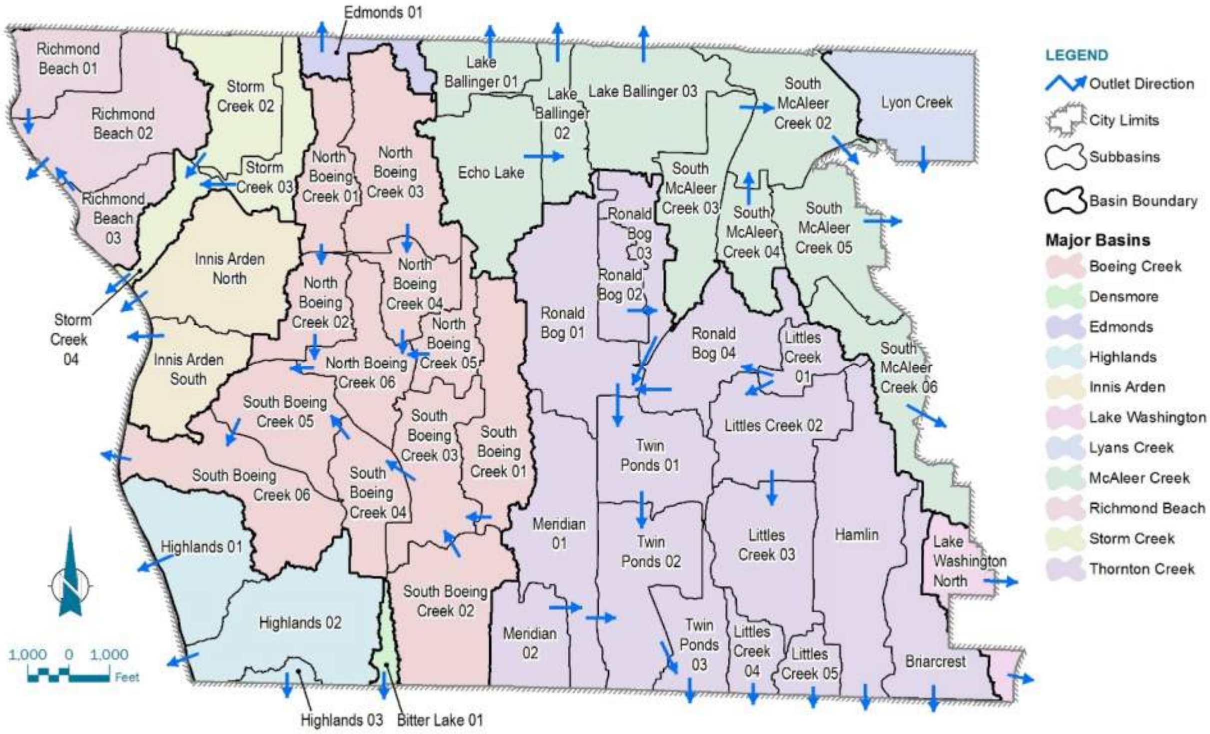

Figure 9. Newly delineated subbasins and connectivity

Once the new subbasin delineations were mapped, geospatial analyses were performed to characterize and score each subbasin per modeling needs. Specifically, the following were calculated:

- **Projects/problems score:** The total number of projects and known problems, as identified in Section 2.1, were summed for each subbasin. Subbasins were then ranked and a score was assigned based on the relative number of projects/problems. A "1" was given to subbasins in the first (i.e., lowest) quartile, "2" was given to subbasin in the second quartile, "3" was given to subbasin in the third quartile, and "4" was given to subbasin in the fourth (i.e., highest) quartile.
- **Subarea plan score:** Subbasins containing subarea plans (Figure 3) were flagged and assigned a score of "4." All other subbasins were assigned a score of "0."
- **Development score:** The potential increase in imperviousness was calculated for each subbasin using the same method as described in Section 2.2. Subbasins were then ranked and a development score was assigned by quartile, where a "1" was given to subbasins in the first quartile, "2" was given to subbasin in the second quartile, "3" was given to subbasin in the third quartile, and "4" was given to subbasin in the fourth quartile.
- **Downstream concern score:** Subbasins draining to outside jurisdictions with TMDL receiving waters or "waters of concern" (see Figure 5) were flagged and assigned a score of "4." All other subbasins were assigned a score of "0."
- **LID infeasibility score:** The percent of the subbasin area falling within areas with geotechnical constraints or till soils as described in Section 2.3. The subbasins were then ranked and an infeasibility score was assigned by quartile, where a "1" was given to subbasins in the first quartile, "2" was given to subbasin in the second quartile, and so on.
- **Infrastructure score:** The relative amount of drainage infrastructure data needs within each subbasin was estimated by calculating the total length of pipe mapped within the subbasin. The subbasins were

then ranked and a score was assigned by quartile, where a "1" was given to subbasins in the first quartile, "2" was given to subbasin in the second quartile, and so on.

Priority scores for each subbasin were then calculated by summing each of the assigned scores, which means scores can range from 4 (i.e., lowest) to 24 (i.e., highest). Table 6 illustrates this scoring using the Echo Lake subbasin as an example. Additional maps and scoring details are provided in Attachment B.

Table 6. Example Prioritization Scoring for Echo Lake Subbasin

Criterion	Score	Notes
Projects/problem score	3	Falls within the 3rd quantile of subbasins
Subarea plan score	4	Affected by Town Center subarea plan
Development score	1	Falls within the 1st quantile of subbasins
Downstream concern score	4	Drains to "waters of concern"
LID infeasibility score	3	Falls within the 3rd quantile of subbasins
Infrastructure score	4	Falls within the 4th quantile of subbasins
Total score	**19**	Final priority score for subbasin

Subbasin scoring results were mapped and examined with respect to drainage connectivity to identify geographic areas that should be grouped together for data collection and model development activities. Figure 10 shows the relative priority scores for the subbasins, as well as the groupings and phase numbers representing the recommended order for data collection and model development activities.

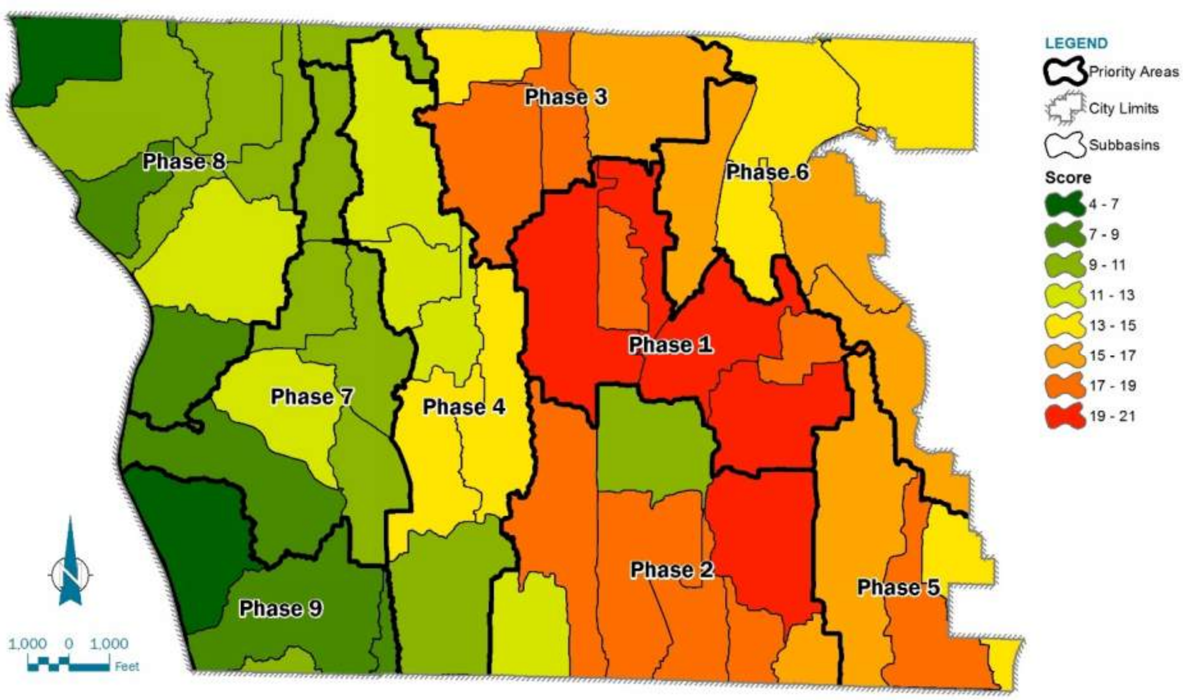

Figure 10. Subbasin priority scores and groupings for phased data collection and model development activities

4.2 Data Collection

As discussed in Section 3.2, the City's geodatabases lack the elevation data needed for model construction. In addition, complex facilities and structures require data beyond what can be contained in an attribute table. Field surveys will likely need to be conducted. Where available, as-built drawings should be reviewed for special structures. Attachment C lists the feature data sets in the City's *Surface Water* geodatabase and highlights key data for use in model development. Typical data needs for modeling include:

- **Pipes:** diameter, upstream invert elevation, downstream invert elevation, depth below grade, depth below rim, length, and material
- **Manholes:** type, size, depth, rim elevation
- **Ponds, vaults, and other storage facilities:** dimensions, stage-storage curve, stage-discharge curve, invert elevations for inlets and outlets.
- **Special structures (flow diversions, splitters, weirs, pump stations, gates, and other hydraulic controls):** dimensions, floor elevations, hydraulic control elevations, inlet/outlet capacities, storage curves, and operating rules.
- **Open channels and ditches:** surveyed cross-sections, slope, culvert dimensions, culvert material, bridge dimensions, roadway elevations, and invert elevations for all structures

4.3 Model Development and Analyses Framework

As data are collected, H&H modeling can be performed to address specific projects or study needs. BC recommends beginning with the top priority (Phase 1) subbasins and developing a tailored modeling plan that focuses on the specific needs to be addressed in those subbasins. Developing the modeling plan should involve the following are basic steps:

- **Clarify the problem:** Defining and analyzing a problem occurs at several levels. The aim is to translate the problem understanding from the planner or policymaker to the modeler to ensure that the modeling effort answers the appropriate questions and provides useful results to inform decisions. The modeling team should craft a problem description and carefully analyze the nuances of the problem to understand the domain, characteristic time scale, spatial scale, and relevant physical processes.
- **Define the objectives:** Building on the problem definition, the goals of the modeling effort should be established and then articulated through specific modeling objectives. There are often goals and objectives for the overarching plan (e.g., the Master Plan)—and while these are related, they are not the same as modeling objectives. This is where the understanding of the problem and the questions at hand are transformed into specific actions that will yield specific results. For example, the modeler should determine which scenarios will be simulated and how those will be defined in model space. Such translations are potentially great sources of misunderstanding and should therefore receive careful and deliberate attention.
- **Specify requirements:** As a modeling approach is developed, the project manager and modeling team can begin to identify project-specific requirements for achieving the modeling objectives. Requirements should address the quality of the calibration and subsequent results, expertise needed to carry out the analyses, time constraints and deadlines for major milestones, communications and reporting protocols, quality assurance/quality control (QA/QC) procedures, and data management practices.

BC will develop a separate technical memorandum titled: *Framework for Hydrologic and Hydraulic Modeling Analyses*, which will describe this process and include a modeling plan for the Phase 1 subbasins. As model development activities continue for subbasins in subsequent phases, the modeling plan can be revisited and improved to address new objectives and apply lessons learned from previous phases.

Section 5: Conclusions

As the City works to evaluate LOS and risks associated the performance of its drainage system, new and updated modeling analyses will be needed to forecast future system demands, identify service gaps, and evaluate capital improvement projects. BC conducted a needs assessment, reviewed existing data, and provided recommendations for prioritizing future data collection and modeling efforts. The following is a summary of the key findings:

- A total of 47 known problems and outstanding projects were identified that could be evaluated, enhanced, or refined through hydrologic and/or hydraulic analyses. Most of these were taken from previous basin planning efforts, however, some problems were identified based on mapped “hot spots,” and others were based on additional areas of interest identified by the City.
- Development standards will substantially mitigate the increases in stormwater runoff associated with new and re-developed areas. However, some small projects may not trigger mitigation requirements, and new developments and redeveloped areas could still require modifications to the City’s drainage system to accommodate new service connections. H&H modeling should be performed to evaluate future service needs, particularly in areas where development densities are expected to significantly increase. Subarea plans provide a strong indication of where redevelopment is likely to occur.
- Areas draining to Echo Lake, Lake Ballinger, Thornton Creek, Lyon Creek and McAleer Creek may need to be evaluated for potential downstream impacts to flooding or water quality conditions within the receiving water. For example, if a TMDL for a downstream water body become a special condition of a future Phase II permit, it could trigger pollutant load reduction requirements for affected stormwater discharges in Shoreline.
- Geotechnical constraints and poorly-drained soils limit the feasibility of LID and onsite stormwater management. More than 16 percent of the city is mapped as having geotechnical constraints (high potential for erosion or landslides) and more than 60 percent is mapped as till soils (low infiltration potential). H&H modeling could be used to evaluate stormwater management alternatives such as constructing regional stormwater facilities at more feasible locations to offset onsite requirements.
- Attribute data such as pipe invert elevations are needed to develop hydraulic models of the drainage system. Previous modeling efforts for the basin plans can provide some information along the main streams, but expanded modeling efforts will require additional data collection.
- BC recommends a phased approach to H&H modeling, focusing foremost on data collection and then on model development. The City should continue to conduct field surveys and collect attribute data for stormwater infrastructure, collecting data according to the priorities shown on Figure 10.
- BC will prepare a follow-up technical memorandum that provides a framework for proceeding through the phased modeling approach. This technical memorandum will include a detailed modeling plan for the Phase 1 subbasins, and guidance on how to revise and update the modeling plan as the City moves into subsequent phases.

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Attachment A: Development Requirement Flow Charts

Flow Chart for Determining Requirements for New Development

Flow Chart for Determining Requirements for Redevelopment

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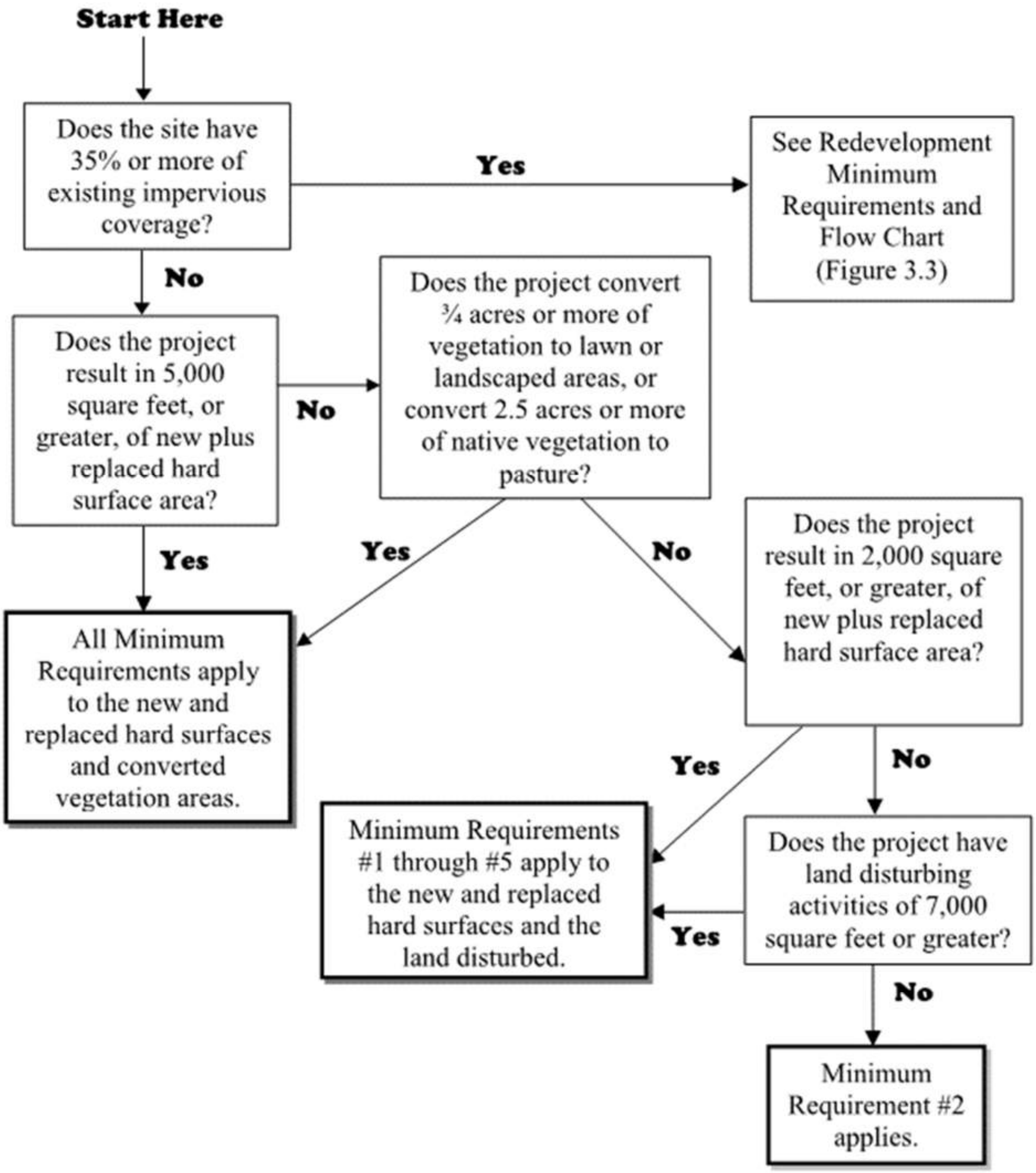

Figure 3.2 Flow Chart for Determining Requirements for New Development

From the Western Washington Phase II Municipal Stormwater Permit

Appendix 1: Minimum Technical Requirements for New Development and Redevelopment (Ecology 2015)

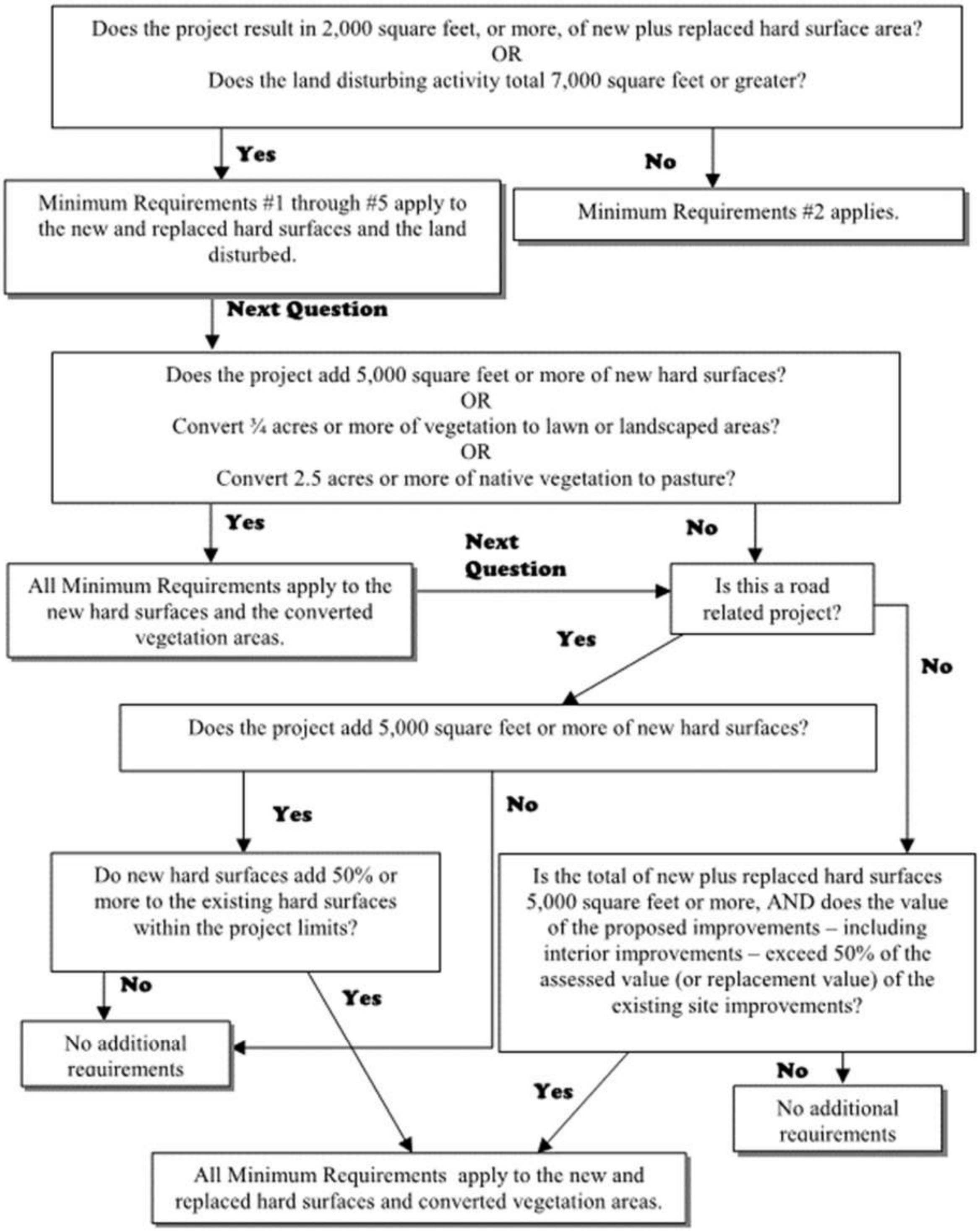

Figure 3.3 Flow Chart for Determining Requirements for Redevelopment

From the Western Washington Phase II Municipal Stormwater Permit

Appendix 1: Minimum Technical Requirements for New Development and Redevelopment (Ecology 2015)

Attachment B: Subbasin Prioritization

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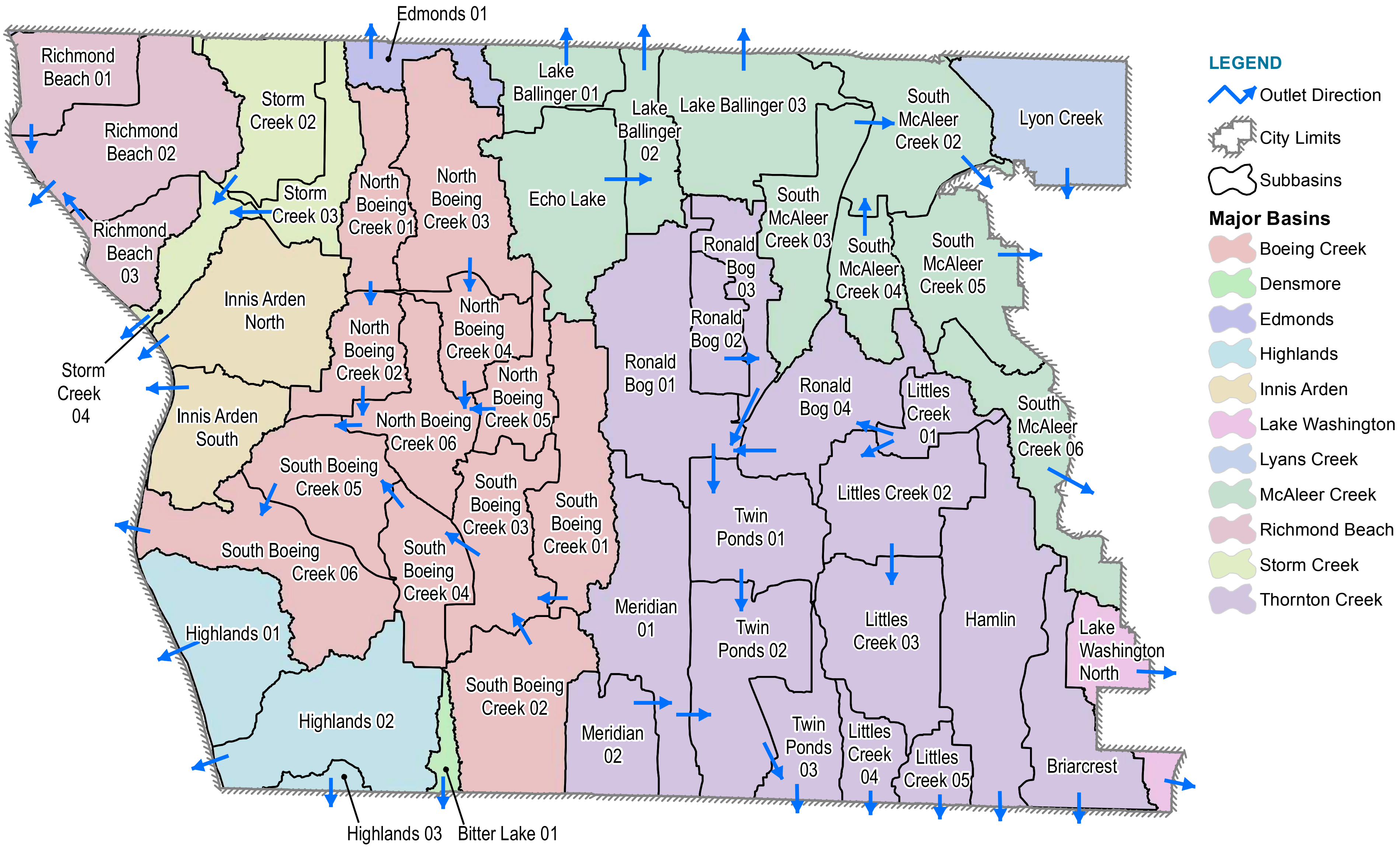
Table B-1. Subbasin Priority Scoring												
Basin	Subbasin	Increase in imperviousness	Number of projects/problems	Geotech/till percentage	Length of pipe (ft)	Projects/problems score	Subarea plan score	Development score	Downstream concern score	Infeasibility score	Infrastructure score	Priority score
Densmore	Bitter Lake 01	44%	0	100%	4,410	1	0	3	0	4	1	9
Boeing Creek	North Boeing Creek 01	15%	0	100%	26,964	1	0	1	0	4	4	10
Boeing Creek	North Boeing Creek 02	33%	0	98%	17,969	1	0	2	0	3	4	10
Boeing Creek	North Boeing Creek 03	35%	0	100%	35,525	1	0	3	0	4	4	12
Boeing Creek	North Boeing Creek 04	42%	1	73%	14,502	3	0	3	0	2	4	12
Boeing Creek	North Boeing Creek 05	33%	1	97%	22,697	3	0	2	0	3	4	12
Boeing Creek	North Boeing Creek 06	37%	0	70%	18,731	1	0	3	0	2	4	10
Boeing Creek	South Boeing Creek 01	23%	1	88%	53,474	3	4	1	0	3	4	15
Boeing Creek	South Boeing Creek 02	34%	3	55%	39,597	4	0	2	0	1	4	11
Boeing Creek	South Boeing Creek 03	29%	1	93%	31,552	3	4	1	0	3	4	15
Boeing Creek	South Boeing Creek 04	35%	0	99%	14,188	1	0	2	0	4	4	11
Boeing Creek	South Boeing Creek 05	33%	0	99%	8,849	1	4	2	0	4	2	13
Boeing Creek	South Boeing Creek 06	55%	0	80%	8,015	1	0	4	0	2	2	9
Edmonds	Edmonds 01	33%	0	98%	9,734	1	0	2	0	4	3	10
Highlands	Highlands 01	0%	0	41%	0	1	0	1	0	1	1	4
Highlands	Highlands 02	48%	0	39%	0	1	0	4	0	1	1	7
Highlands	Highlands 03	58%	0	83%	6,638	1	0	4	0	2	1	8
Innis Arden	Innis Arden North	63%	0	100%	0	1	0	4	0	4	1	10
Innis Arden	Innis Arden South	36%	5	56%	23,741	4	0	3	0	1	4	12
Lake Washington	Lake Washington North	38%	0	91%	7,700	1	0	3	0	3	2	9
Lyon Creek	Lyon Creek	38%	2	82%	8,123	4	4	3	0	2	2	15
McAleer Creek	Echo Lake	44%	1	15%	37,478	3	4	3	0	1	4	15
McAleer Creek	Lake Ballinger 01	31%	1	95%	46,515	3	4	1	4	3	4	19
McAleer Creek	Lake Ballinger 02	26%	0	100%	24,425	1	0	1	4	4	4	14
McAleer Creek	Lake Ballinger 03	34%	2	100%	19,735	4	0	2	4	4	4	18

Table B-1. Subbasin Priority Scoring												
Basin	Subbasin	Increase in imperviousness	Number of projects/problems	Geotech/till percentage	Length of pipe (ft)	Projects/problems score	Subarea plan score	Development score	Downstream concern score	Infeasibility score	Infrastructure score	Priority score
McAleer Creek	South McAleer Creek 02	54%	0	96%	27,620	1	0	4	4	3	4	16
McAleer Creek	South McAleer Creek 03	0%	0	2%	231	1	0	1	4	1	1	8
McAleer Creek	South McAleer Creek 04	53%	0	17%	24,241	1	0	4	4	1	4	14
McAleer Creek	South McAleer Creek 05	68%	2	59%	14,656	4	0	4	4	2	3	17
McAleer Creek	South McAleer Creek 06	69%	1	16%	6,670	3	0	4	4	1	2	14
Richmond Beach	Richmond Beach 01	37%	2	32%	23,090	4	0	3	4	1	4	16
Richmond Beach	Richmond Beach 02	42%	2	78%	18,516	4	0	3	4	2	4	17
Richmond Beach	Richmond Beach 03	27%	0	53%	17,149	1	0	1	0	1	3	6
Storm Creek	Storm Creek 02	26%	6	81%	42,855	4	0	1	0	2	4	11
Storm Creek	Storm Creek 03	31%	1	42%	5,960	3	0	2	0	1	2	8
Storm Creek	Storm Creek 04	100%	0	80%	2,052	1	0	4	0	2	1	8
Thornton Creek	Briarcrest	41%	1	48%	21,157	3	0	2	0	1	4	10
Thornton Creek	Hamlin	30%	2	84%	16,903	4	0	1	0	2	4	11
Thornton Creek	Littles Creek 01	52%	3	29%	7,884	4	0	3	0	1	2	10
Thornton Creek	Littles Creek 02	29%	0	99%	31,870	1	4	1	4	4	4	18
Thornton Creek	Littles Creek 03	39%	0	66%	41,119	1	4	2	4	2	4	17
Thornton Creek	Littles Creek 04	34%	1	85%	16,268	3	4	1	4	3	4	19
Thornton Creek	Littles Creek 05	39%	4	59%	22,300	4	4	2	4	2	4	20
Thornton Creek	Meridian 01	48%	1	81%	26,398	3	4	3	4	2	4	20
Thornton Creek	Meridian 02	70%	0	98%	3,867	1	4	4	4	4	1	18
Thornton Creek	Ronald Bog 01	57%	0	91%	9,658	1	4	3	4	3	2	17
Thornton Creek	Ronald Bog 02	41%	0	98%	37,206	1	4	2	4	4	4	19
Thornton Creek	Ronald Bog 03	43%	0	85%	21,022	1	0	2	4	3	3	13
Thornton Creek	Ronald Bog 04	42%	1	96%	49,220	3	4	2	4	3	4	20
Thornton Creek	Twin Ponds 01	58%	0	100%	9,402	1	4	4	4	4	2	19
Thornton Creek	Twin Ponds 02	71%	0	96%	17,720	1	4	4	4	3	4	20
Thornton Creek	Twin Ponds 03	72%	3	27%	25,486	4	4	4	4	1	4	21



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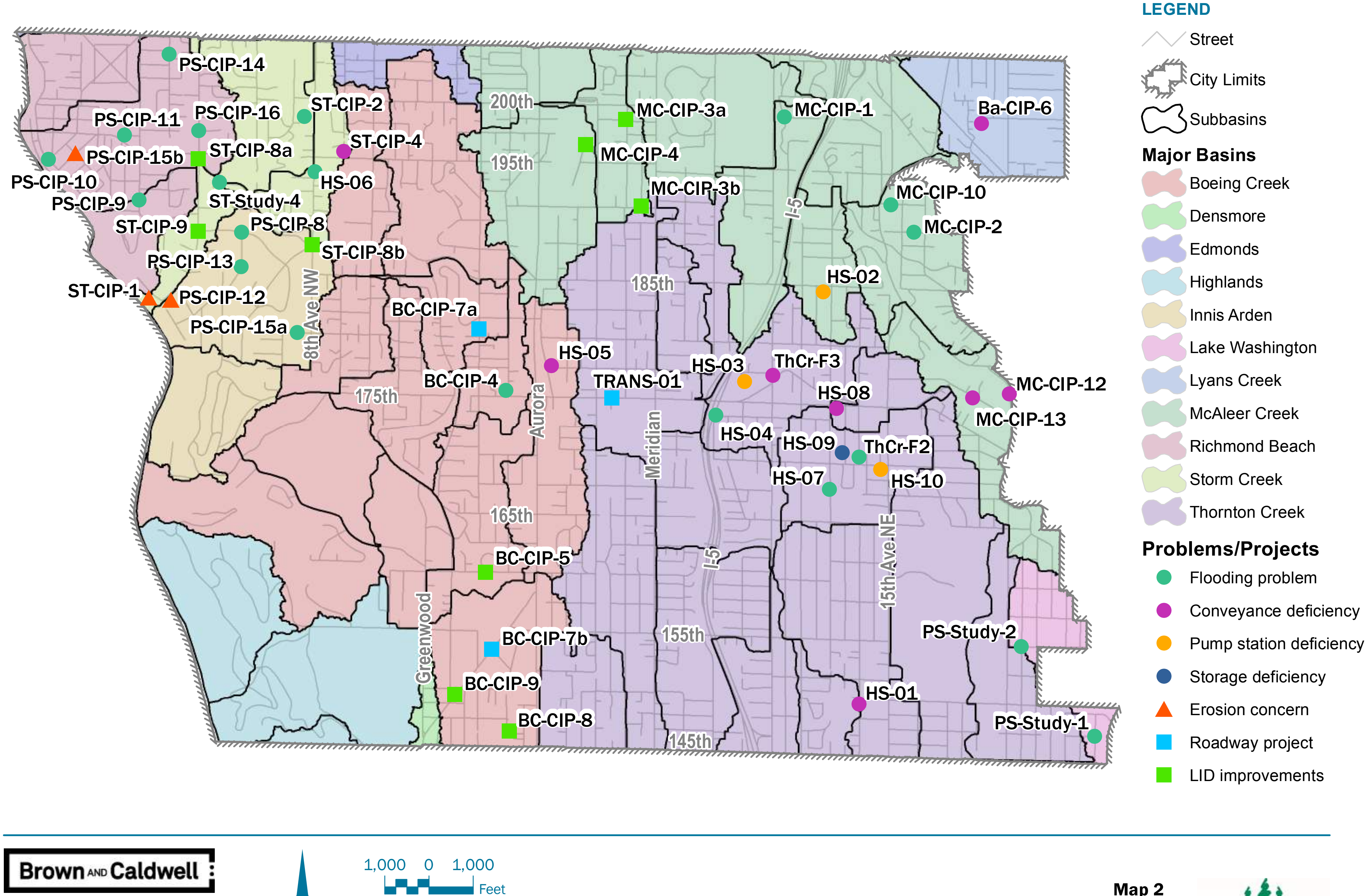
Map 1

Subbasins for Model Prioritization

Approach to H&H Modeling Analyses (D31)

Surface Water Master Plan

CITY OF SHORELINE



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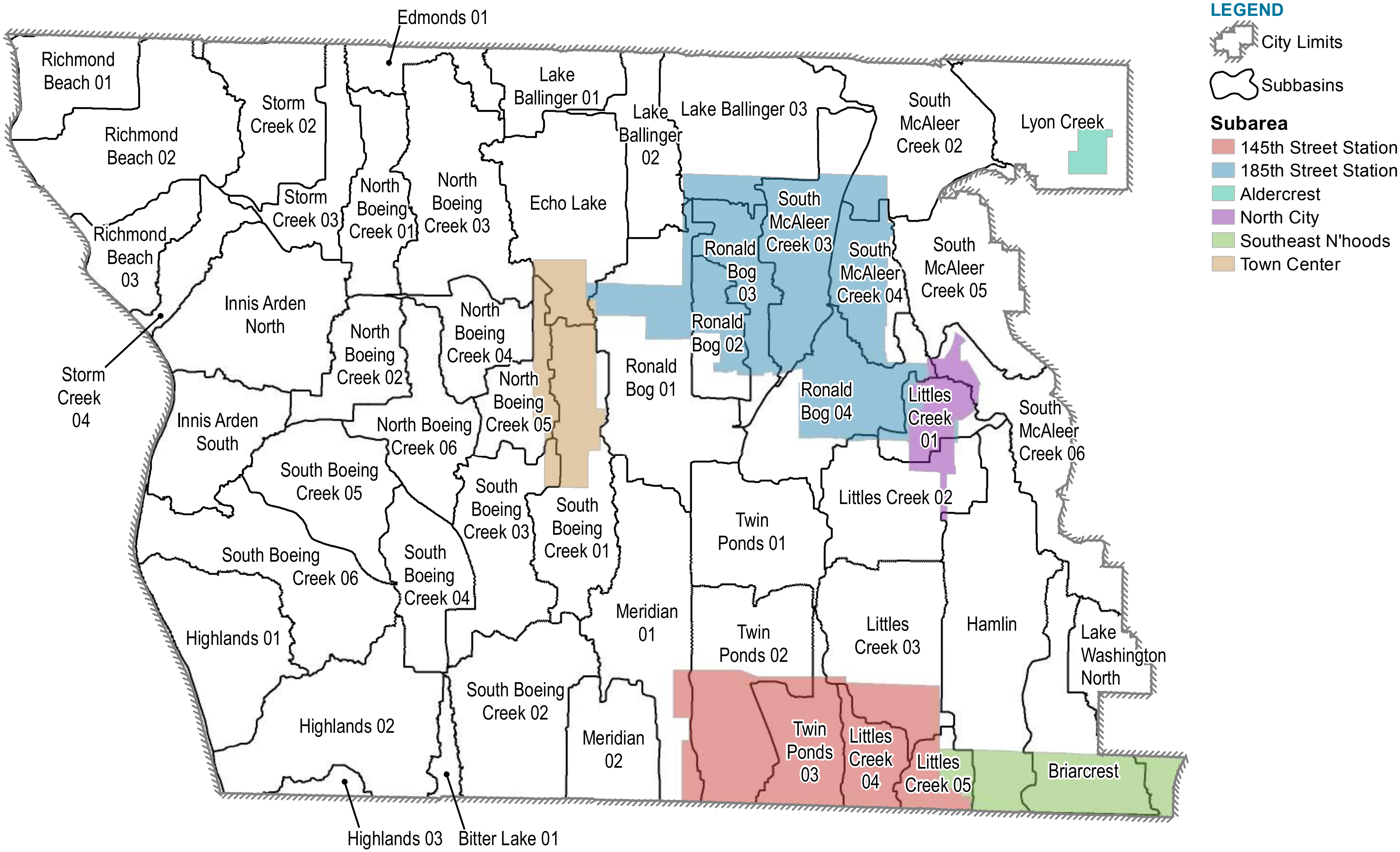
Map 2

Known Problems and Project by Subbasin

Approach to H&H Modeling Analyses (D31)

Surface Water Master Plan

CITY OF SHORELINE



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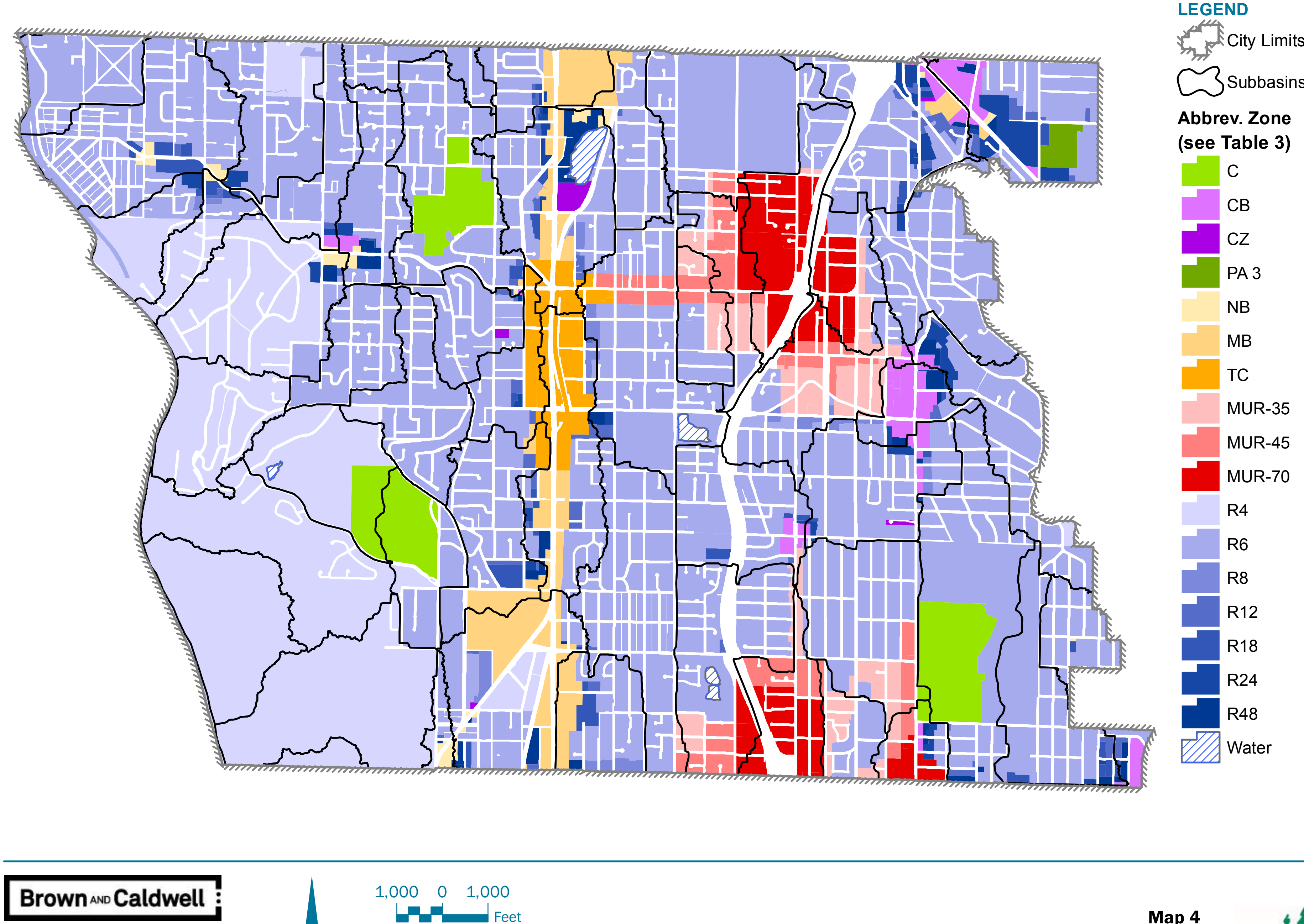
Map 3

Subarea Planning Areas

Approach to H&H Modeling Analyses (D31)

Surface Water Master Plan

CITY OF SHORELINE



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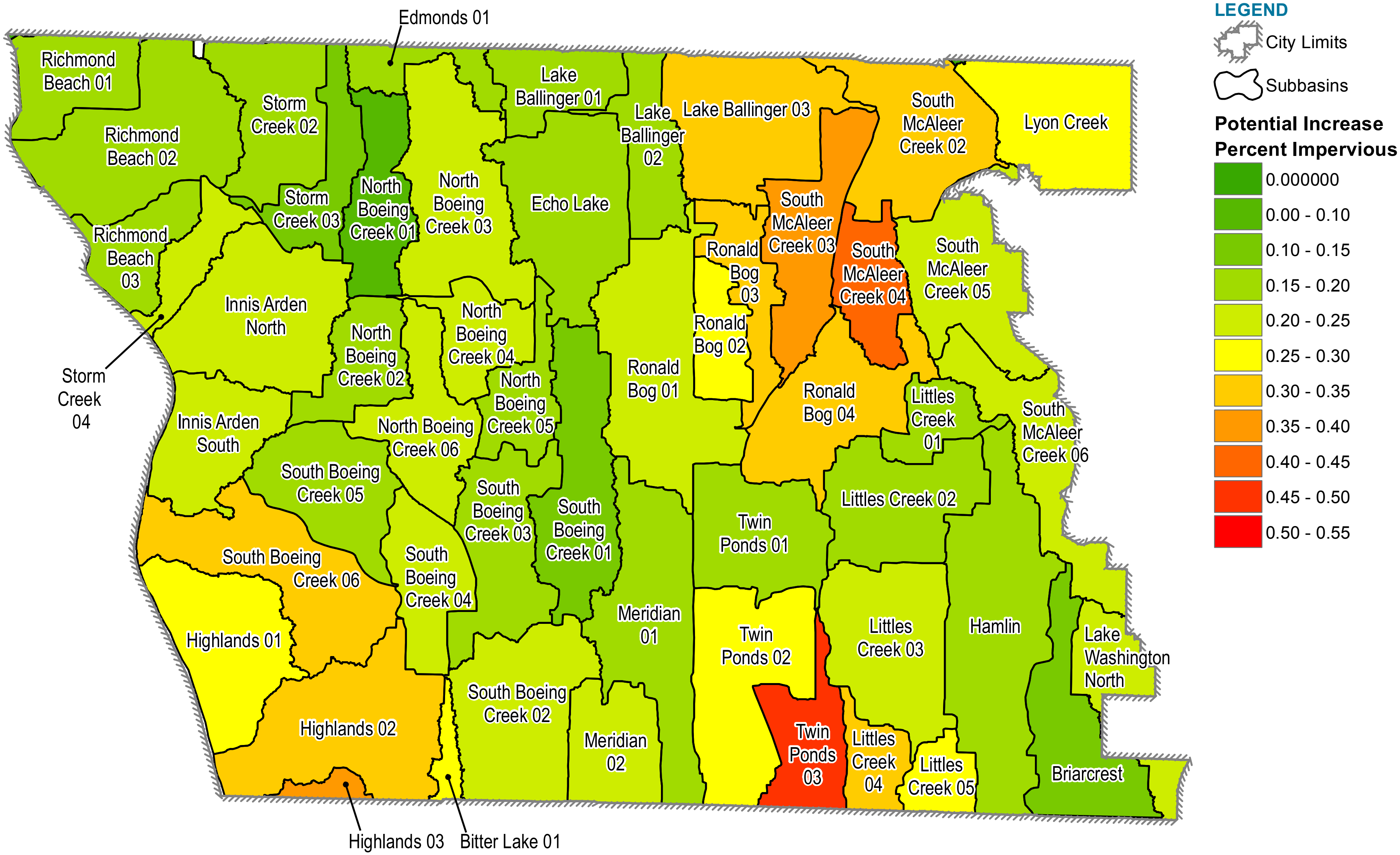
Map 4

Zoning Used for Future Imperviousness Analysis

Approach to H&H Modeling Analyses (D31)

Surface Water Master Plan

CITY OF SHORELINE



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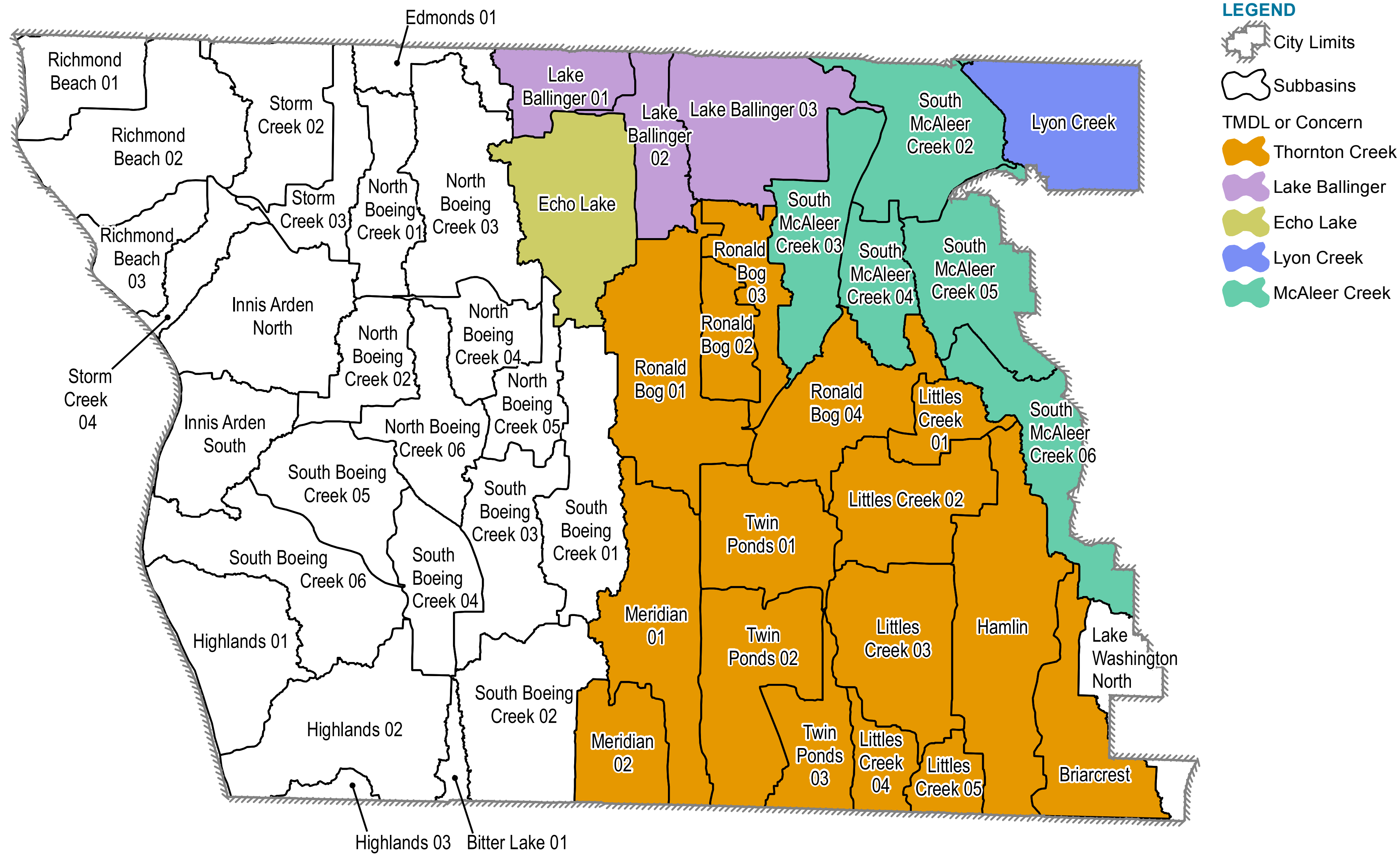
Map 5

Potential Increase in Impervious at Buildout

Approach to H&H Modeling Analyses (D31)

Surface Water Master Plan

CITY OF SHORELINE



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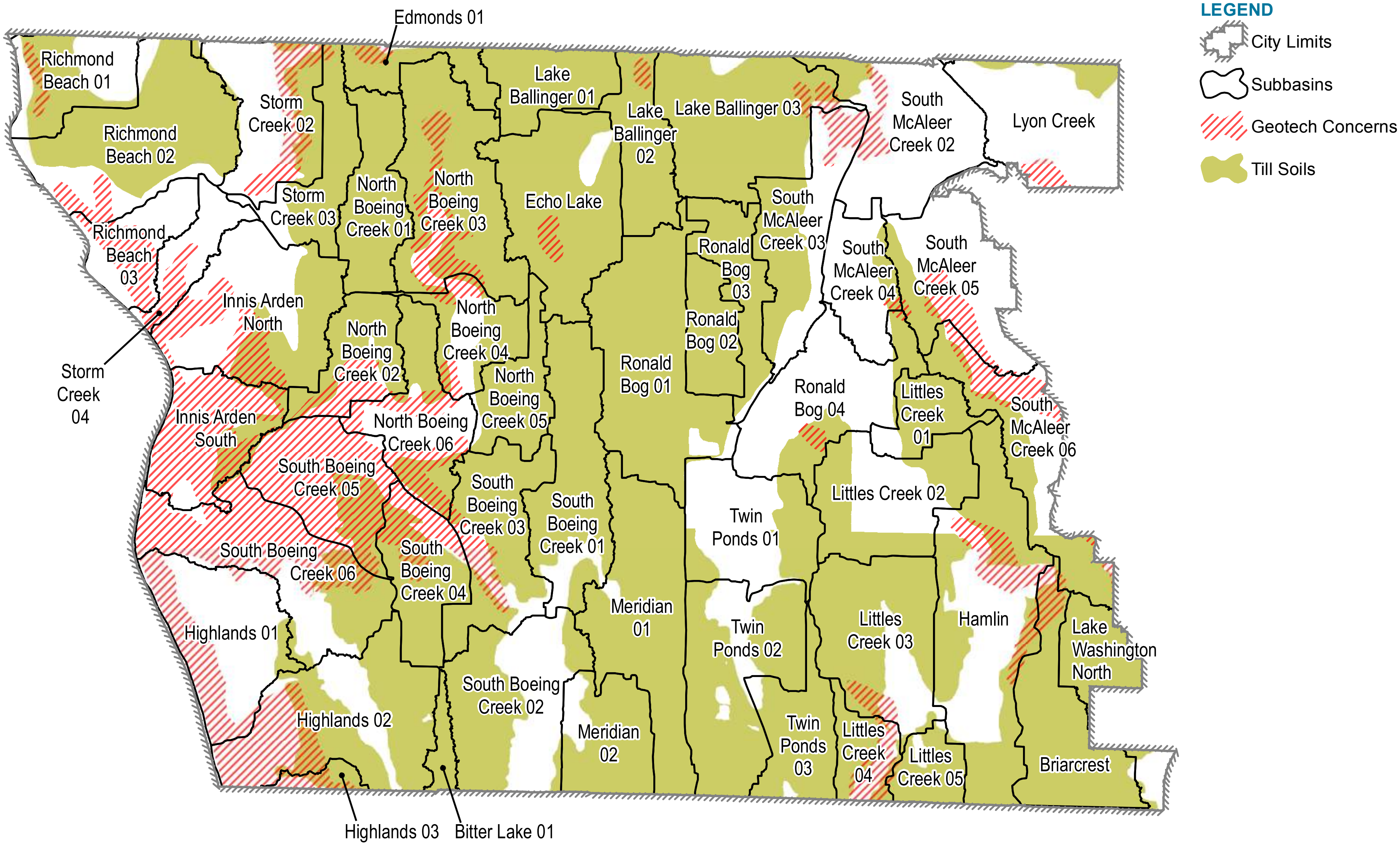
Map 6

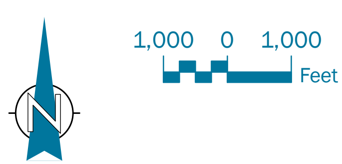
Basins with Potential Concerns Downstream

Approach to H&H Modeling Analyses (D31)

Surface Water Master Plan

CITY OF SHORELINE





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Map 7

Feasibility Constraints for Onsite Stormwater Management

Approach to H&H Modeling Analyses (D31)

Surface Water Master Plan

CITY OF SHORELINE

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Attachment C: Feature GIS Data Sets and Key Attributes

Table C-1. Metadata and Modeling Needs for Feature Data Sets in *SurfaceWater* Geodatabase

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Table C-1. Metadata and Modeling Needs for Feature Data Sets in *SurfaceWater* Geodatabase				
Feature Class	Summary (from metadata)	Description (from metadata)	Source (from metadata)	Modeling Need
swAccessRiser	This inventory of the City's stormwater access risers was created for surface water site investigations, permitting, and asset management.	This feature class contains the locations and details of the access risers within the City of Shoreline.	These assets were digitized based on Engineering Record Drawings and in the field observations.	Low
swBasin	This feature class was developed to divide the City of Shoreline's water-sheds into drainage basins and subbasins for planning and analysis purposes.	This feature class was developed to divide the City of Shoreline's watersheds into drainage basins and subbasins for planning purposes. There are two watersheds within the City of Shoreline - Central Puget Sound Watershed and Cedar River-Lake Washington Watershed.	Field studies and surface water inventories were used to divide these watersheds into 6 basins and then into subbasins.	Low
swBerm	This inventory of the City's stormwater berms was created for surface water site investigations, permitting, and asset management.	This feature class contains the locations and details of berms within the City of Shoreline. Berms is primarily used to divert street water sheet flow to prevent localized flooding. Berms are intended to divert flow into catch basins or ditches and are usually formed as a ridge of asphalt several inches high and wide.	Berms were mapped by college volunteers using IPads and ArcGIS Online. Mapping accuracy was aided with the use of 2012 high resolution/high accuracy aerial photograph	Medium
swBioRentention	This inventory of the City's stormwater bioretention facilities was created for surface water site investigations, permitting, and asset management.	This feature class contains the locations and details of the bioretention facilities within the City of Shoreline.	These assets were digitized based on Engineering Record Drawings and in the field observations.	Medium
swCatchBasin	This inventory of the City's stormwater catch basin, area drains, yard drains, and downspoint drains was created for surface water site investigations, permitting, and asset management.	This feature class contains the locations and details of catch basin, area drains, yard drains, and downspoint drains within the City of Shoreline.	These assets were digitized based on data initially received from King County and then updated wtih Engineering Record Drawings and field observations.	Medium
swControlPanel	This inventory of the City's stormwater Pump Control Panels was created for surface water site investigations, permitting, and asset management.	This feature class contains the locations and details of Pump Control Panels within the City of Shoreline.	These assets were digitized based on Engineering Record Drawings and in the field observations.	Medium
swCulvert	This inventory of the City's stormwater culverts was created for surface water site investigations, permitting, and asset management.	This feature class contains the locations and details of culverts within the City of Shoreline.	These assets were digitized based on Engineering Record Drawings and in the field observations.	High[a]
swDam	This inventory of the City's stormwater dams was created for surface water site investigations, permitting, and asset management.		These assets were digitized based on Engineering Record Drawings and in the field observations.	Medium
swDitch	This inventory of the City's stormwater ditches was created for surface water site investigations, permitting, and asset management.	This feature class contains the locations and details of ditches within the City of Shoreline.	These assets were digitized based on Engineering Record Drawings and in the field observations.	High[a]
swDrain	This inventory of the City's stormwater drains was created for surface water site investigations, permitting, and asset management.	This feature class contains the locations and details of drains within the City of Shoreline. This dataset includes french drains, under drains, and trench drains. French drains work in the opposite manner as a infiltration pipes. French drains collect	These assets were digitized based on Engineering Record Drawings and in the field observations.	Medium

Table C-1. Metadata and Modeling Needs for Feature Data Sets in *SurfaceWater* Geodatabase

Feature Class	Summary (from metadata)	Description (from metadata)	Source (from metadata)	Modeling Need
		water which is then routed to another location.		
swDrainagePlans	This dataset was created for Surface Water Planning purposes. It depicts the boundaries for each Drainage Basin Plan	This dataset depicts the boundaries for each Drainage Basin Plan. It does NOT depict the actual basin boundaries, although the names are similar. This is for the Basin Plan only.	Surface Water Basin feature class was exported on 2/6/2015. This exported feature class was then renamed and edited to depict the Surface Water Drainage Basin Plan Boundaries. Non-applicable fields were deleted and other fields were added and populated.	Low
swFacility	This inventory of the City's stormwater Facility Inspection areas was created for surface water site investigations, permitting, and asset management.	This feature class contains the locations and details of Facility Inspection areas within the City of Shoreline.	These assets were digitized based on King County data and in the field observations.	Low
swFilterra	This inventory of the City's stormwater filterra was created for surface water site investigations, permitting, and asset management.	This feature class contains the locations and details of filterra within the City of Shoreline.	These assets were digitized based on Engineering Record Drawings and in the field observations.	Low
swFilterStrip	This inventory of the City's stormwater filter strips was created for surface water site investigations, permitting, and asset management.	This feature class contains the locations and details of filter strips within the City of Shoreline.	These assets were digitized based on Engineering Record Drawings and in the field observations.	Medium
swFitting	This inventory of the City's stormwater Pipe Fittings was created for surface water site investigations, permitting, and asset management.	This feature class contains the locations and details of Pipe Fittings within the City of Shoreline.	These assets were digitized based on Engineering Record Drawings and in the field observations.	Low
swFloodPlain	This inventory of the City's stormwater floodplain is maintained for surface water site investigations, permitting, and asset management.	This feature class contains the locations and details of floodplain within the City of Shoreline and some of the surrounding areas.	This dataset was created by FEMA and is updated as needed with local survey results.	Medium
swFloodWall	This inventory of the City's stormwater flood walls was created for surface water site investigations, permitting, and asset management.	This feature class contains the locations and details of flood walls within the City of Shoreline.	These assets were digitized based on Engineering Record Drawings and in the field observations.	Medium
swFlowDirection	This inventory of the City's stormwater flow direction arrows was created for surface water site investigations, permitting, and asset management. This is NOT a physical asset of the City of Shoreline. These data are for GRAPHIC information purposes ONLY to aid in the understanding of the flow direction of the stormwater system.	This feature class contains the locations and details of flow direction arrows within the City of Shoreline.	These assets were digitized based on Engineering Record Drawings and in the field observations.	Medium
swFlowSplitter	This inventory of the City's stormwater flow splitters was created for surface water site investigations, permitting, and asset management.	This feature class contains the locations and details of flow splitters within the City of Shoreline.	These assets were digitized based on Engineering Record Drawings and in the field observations.	High[b]
swGateValve	This inventory of the City's stormwater gate valves was created for surface	This feature class contains the locations and details of gate valves within the City of	These assets were digitized based on Engineering Record	High[b]

Table C-1. Metadata and Modeling Needs for Feature Data Sets in *SurfaceWater* Geodatabase				
Feature Class	Summary (from metadata)	Description (from metadata)	Source (from metadata)	Modeling Need
	water site investigations, permitting, and asset management.	Shoreline.	Drawings and in the field observations.	
swGuage	This inventory of the City's stormwater staff gauges was created for surface water site investigations, permitting, and asset management.	This feature class contains the locations and details of staff gauges within the City of Shoreline. These staff gauges measure the water levels from bottom of water body.	These assets were digitized based on Engineering Record Drawings and in the field observations.	Medium
swHotSpot	The purpose of the layer is the depict the locations of the Hot Spot Inspection Locations.	This information was inherited from King County based on local knowledge of known areas of concern for Surface Water issues.	This information was inherited from King County based on local knowledge of known areas of concern for Surface Water issues.	Low
swInfiltration	This inventory of the City's stormwater infiltration features was created for surface water site investigations, permitting, and asset management.	This feature class contains the locations and details of infiltration features within the City of Shoreline.	These assets were digitized based on Engineering Record Drawings and in the field observations.	Medium
swManhole	This inventory of the City's stormwater manhole was created for surface water site investigations, permitting, and asset management.	This feature class contains the locations and details of manhole within the City of Shoreline.	These assets were digitized based on Engineering Record Drawings and in the field observations.	High[c]
swMediaFilter-Drain	This inventory of the City's stormwater Media Filter Drains was created for surface water site investigations, permitting, and asset management.	This feature class contains the locations and details of Media Filter Drains within the City of Shoreline.	These assets were digitized based on Engineering Record Drawings and in the field observations.	Medium
swNatural-Channel	Support City of Shoreline's Asset Management system.	A stream or other natural channel that conveys surface water flow. It is differentiated from ditches and pipes that are man made features.		High[a]
swOutfall	Provides the map of discharges of City outfalls into streams, lakes, main line pipes and ditches.	Those discharges into streams or lakes are considered MS4 outfalls and are regulated by the State and Federal government as part of the NPDES program.		High[b]
swPermeable-Pavement	This inventory of the City's stormwater Permeable Pavement was created for surface water site investigations, permitting, and asset management.	This feature class contains the locations and details of Permeable Pavement within the City of Shoreline.	These assets were digitized based on Engineering Record Drawings and in the field observations.	Medium
swPipe	This inventory of the City's stormwater pipes was created for surface water site investigations, permitting, and asset management.	This feature class contains the locations and details of stormwater pipes within the City of Shoreline. Stormwater pipes are designed to convey storm water. The direction of the pipes is matches the drainage flow and is contained in the topology of the geodatabase. This dataset supports our surface water utility and its associated regulatory, monitoring, and asset management processes.	These assets were digitized based on Engineering Record Drawings and in the field observations.	High[d]
swPipeInlet	This inventory of the City's stormwater pipe inlets was created for surface water site investigations, permitting, and asset management.	This feature class contains the locations and details of pipe inlets within the City of Shoreline.	These assets were digitized based on Engineering Record Drawings and in the field observations.	Medium
swPond	This inventory of the City's stormwater	This feature class contains the locations	These assets were digitized	High[b]

Table C-1. Metadata and Modeling Needs for Feature Data Sets in *SurfaceWater* Geodatabase				
Feature Class	Summary (from metadata)	Description (from metadata)	Source (from metadata)	Modeling Need
	ponds was created for surface water site investigations, permitting, and asset management.	and details of ponds within the City of Shoreline.	based on Engineering Record Drawings and in the field observations.	
swRainGarden	This inventory of the City's stormwater rain gardens and conservation landscape areas was created for surface water site investigations, permitting, and asset management.	This feature class contains the locations and details of rain gardens and conserva-tion landscape areas within the City of Shoreline.	These assets were digitized based on Engineering Record Drawings and in the field observations.	Medium
swSwale	This inventory of the City's stormwater Bioinfiltration Swales was created for surface water site investigations, permitting, and asset management.	This feature class contains the locations and details of Bioinfiltration Swales within the City of Shoreline.	These assets were digitized based on Engineering Record Drawings and in the field observations.	Medium
swUnconfirmed	This inventory of the City's stormwater Unconfirmed Pipe Connections was created for surface water site investiga-tions, permitting, and asset manage-ment.	This feature class contains the locations and details of Unconfirmed Pipe Connec-tions within the City of Shoreline.	These assets were digitized based on Engineering Record Drawings and in the field observations.	Medium
swVault	This inventory of the City's stormwater Vaults was created for surface water site investigations, permitting, and asset management.	This feature class contains the locations and details of Stormwater Vaults within the City of Shoreline. Underground detention of stormwater including wet vaults, an underground structure similar in appear-ance to a detention vault, except that a wet vault has a permanent pool of water that dissipates energy and improves the settling of particulate pollutants.	These assets were digitized based on Engineering Record Drawings and in the field observations.	High[b]
swWaterQuality-Sample	This inventory of the City's stormwater Water Quality Sample Sites was created for surface water site investigations, permitting, and asset management.	This feature class contains the locations and details of Water Quality Sample Sites within the City of Shoreline.	These assets were digitized based on Engineering Record Drawings and in the field observations.	Low

a. *Conveyance features (links) require basic inputs for cross-sectional geometry, invert elevations, slope, and roughness of the material or lining.*

b. *Special structures need to be described in terms of configuration and dimensions such that hydraulic functions can be simulated; storage facilities such as ponds and vaults require dimensions and elevations for stage-storage and stage-discharge relationships.*

c. *Manholes are important nodes in the drainage network; key attributes in the geodatabase include: Wall_Diameter; Wall_Material; MHDPTH; FeatureType; FLOW_CNTRL; PUMP; Rim_To_Invert; Grade_To_Invert; Rim_To_Grade.*

e. *Pipes are important links in the drainage network; key attributes in the geodatabase include: DWNDPTH; DWNELEV; PIPEDIAM; PIPESHP; UPSDPTH; UPSELEV; PipeMaterial; FeatureType; PipeLength; Up_Rim_to_Invert; Up_Grade_Invert; Up_Rim_to_Grade; Down_Rim_to_Invert; Down_Grade_Invert; Down_Rim_to_Grade; LiningMaterial; PipeWidth; Upstream_MH; Downstream_MH*

Appendix F: Water Quality Treatment Evaluations

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Technical Memorandum

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T: 206.624.0100
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Prepared for: City of Shoreline

Project title: Shoreline Surface Water Master Plan

Project no.: 149479

Deliverable D09 (Revised)

Subject: Comparison of Stormwater Treatment Options

Date: December 22, 2016

To: Uki Dele, P.E.

From: Nathan Foged, P.E.

Prepared by: Michael Milne

Reviewed by: Abbi Dorn, P.E.
Damon Diessner

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List of Abbreviations

B-IBI	benthic index of biotic integrity
BC	Brown and Caldwell
BMP	best management practice
City	City of Shoreline
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
GSI	green stormwater infrastructure
LID	low-impact development
O&M	operations and maintenance
Phase I Permit	Phase I Municipal Stormwater Permit
Phase II Permit	Phase II Municipal Stormwater Permit
SCC	Shoreline Community College
SOW	scope of work
TMDL	total maximum daily load
WSDOT	Washington State Department of Transportation

Section 1: Introduction

Brown and Caldwell (BC) is working with the City of Shoreline (City) to prepare an updated Surface Water Master Plan (Master Plan) for the Surface Water Utility (Utility) that will address drainage and water quality issues associated with growth, increasing regulations, and aging infrastructure. The Master Plan will guide Utility activities for the next 5 to 10 years and will include recommendations for capital improvement projects, policies, programs, and a financial plan for long-term asset management.

One of the primary goals of the Master Plan is to provide guidance and recommendations on how to comply with regulatory requirements, particularly those specified by the Washington State Phase II Municipal Stormwater Permit (Phase II Permit). The City has asked BC to examine stormwater treatment options by comparing regional (sometimes viewed as “end-of-pipe”) facilities with distributed best management practices (BMPs) such as green stormwater infrastructure (GSI). As part of this, the City requested a preliminary evaluation and relative comparison of stormwater treatment costs for each of these options.

Section 2: Stormwater Treatment Requirements

Stormwater discharges from the City are covered by the Phase II Permit. The Phase II permit regulates municipal separate storm sewer (MS4) discharges to receiving water bodies such as creeks, streams, rivers, lakes, wetlands, marine waters, or groundwater. The Phase II Permit requires treatment and flow control for stormwater discharges from new development and redevelopment projects that exceed certain thresholds. New development projects that add 5,000 square feet of new hard surfaces, or convert 0.75 acres of vegetation to lawn or landscaping, typically must treat runoff and control flow rates from the new and replaced hard surfaces or lawn/landscaped areas. Redevelopment projects that exceed these criteria typically must treat and control flows from the new hard surfaces and converted pervious areas. Redevelopment projects must also treat the replaced hard surfaces if the valuation of the proposed improvements exceeds 50 percent of the valuation of the existing site improvements.

The Phase II Permit requires application of low-impact development (LID) principles and LID BMPs (also known as GSI) to make LID the preferred and most commonly used approach to site development. Examples of LID BMPs or GSI include bioretention, rain gardens, permeable pavement, vegetated roofs, downspout controls, and dispersion. Other types of stormwater BMPs, such as wet ponds or media filters, can be implemented to meet permit requirements for new and redevelopment projects where LID opportunities are limited by site conditions.

In certain situations, regional facilities may be used instead of onsite BMPs to meet permit requirements for multiple new development or redevelopment projects within a catchment area. However, the regional facility must be operational before the new or redevelopment activity occurs and the permittee must demonstrate that the regional facility will fulfill the new and redevelopment requirements, such that onsite treatment is not needed.

The current Phase II Permit does not generally require retrofitting to treat or control runoff from previously developed areas. In contrast, the Washington State Phase I Municipal Stormwater Permit (Phase I Permit), which applies to large jurisdictions (populations greater than 100,000), requires the permittee to develop a structural control program to reduce stormwater impacts from existing developed areas as well as future development. It is possible that a similar requirement could be added to the next Phase II Permit, which is expected to be issued in 2018.

Although the current Phase II Permit does not explicitly require treatment or flow control for runoff from existing development, it does require compliance with any total maximum daily loads (TMDLs) established for water bodies that receive municipal stormwater runoff. Phase II permittees whose stormwater drains to TMDL water bodies might need to implement regional projects, distributed BMPs, and/or GSI to reduce stormwater pollutant loads from existing development.

The Washington State Department of Ecology (Ecology) performs a statewide Water Quality Assessment every 2 to 4 years to identify water bodies that do not meet the state water quality standards. Water bodies that do not meet standards are placed on the Clean Water Act Section 303(d) list. Ecology develops TMDLs for the water bodies on the 303(d) list to bring them into compliance with water quality standards. TMDLs typically apply to the watershed areas that contribute flow to the 303(d)-listed reaches.

Although McAleer Creek is the only water body within Shoreline on the current 303(d) list, several watersheds within the city contribute flow to downstream 303(d)-listed water bodies. Figure 2 shows the areas potentially affected by TMDLs for 303(d)-listed water bodies.

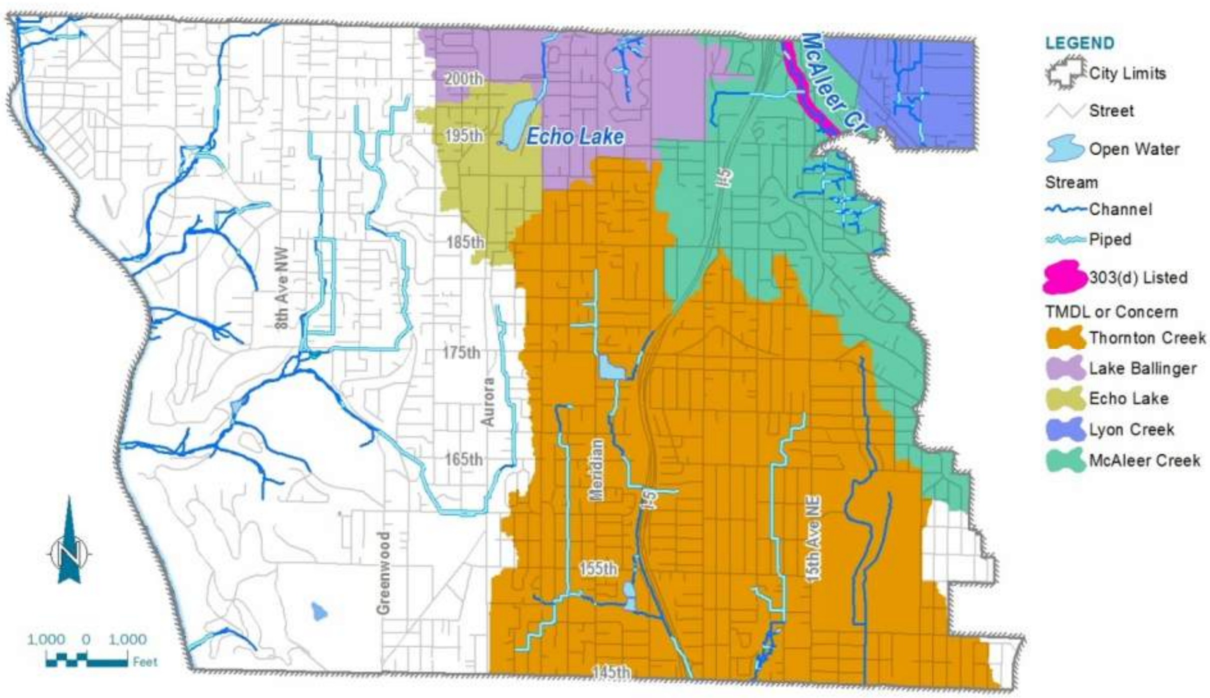

Figure 1. Areas potentially affected by TMDL or "waters of concern"

McAleer Creek is on the 303(d) list for fecal coliform bacteria, dissolved oxygen, water temperature, and low benthic index of biotic integrity (B-IBI) scores. Ecology has established a TMDL to limit phosphorus discharges to Lake Ballinger, which receives drainage from a portion of Shoreline. Reaches of Thornton Creek downstream of Shoreline are on the 303(d) list for bacteria, dissolved oxygen, and water temperature. Echo Lake is listed as a water body of concern because of elevated fecal coliform bacteria concentrations.

TMDLs for water bodies downstream of Shoreline could trigger pollutant load reduction requirements for stormwater discharges in Shoreline. TMDL requirements become a special condition of the next Phase II Permit after the TMDL has been developed by Ecology and approved by the U.S. Environmental Protection Agency (EPA). The TMDL could require treatment or removal of stormwater runoff from existing developed areas that drain to the affected water bodies. Thus, TMDLs could affect future stormwater treatment requirements for the highlighted areas on Figure 1.

Section 3: Comparison of Stormwater Treatment Options

The City could use regional facilities, LID/GSI, and/or other stormwater BMPs to meet Phase II Permit requirements for new and redeveloped areas, as well as potential future TMDL requirements. The following sections summarize the pros and cons of each.

3.1 Regional Facilities

Regional stormwater facilities are typically located within the downstream portion of a basin and are sized to accommodate multiple development projects (both new development and redevelopment). Regional stormwater facilities can include wet ponds, vaults, media filters, infiltration basins, constructed wetlands, treatment trains (e.g., hydrodynamic separator followed by media filter), and even chemical treatment systems. Regional facilities can be used to meet new and redevelopment requirements and/or TMDL requirements as noted above. To use a regional facility in lieu of onsite controls, the jurisdiction or developer must prepare a basin plan or similar documentation showing that the regional facility provides an equivalent or better treatment/flow control than onsite facilities. The facility must be installed and operational before the new or redevelopment occurs.

Potential advantages of regional facilities include:

- Regional facilities can allow jurisdictions to take advantage of favorable site conditions, existing infrastructure, and other opportunities to reduce stormwater management costs for new and redevelopment. For example,
  - The City of Puyallup recently installed a system to divert downtown-area stormwater runoff away from a sensitive creek with TMDL and flow control requirements and conveyed the runoff directly to the Puyallup River, which is not subject to TMDL or flow control requirements. Puyallup would need to spend approximately $10M to build the infrastructure required to convey stormwater to the diversion pipe. Once these conveyance improvements are in place, new and redevelopment in the downtown area would not need to meet flow control (MR 7) requirements. Initial estimates indicate that this regional system could reduce the total stormwater management costs for the downtown area by $7.5M to $25M.
  - Spokane County identified several permeable "paleochannels" in an area zoned for commercial development near the Spokane International Airport where a regional facility would allow stormwater infiltration at a fraction of the cost of onsite detention.

  Shoreline recently evaluated regional and onsite approaches to meet flow control requirements for the redevelopment of the Aurora Square area. The preliminary analysis identified two regional stormwater flow control alternatives (KPG, 2014). One alternative would take advantage of infiltrative soils at the Shoreline Community College (SCC) campus while the other would enlarge an existing City pond on Boeing Creek. This preliminary analysis indicated that both regional alternatives would be considerably less expensive per volume treated than onsite flow control.
- Regional facilities can incorporate advanced technologies to meet project objectives. These technologies might not be cost-effective when implemented at onsite BMPs. For example, Clean Water Services in Hillsborough, Oregon, has installed a continuous monitoring and control system to optimize flow control from regional ponds.
- A regional facility can be easier to monitor and maintain than numerous small BMPs or GSI facilities distributed throughout a catchment area. Limited City resources can allocate less time to existing stormwater BMPs and more time to other tasks.

- Regional facilities can be created as multi-use facilities. Stormwater BMPs can be integrated in public parks or open space to provide recreation and education opportunities during dry periods.
- Some habitat restoration projects can provide significant water quality benefits. For example, the Clarks Creek Sediment Reduction Action Plan (Puyallup Tribe of Indians, 2013) identified a number of channel stabilization projects that should substantially reduce long-term sediment loads.

Potential drawbacks of regional stormwater facilities include:

- It can be difficult to find sites with suitable physical characteristics (e.g., size, near downstream end of conveyance system, near suitable discharge point, suitable soils and slopes).
- Site constraints (e.g., small parcels) may limit the capture volume or treatment capacity for the regional facility, such that the facility may not fully satisfy treatment or flow control requirements for its entire catchment area.
- The conveyance system upstream of the regional facility may need to be modified to accommodate larger volumes of runoff and higher quantities of contaminants.
- Facilities intended to provide flow control as well as pollutant removal may require a large footprint if site soils are not amenable to infiltration.
- Property acquisition (if required) can be costly, time-consuming, and sometimes politically difficult.
- Discharges from regional facilities are typically more concentrated and less like the natural hydrology of the area than discharges from properly functioning distributed facilities.
- Regional treatment facilities with large catchment areas typically have lower influent pollutant concentrations than distributed facilities located closer to pollution sources. Water quality treatment efficiency generally decreases with influent concentrations. To compensate for this decreased efficiency, more robust treatment strategies are needed.
- Regional facilities intended to address Phase II Permit requirements for new and redevelopment must be constructed before the new development or redevelopment occurs. The jurisdiction or developer must have sufficient funding for design and construction of the facility, and conveyance system modifications if necessary. Large regional facilities are often bond financed, and backed by utility fees. Public financing for regional facilities can be controversial, especially for facilities perceived to benefit specific areas or development projects. There are a number of potential ways to recover the capital costs from developers and/or areas benefitted. The timeliness of repayment by developers may vary depending on development rates.

  Financing of regional facilities can be challenging for Phase II communities. Task 7 in our SOW will include further analysis and recommendations for financing capital facilities.

3.2 Green Stormwater Infrastructure

As noted above, GSI and other stormwater BMPs are required for new and redevelopment sites that exceed the thresholds outlined in Appendix 1 of the Phase II Permit, unless a regional facility has been installed to provide the requisite treatment and flow control for new and redevelopment projects in its catchment area. GSI can also provide treatment and flow control to help meet TMDL requirements. GSI examples include bioretention, rain gardens, permeable pavement, vegetated roofs, downspout controls, and dispersion. Typically, GSI facilities are small and distributed throughout a catchment area rather than installed at the outfall.

GSI facilities located in areas with permeable soil can provide significant flow control in addition to water quality treatment. Map 4 (Appendix A) shows the City sub-basins where non-till soils predominate. Additional investigations would be needed to assess site suitability based on soil permeability, depth to seasonal groundwater, proximity to steep slopes, and other potential constraints for infiltration.

Potential advantages of GSI include:

- The Phase II Permit requires that jurisdictions make GSI their preferred approach for stormwater management. Using GSI instead of regional facilities or traditional BMPs helps demonstrate compliance with this Phase II Permit requirement.
- Distributed GSI facilities that involve infiltration are better able to mimic natural hydrology than regional infiltration facilities. Thus, distributed GSI is less likely to adversely affect the hydrology of receiving water bodies.
- Distributed GSI facilities can be located close to stormwater pollutant sources where pollutant concentrations are highest. Treatment efficiency generally increases as influent concentrations increase.
- GSI facilities are flexible and can be integrated into the landscape, which improves aesthetics, support traffic safety improvements, attenuate road noise, and provide urban wildlife habitat.
- GSI within public ROW can be implemented wherever the City determines it is cost-effective based on site conditions. Ecology has historically been a good source of grant funding for GSI projects.
- Permeable pavement can help jurisdictions manage stormwater runoff within their existing rights-of-way (instead of needing to acquire additional land to meet treatment or flow control requirements).
- Design and construction costs associated with GSI for new development and redevelopment are typically borne by the property owner.
- The property owner is typically responsible for operation and maintenance (O&M) costs for onsite GSI facilities (i.e., facilities on private land that do not treat runoff from public properties or rights-of-way).

Potential disadvantages of GSI include:

- Inspecting and maintaining numerous small, distributed facilities (especially vegetated facilities) is typically more time-consuming than inspecting/maintaining a few large regional facilities.
- Enforcement of private system O&M by local government can involve difficult legal and political issues (e.g., access to private property for inspection/enforcement, appeals of non-compliance findings, remediation actions, fines, etc.).
- GSI facilities that rely on infiltration may not be appropriate for areas with unsuitable soil, seasonal high groundwater, or steep slopes. Infiltration GSI above steep slopes could increase the risk of landslides. In areas where infiltration is not feasible, GSI alone may not be able to meet flow control requirements.
- Failure of multiple GSI facilities could result in drainage or erosion problems near the catchment area outlet.

3.3 Other Distributed BMPs

Distributed BMPs are typically small facilities designed to mitigate changes in stormwater quality and quantity from new and redevelopment. They may also be used as retrofits to manage stormwater from existing developed areas. A wide range of BMPs has been developed to remove suspended solids and other pollutants from stormwater runoff (e.g., cartridge filters, sand filters, hydrodynamic separators, modular wetlands, baffle boxes).

Distributed infiltration facilities such as infiltration swales, galleries, and injection wells, can reduce stormwater volumes and pollutant loads. Facilities located in areas with permeable soil could provide significant flow control. Map 1 (Appendix A) shows the City sub-basins where infiltration may be feasible based on the predominance of non-till soils. Deep injection wells could be used to infiltrate pre-treated stormwater in areas where the till is underlain by more permeable, unsaturated material. Additional investigations would be needed to assess site suitability based on soil permeability, depth to seasonal groundwater, proximity to steep slopes, and other potential constraints for distributed infiltration facilities.

Potential advantages of distributed BMPs include:

- Because there are many types of BMPs, they can be tailored to specific site conditions and water quality objectives.
- Properly sited infiltration swales, galleries, and injection wells can help meet flow control as well as treatment requirements.
- Inspection and maintenance procedures are well established for many BMPs.
- Distributed BMPs that involve infiltration are better able to mimic natural hydrology than regional facilities.
- Distributed BMPs can be located close to stormwater pollutant sources where pollutant concentrations are highest. As noted above, treatment efficiency generally increases as influent concentrations increase.
- Design and construction costs associated with distributed BMPs for new development and redevelopment are typically borne by the property owner.

Potential disadvantages of distributed BMPs include:

- Inspecting and maintaining numerous small, distributed facilities is costlier and more time-consuming than inspecting/maintaining a few large regional facilities.
- Enforcement of private system O&M by local government can involve difficult legal and political issues (e.g., access to private property for inspection/enforcement, appeals of non-compliance findings, remediation actions, fines, etc.).
- Distributed BMPs that rely on infiltration may not be feasible for areas with till soil, high groundwater, or steep slopes.
- Infiltration BMPs above steep slopes could increase the risk of landslides.
- In areas where infiltration is not feasible, distributed BMPs may not be able to meet flow control requirements.
- Failure of multiple distributed BMPs could result in drainage or erosion problems near the catchment area outlet.

Section 4: Preliminary Cost Evaluation

The City requested that BC evaluate treatment options based on outfall locations. Thus, BC began by reviewing the City's *SurfaceWater* geodatabase and found that it included 678 features identified as "outfalls." Of these, 148 are attributed as discharging to a stream or a lake, which are defined by the GIS metadata as being regulated MS4 outfalls[1]. Figure 2 shows the distribution of outfall locations throughout the city. Additional detailed maps are provided in Appendix A.

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[1] Outfall means a point source as defined in 40 CFR 122.2 as the point where a discharge leaves the Permittee's MS4 and enters a surface receiving waterbody or surface receiving waters. Outfall does not include pipes, tunnels, or other conveyances which connect segments of the same stream or other surface water and are used to convey primarily surface waters (i.e., culverts).

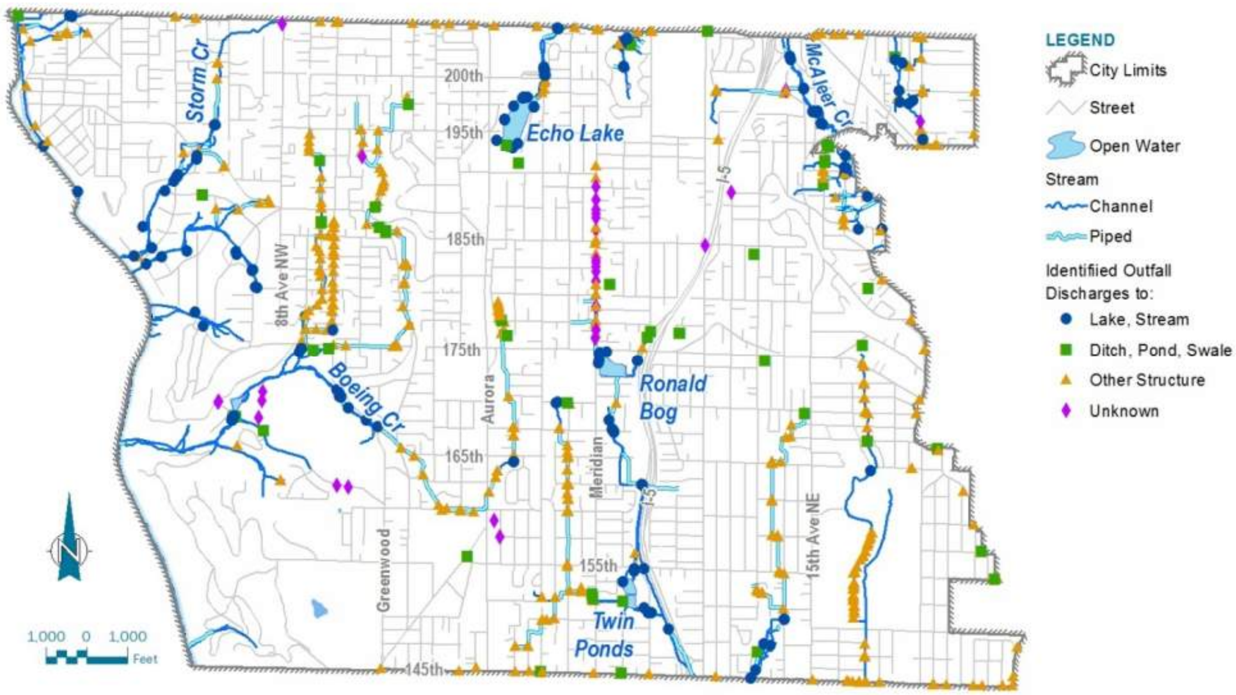


Figure 2. Distribution of outfalls as mapped in the City's *SurfaceWater* geodatabase

It was not feasible to delineate the drainage areas for each of the 148 outfalls. Alternatively, BC divided the city into 53 subbasins. Each subbasin was analyzed for development potential (future increases in hardscape surfaces) and constraints to infiltration (i.e., till soils and steep slopes). BC then developed ballpark cost estimates for providing stormwater treatment/flow control in each sub-basin, assuming either:

- a regional facility near the basin outlet sized to treat the projected increase in impervious area, or
- GSI facilities distributed throughout the basin (instead of a regional for facility).

The estimated total cost for regional facilities was then divided by the estimated total cost for distributed BMPs to create a comparative cost ratio. A ratio above 1.00 indicates that regional facilities cost more than distributed BMPs. Appendix B provides a step-by-step description of the cost evaluation, including notes on key assumptions. Results for each of the subbasins are shown in Figure 3 and Map 5 (Appendix A).

It is important to keep in mind that these evaluations are based on numerous assumptions because site-specific data are not available. As such, the results should be viewed in relative terms to compare the options and illustrate how facility sizing, possible constraints to feasibility, and potential costs could vary for different areas. Additional investigations would be needed to confirm site suitability for infiltration and more detailed data collection and analysis are necessary to support capital improvement planning.

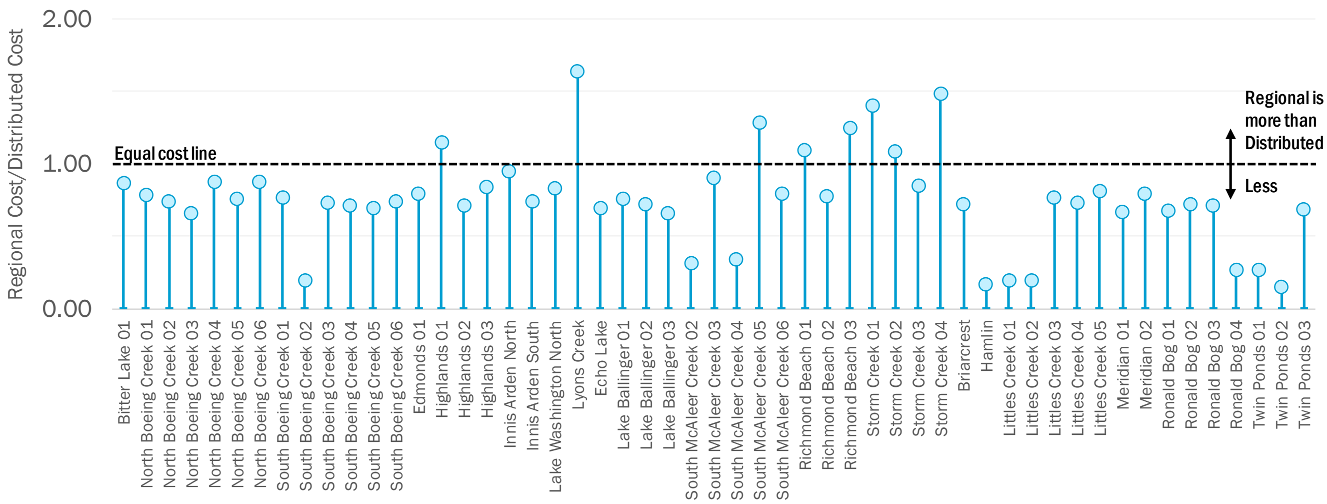


Figure 3. Comparative cost ratio for regional versus distributed BMPs

See Appendix B, Table B-5 for details.

Regional facilities cost less than distributed BMPs in most cases. On average, regional facilities cost about $535,000 per acres of impervious treated, compared with $837,000 for distributed BMPs. Regional facilities appear to have the greatest benefit in areas where there are upland constraints to infiltration, but it is assumed that infiltration can be achieved at the regional facility location. Conversely, distributed BMPs appear to be more cost-effective in small subbasins where the regional facility cannot infiltrate, yet much of the upper portion of the subbasin allows infiltration for the distributed BMPs.

This importance of infiltration capacity was also illustrated by the stormwater study completed for Aurora Square (KPG 2015). The Aurora Square study performed sized three alternative regional facilities; the first alternative looked at on-site facilities without infiltration, and the other two alternatives looked at regional facilities with infiltration capacities of 2 inches per hours (Table 1). Onsite (distributed) facilities with no infiltration where shown to cost much more than regional facilities with infiltration.

Table 1. Summary of Facility Sizing Results from Aurora Square Study (KPG 2015)

Alternative	Facility Description	Impervious Area (ac)	Pervious Area (ac)	Volume (ft^3)	Volume per Unit Impervious (ft^3/ac)	Estimated Cost in $M	Cost per area of Impervious ($/ac)
1	Onsite flow control facilities *No infiltration*	35.2	8.8	1,042,871	29,627	22.7	644,886
2	Regional flow control at SCC Greenwood Parking Lot *2 inches/hour of infiltration*	60.4	15.4	498,666	8,256	4.26	70,530
3	Regional flow control at SCC by expanding the existing M1 Dam facility. *2 inches/hour of infiltration*	104.4	26.4	901,648	8,636	6.18	59,195

For Alternative 3, KPG identified a potential opportunity to collaborate with SCC on a combined regional facility that would take advantage of infiltrative soils at SCC to address flow control needs for both Aurora Square and SCC, estimated at a fraction of the cost for onsite flow control (KPG, 2014).

Section 5: Conclusions

Regional facilities, GSI, and/or distributed BMPs can be used to meet Phase II Permit requirements for new development and redevelopment, as well as future TMDL requirements. This technical memorandum presents the pros and cons of each option and a rough cost comparison for subbasins around the city.

The cost comparison indicated that regional facilities may be less expensive than distributed BMPs in most subbasins, especially if infiltration can be achieved at the regional facility site. Allowable infiltration capacity is clearly the most important factor in determining the cost feasibility of a project. The Aurora Square study (KPG 2015) found that the cost to manage one acre of impervious with distributed/onsite facilities with no infiltration is over nine times the cost with a regional facility with infiltration. Another key factor is that regional facilities tend to have smaller unit costs (both capital and O&M) as the size of the facility increases due to economies of scale. Regional facilities could also be used to help meet other City objectives such as encouraging redevelopment and economic growth.

Regional facilities can be more challenging to implement than GSI or distributed BMPs for several reasons. First, feasibility and cost for a regional facility depend, to a large extent, on the availability of suitable sites. Second, individual regional facilities are generally larger and more expensive to build than distributed BMPs, making them difficult to break into phases if capital funding is limited. Third, regional facilities that are intended to meet Phase II Permit requirements for new development or redevelopment must be built *before* the development takes place. The jurisdiction or developer must make an up-front investment to build the regional facility. These costs can be recovered from developers or property owners in the benefited area using a variety of mechanisms, but the timeliness of repayment could vary depending on redevelopment rates. Some stakeholders may feel that public financing of a regional facility is a gift to developers. For these reasons, financing can often be more challenging than the technical issues associated with regional stormwater facilities.

In summary, the optimum treatment approach for a given situation will vary depending on site constraints and opportunities, regulatory requirements, and stakeholder interests. Regional facilities and distributed BMPs can both be implementable cost-effective solutions in the right circumstances. Focused studies like the one performed for Aurora Square can be conducted to evaluate site constraints and opportunities for specific areas of the city. Furthermore, given the importance of infiltration capacity, site investigations may be warranted even at the planning stage.

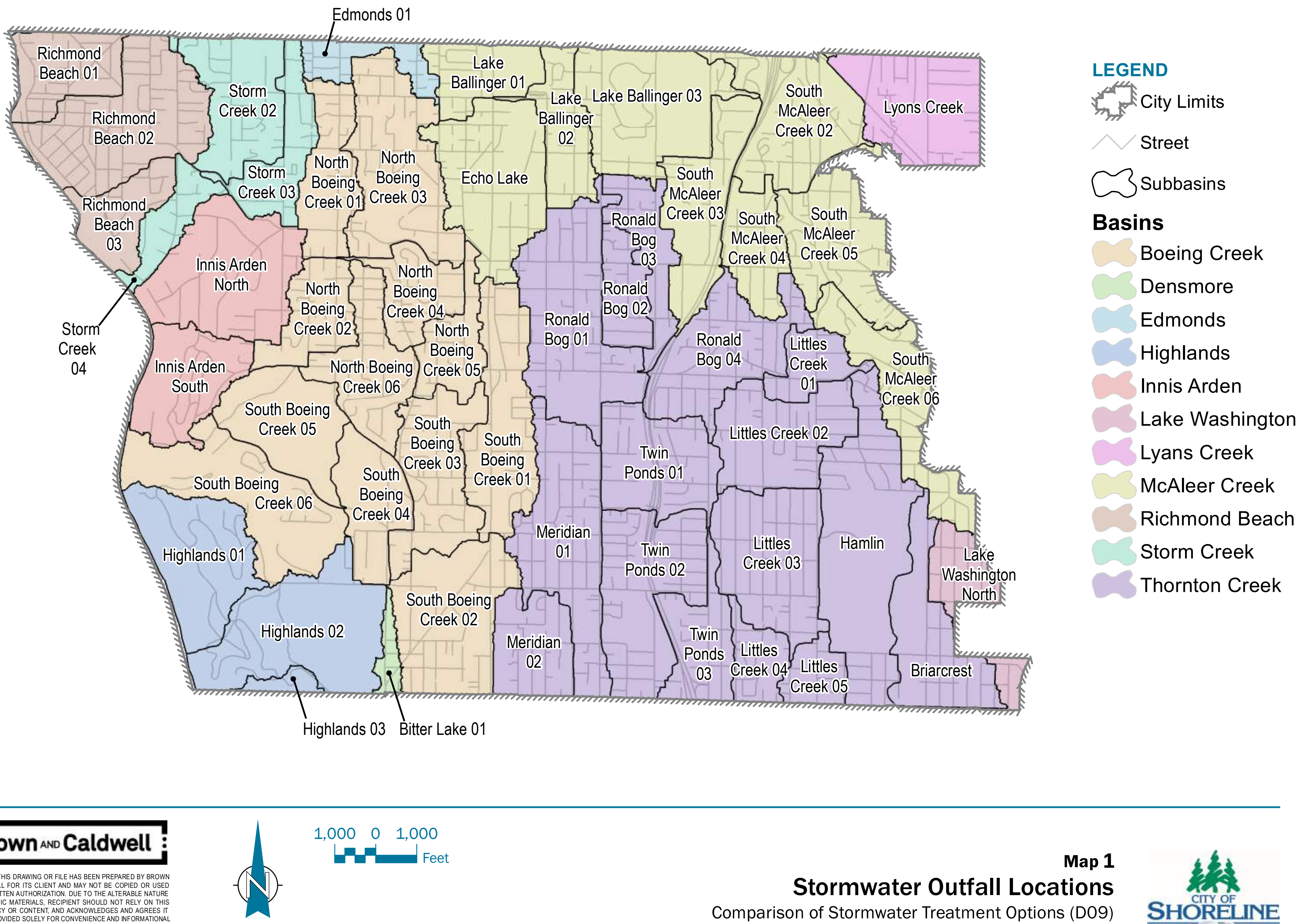
Section 6: References

Herrera Environmental Consultants (2012), *Puget Sound Stormwater BMP Cost Database*, Prepared for Washington State Department of Ecology, Environmental Assessment Program.

KPG, *Aurora Square Community Renewal Area, Stormwater Concept Development Study*, Prepared for the City of Shoreline, 2014.

Washington State Department of Ecology (WSDOE), *Western Washington Phase II Municipal Stormwater Permit*, effective date August 1, 2013.

Attachment A: Maps



Brown AND Caldwell

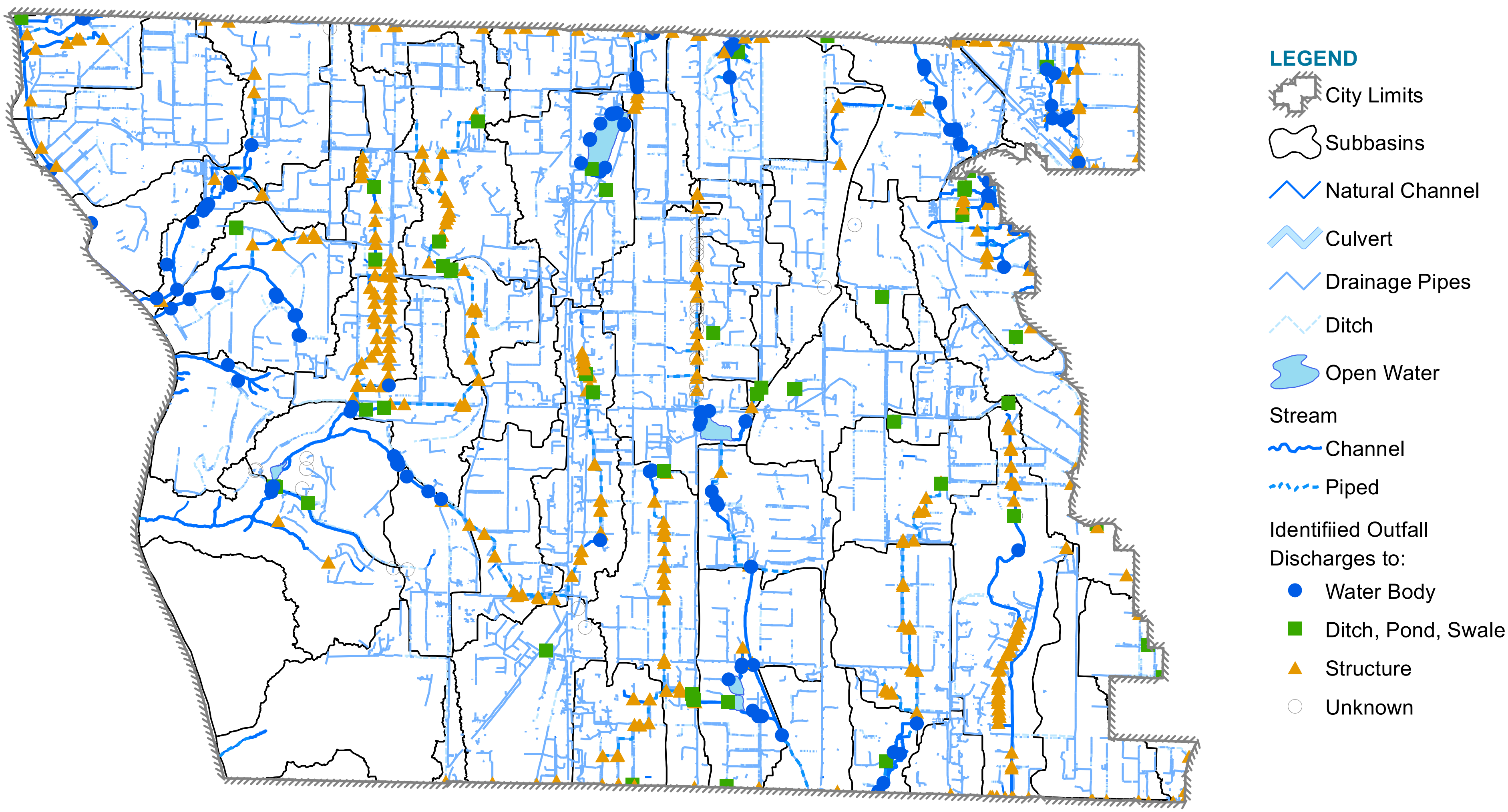
Map 1

Stormwater Outfall Locations

Comparison of Stormwater Treatment Options (D09)

Surface Water Master Plan

CITY OF SHORELINE



Brown AND Caldwell

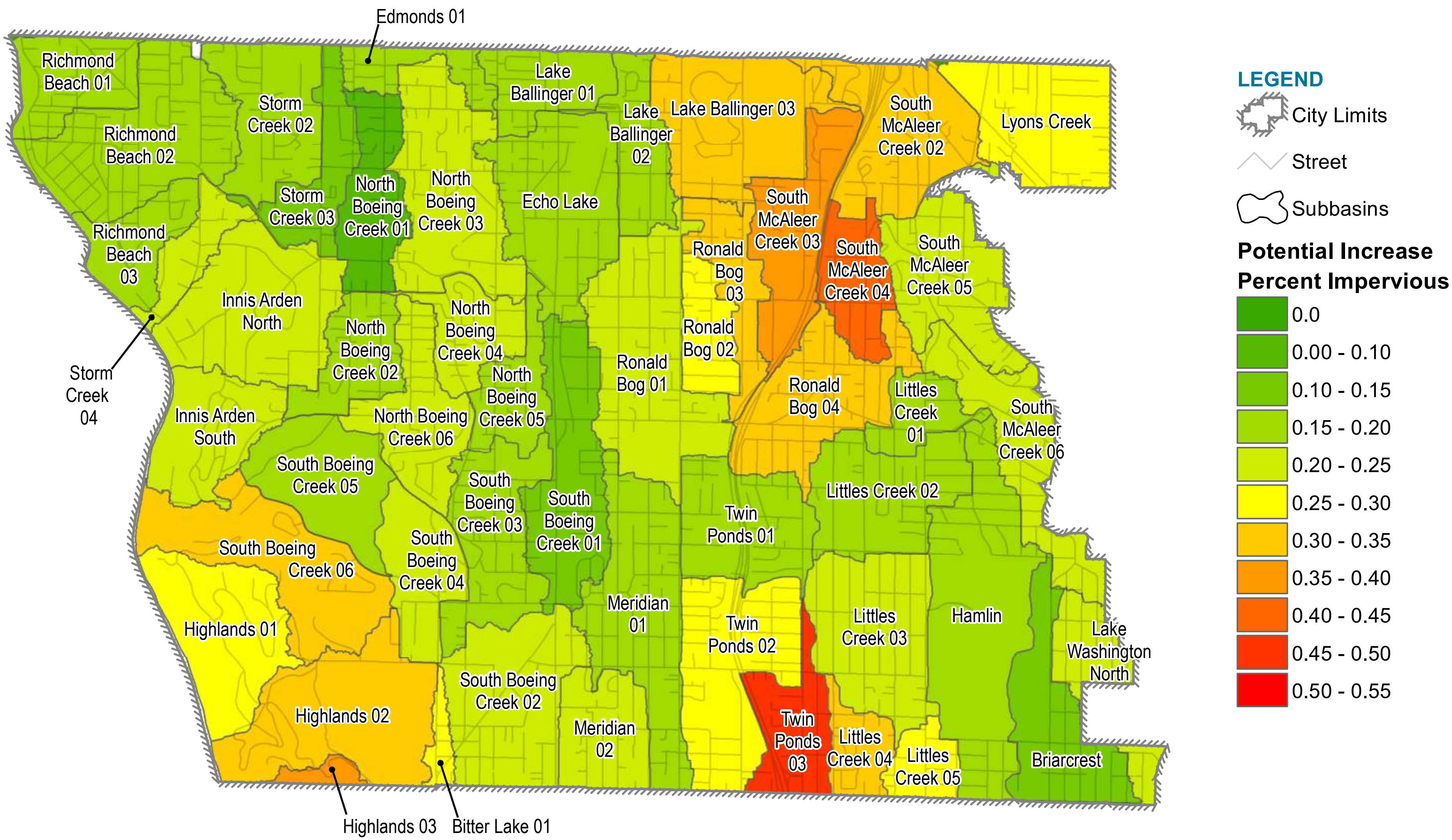
Map 2

Stormwater Outfall Locations

Comparison of Stormwater Treatment Options (D09)

Surface Water Master Plan

CITY OF SHORELINE



Brown AND Caldwell

N

1,000 0 1,000
Feet

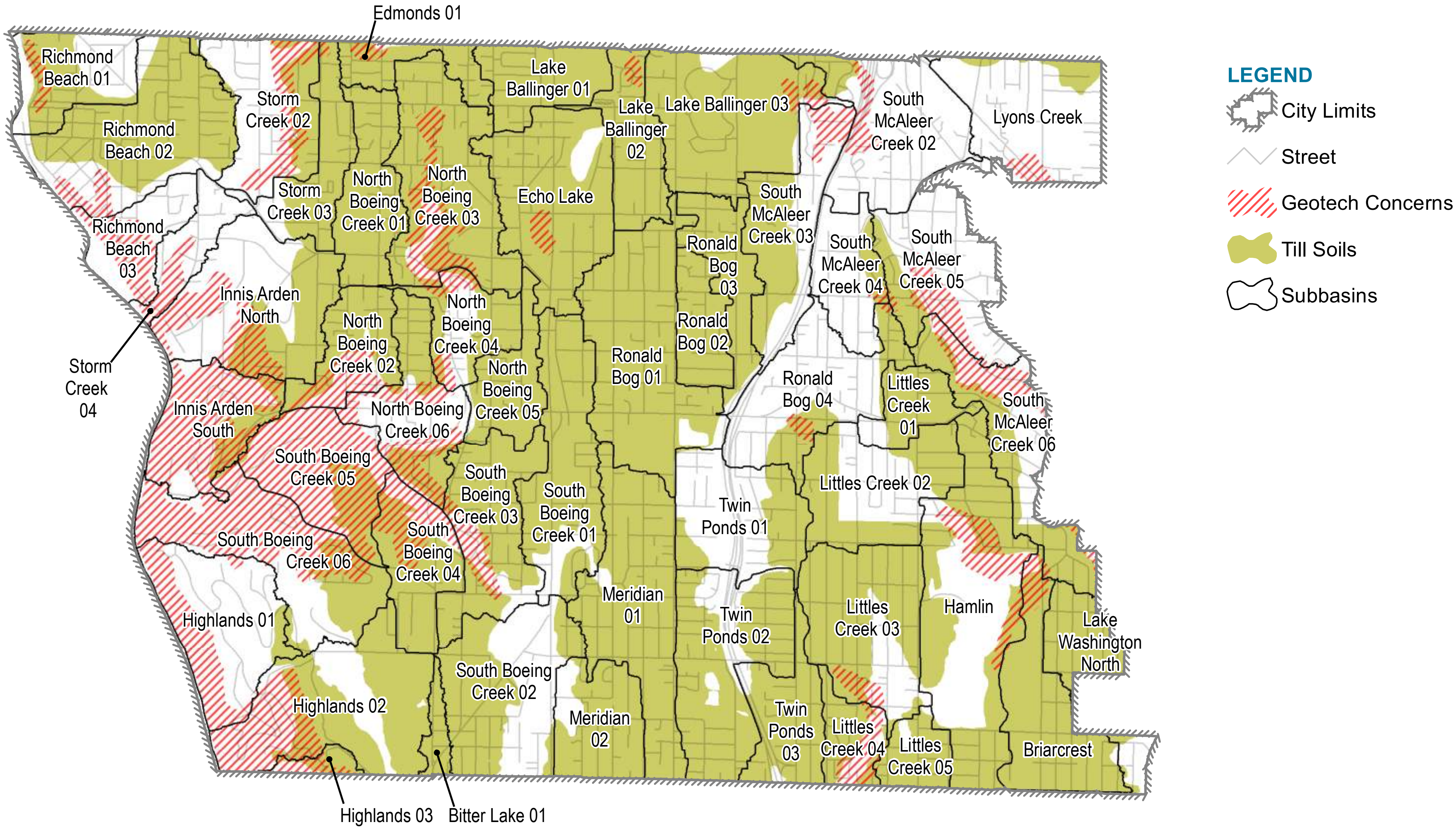
Map 3

Potential Increase in Imperviousness at Buildout

Comparison of Stormwater Treatment Options (D09)

Surface Water Master Plan

CITY OF SHORELINE



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N

1,000 0 1,000
Feet

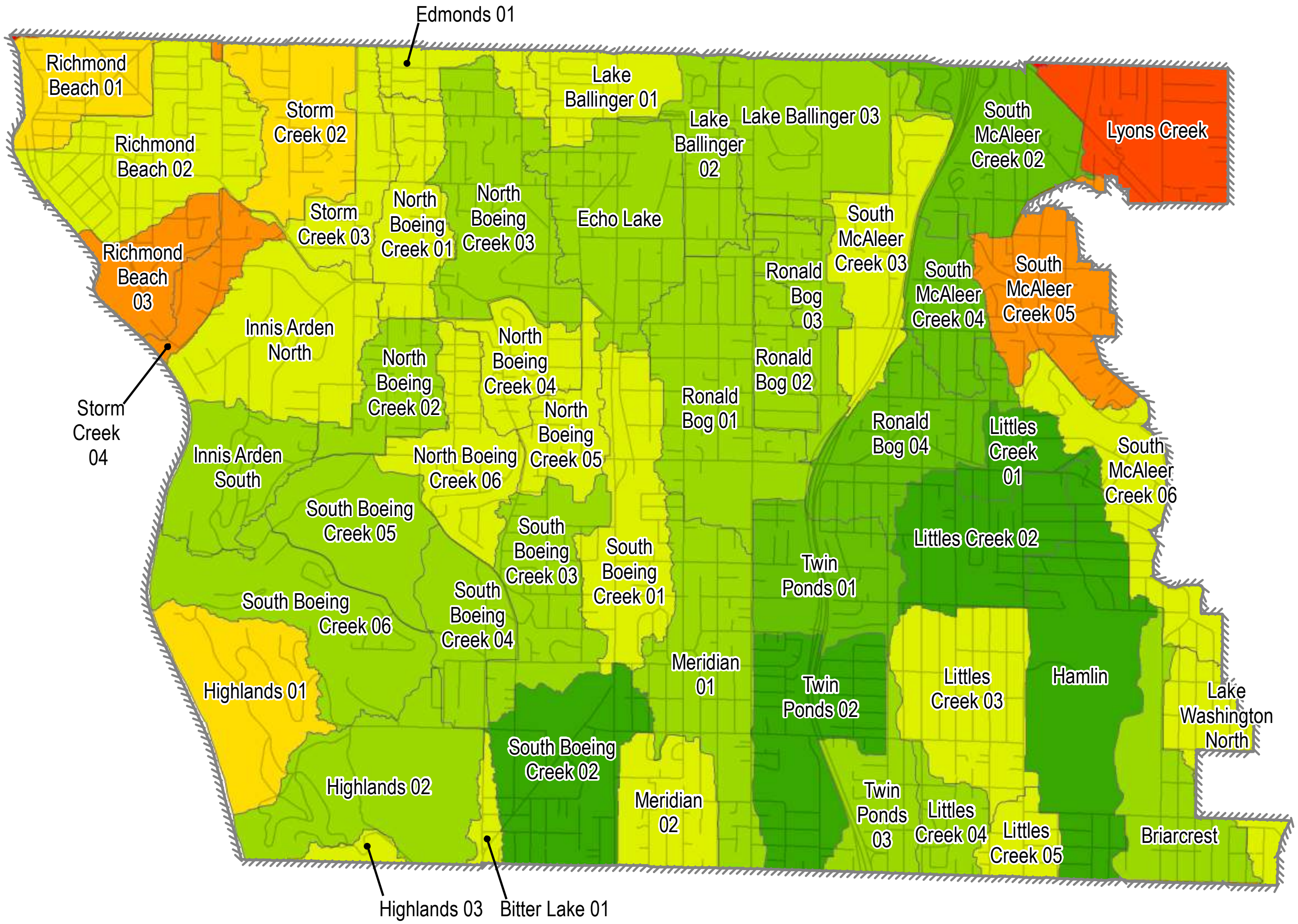
Map 4

Feasibility Constraints for Infiltration of Stormwater

Comparison of Stormwater Treatment Options (D09)

Surface Water Master Plan

CITY OF SHORELINE



LEGEND

City Limits

Street

Cost Ratio*

- 0.0 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.25
- 1.25 - 1.50
- 1.50 - 1.75
- 1.75 - 4.00

**Cost ratio calculated by dividing the estimated cost of regional facility by the estimated cost of distributed facilities for each subbasin.*

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N

1,000 0 1,000 Feet

Map 5

Cost Comparison for Regional versus Distributed

Comparison of Stormwater Treatment Options (D09)

Surface Water Master Plan

CITY OF SHORELINE

Attachment B: Cost Evaluation

Preliminary Evaluation of Costs

The City asked BC to compare the relative costs of distributed vs. regional facilities for meeting stormwater treatment and flow control requirements. BC performed the evaluation as described below. Please note that the evaluation is based on available GIS data and general cost information rather than site-specific data. As such, the results should be regarded as preliminary and suitable for general planning purposes only. The results are intended to illustrate how facility sizing, feasibility constraints, and potential costs could vary for different areas of the City. Additional data collection and more detailed analyses would need to be conducted to support for capital improvement planning.

1. **Delineate subbasins:** BC began by performing automated delineations using a digital elevation model (DEM) obtained from the Puget Sound LiDAR Consortium (PSLC 2006). Automated delineations were then adjusted where stormwater infrastructure crossed subbasin boundaries. Subbasin areas were calculated using ArcGIS tools. Although some subbasin delineations crossed city limits, only the portions within Shoreline are considered in the analysis.

2. **Calculate new impervious areas:** BC performed geospatial analyses to map imperviousness for existing and future conditions. Existing impervious surface areas were based on the City's current GIS data, which include delineated surfaces for transportation (ImperviousTrans2012), buildings (Buildings2012), and other surfaces such as parking lots and sidewalks (ImperviousOther2012). Future imperviousness was estimated based on modified zoning data. The baseline zoning data were obtained from the City's current GIS. Modifications were made in the 145th Street and 185th Street subareas to reflect the current online mapping by the City for those areas (Shoreline 2016). In addition, water bodies and parks were overlaid to isolate those areas as separate categories. Each zone/category was assumed to be built out to the maximum allowable hardscape percentage as defined by the City's current Development Code (Table B-1.). Existing impervious surface percentages were subtracted from future impervious surface percentages to obtain a potential increase in imperviousness for each subbasin.

Table B-1. Future Imperviousness Percentages Based on Zoning

Zoning Category		Estimated Percentage of Total Impervious Area
Abbrev.	Description	
R4	Residential, 4 units per acre	45%
R6	Residential, 6 units per acre	50%
R8	Residential, 8 units per acre	65%
R12	Residential, 12 units per acre	75%
R18	Residential, 18 units per acre	85%
R24	Residential, 24 units per acre	85%
R48	Residential, 48 units per acre	90%
MUR-35	Mixed-use residential (35' height based on R-18 zoning)	85%
MUR-45	Mixed-use residential (45' height based on R-48 zoning)	90%
MUR-70	Mixed-use residential (70' height)	90%
NB	Neighborhood business	85%
CB	Community business	85%
MB	Mixed business	95%
TC	Town center (1, 2, 3, or 4)	95%

Table B-1. Future Imperviousness Percentages Based on Zoning		
Zoning Category		Estimated Percentage of Total Impervious Area
Abbrev.	Description	
PA 3	Planned Area 3	85%
CZ	Contract zone	90%
C	Campus	60%
ROW	Right-of-way	90%
Water	Major water bodies	0%
Park	Parks	15%

Imperviousness percentages were based on maximum hardscape allowed by City Development Code (Code Publishing Company 2016) with the exceptions of right-of-way, parks, and water bodies. Impervious percentages for those categories were assumed based on work done for the Thornton Creek and Boeing Creek basin plans.

3. **Estimate treatment and flow control requirements:** Whether it is regional or distributed, designing a stormwater facility to meeting treatment and flow control requirements requires hydrologic analyses to compare pre-developed and post-developed conditions. Such analyses require site-specific information, including topography, slopes, predeveloped land cover, developed land cover, soil type and infiltration capacity. Collecting this information and performing site-specific analyses are beyond the scope of this effort. However, for the purpose of this evaluation, we can make a simple and general assumption regarding the amount of storage needed to treat and control flows for one acre of impervious and apply that universally. One key factor that cannot be ignored is whether or not a site has capacity to infiltrate water. The stormwater study completed for Aurora Square (KPG 2015) performed analyses to size three alternative regional facilities; the first alternative looked at on-site facilities without infiltration, and the other two alternatives looked at regional facilities with infiltration capacities of 2 inches per hours (see Table B-2).

Table B-2. Summary of Facility Sizing Results from Aurora Square Study (KPG 2015)						
Alt	Facility Description	Impervious Area (ac)	Pervious Area (ac)	Volume (ft^3)	Volume per Unit Impervious (ft^3/ac)	Estimated Project Cost ($M)
1	On-site flow control facilities (22 ac-ft, no infiltration)	35.2	8.8	1,042,871	29,627	22.7
2	Regional flow control at SCC Greenwood Parking Lot (11.8 ac-ft with infiltration)	60.4	15.4	498,666	8,256	4.26
3	Regional flow control at SCC by expanding the existing M1 Dam facility. (20.7 ac-ft added, with infiltration)	104.4	26.4	901,648	8,636	6.18

Based on the results from the Aurora Square study, it was assumed that 30,000 cubic feet (ft^3) of storage is needed to manage runoff from 1 acre of impervious with no infiltration at the facility. It was assumed that 9,000 ft^3 of storage is needed to manage runoff from 1 acre of impervious with infiltration.

4. **Map geotechnical constraints:** Two of the biggest constraints affecting feasibility are geotechnical concerns (i.e., erosion or landslide potential) and insufficient infiltration capacity of underlying soils. BC used the City's GIS data to map areas delineated as "erosion" and "landslide" geotechnical concerns. In addition, BC used geologic data from the Department of Natural Resources to map areas of predominantly till soils, which generally have poor infiltration capacity. Areas covered by geotechnical concerns and till soils were calculated for each subbasin. In addition, subbasins were assessed for the likelihood that a regional facility could be located in an area with potential for infiltration. Subbasins with mostly till soils and/or geotechnical concerns in the downgradient portion of the basin were flagged as "regional infiltration likely infeasible."

5. **Develop unit costs:** As part of their work with Ecology, Herrera Environmental Consultants (Herrera) gathered costs for BMPs installed in the Puget Sound region to be integrated into the System for Urban Stormwater Treatment and Analysis INtegration (SUSTAIN) model. The report titled *Puget Sound Stormwater BMP Cost Database* provides unit cost estimates for a variety of BMPs (Table B-3). BC used the average unit cost estimated for bioretention facilities to estimate capital and O&M costs for distributed facilities. Average unit costs for wet ponds were used to estimate capital and O&M costs for regional facilities. The unit capital costs for wet ponds was adjusted for scale to account for the efficiencies of designing a larger facility (see Step 6).

Table B-3. Unit Costs from the Puget Sound Stormwater BMP Cost Database (Herrera 2012)

Facility Type	Cost Type	Unit cost per Square Foot[c]			Unit cost per Cubic Foot[d]		
		Low	Average	High	Low	Average	High
Bioretention (Distributed)[a]	Capital Cost	$4.28	$31.61	$88.75	$2.14	$15.81	$44.38
	O&M Cost[e]	$5.70	$38.10	$83.40	$2.85	$19.05	$41.70
Wet Pond (Regional)[b]	Capital Cost	$3.78	$24.78	$122.58	$1.26	$8.26	$40.86
	O&M Cost[e]	$2.70	$2.70	$2.70	$0.90	$0.90	$0.90

a. Bioretention unit costs were assumed to be representative of all distributed facilities; no adjustments were applied for site constraints; no adjustments were made for scale.

b. Wet pond unit costs were assumed to be representative of all regional facilities; no were applied for site constraints; costs were scaled according to a power regression.

c. Unit costs for bioretention were converted from converted from "per Square Foot" to "per Cubic Foot" by assuming an average storage depth of 2 feet.

d. Unit costs for wet pond were converted from converted from "per Cubic Foot" to "per Square Foot" by assuming an average storage depth of 3 feet.

e. Unit O&M Costs multiplied by 30 years; no discount rate was applied.

f. All costs

Note that while only the average unit costs were used for this evaluation, the range of the unit costs varies greatly from low to high. This is likely due to variations in site conditions, site constraints, and appurtenances.

6. **Develop scaling function for regional facility costs:** Twenty of the 24 projects used by Herrera (2012) to develop the unit costs for wet ponds were projects completed by the Washington State Department of Transportation (WSDOT). Background information for these projects are available on-line, so BC obtained the size of each facility, along with the total capital cost. These data were plotted and then a regression was performed to fit a power function to the data (Figure B-1). This relationship was applied to the unit costs scale the cost up for very small facilities, and down for large facilities.

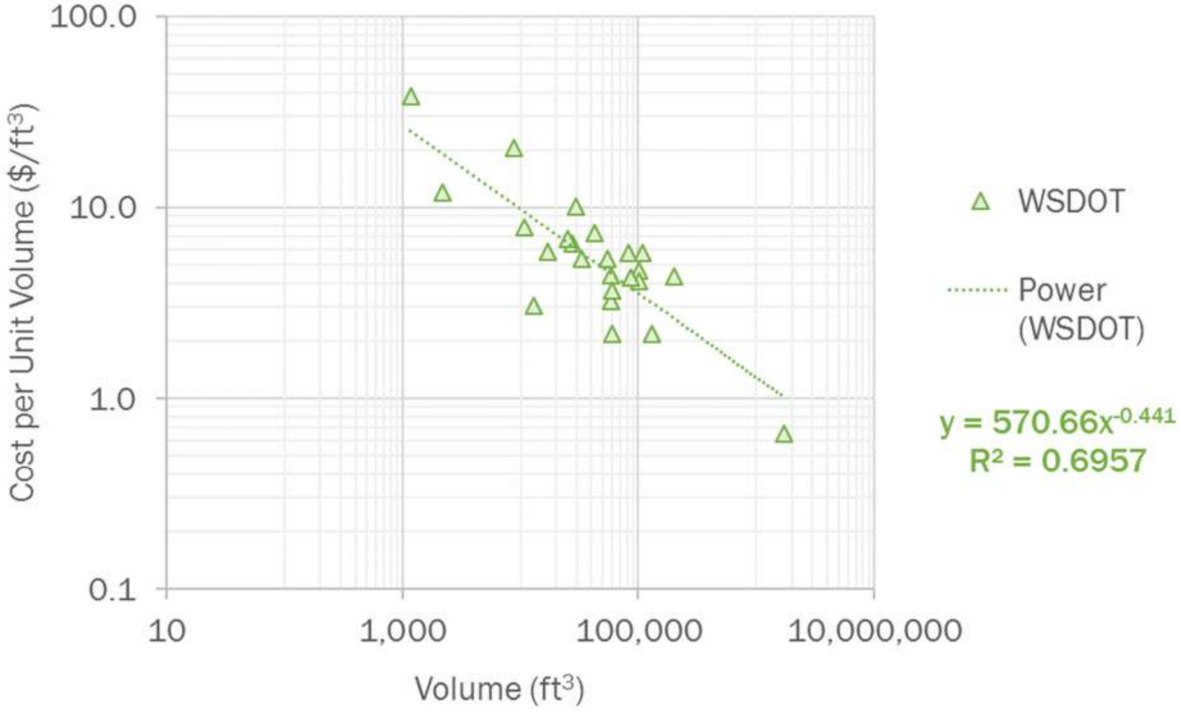

Figure B-1. Power regression used to define a scaling function for wet pond unit costs

7. **Estimate land acquisition costs:** As part of the stormwater retrofit project for Water Resources Inventory Area (WRIA) 9, King County developed land cost assumptions for siting detention ponds (Table B-4).

Table B-4. Unit Cost from WRIA9 Study by King County (2014)		
Land Use	Low land cost Unit Value ($/ft2)	High land cost Unit Value ($/ft2)
Commercial/Industrial	25.63	26.03
High Density Residential	11.24	19.75
Low Density Residential	3.68	8.72
Agriculture	1.06	3.38

Given the likely for acquiring land in highly urbanized areas, and escalating from 2013 to 2016, the land acquisition cost for regional stormwater facilities was assumed to be $25 per ft^2.

8. **Calculate total costs by subbasin for distributed facilities:** The total volume requirements for distributed facilities in areas with no infiltration were calculated by multiplying 30,000 ft^3 per acre times the total anticipated increase in impervious area, times the calculated percentage of subbasin falling within areas mapped as till or geotechnical concerns. The total volume requirements for distributed facilities in areas with allowable infiltration were calculated by multiplying 9,000 ft^3 per acre times the total anticipated increase in impervious area, times the remaining area percentage. The sums of these volumes were then multiplied by the unit costs for capital and O&M. These costs were then summed to obtain a total cost for distributed facilities per subbasin. Note that land acquisition costs were not included for distributed facilities because it was assumed that they would be located onsite or within the right-of-way.

9. **Calculate total costs by subbasin for regional facilities:** The total volume requirements for subbasins identified as having infiltration potential were calculated by multiplying 30,000 ft^3 per acre times the total anticipated increase in impervious area for that subbasin. The total volume requirements for subbasins flagged as "regional infiltration likely infeasible" were calculated by multiplying 9,000 ft^3 per acre times the total anticipated increase in impervious area for that subbasin. The estimated volume requirements were then multiplied by the unit costs for capital, O&M, and land acquisition (assuming a 20 percent increase in the required footprint to account for a buffer around the facility). These costs were then summed to obtain a regional facility cost for each subbasin. Note that costs were not included for conveyance projects that may be need to reroute and divert water to the regional facility. Rarely can a regional facility be constructed right at the end of a large drainage system. Therefore, modifications to the drainage network may be required to get water to the facility to maximize the contributing area. These costs can be substantial, but are difficult to evaluate without a specific site identified.

10. **Compare distributed versus regional costs:** The estimated cost for a regional facility was divided by the estimated cost for distributed facilities for each subbasin to obtain a comparative cost ratio, where a value of "1.0" would indicate equal costs. A summary of the cost results is provided in Table B-5 and the cost ratios by subbasin are shown in Map 5 of Appendix A.

Table B-5. Stormwater Treatment and Flow Control Options Comparison by Subbasin

Basin	Subbasin	Increase in Impervious Percentage	Slope/Till Percentage	Regional Infiltration?	Required Storage Volume (ft^3)		Total Cost ($M)		Cost Ratio Regional / Distributed
					Regional	Distributed	Regional	Distributed	
Densmore	Bitter Lake 01	26%	100%	No	171,560	171,538	5.2	6.0	0.86
Boeing Creek	North Boeing Creek 01	9%	100%	No	308,034	308,034	8.4	10.7	0.79
Boeing Creek	North Boeing Creek 02	19%	98%	No	543,837	536,582	13.8	18.7	0.74
Boeing Creek	North Boeing Creek 03	21%	100%	No	1,390,454	1,388,318	32.0	48.4	0.66
Boeing Creek	North Boeing Creek 04	24%	73%	No	637,364	518,546	15.9	18.1	0.88
Boeing Creek	North Boeing Creek 05	19%	97%	No	457,301	447,026	11.9	15.6	0.76
Boeing Creek	North Boeing Creek 06	22%	70%	No	890,733	702,069	21.4	24.5	0.87
Boeing Creek	South Boeing Creek 01	13%	88%	No	726,716	665,052	17.8	23.2	0.77
Boeing Creek	South Boeing Creek 02	20%	55%	Yes	372,910	851,973	5.9	29.7	0.20
Boeing Creek	South Boeing Creek 03	17%	93%	No	799,446	758,302	19.4	26.4	0.73
Boeing Creek	South Boeing Creek 04	21%	99%	No	685,252	681,781	16.9	23.8	0.71
Boeing Creek	South Boeing Creek 05	19%	99%	No	879,675	871,676	21.1	30.4	0.70
Boeing Creek	South Boeing Creek 06	32%	80%	No	2,142,875	1,836,345	47.5	64.0	0.74

Table B-5. Stormwater Treatment and Flow Control Options Comparison by Subbasin									
Basin	Subbasin	Increase in Impervious Percentage	Slope/Till Percentage	Regional Infiltration?	Required Storage Volume (ft^3)		Total Cost ($M)		Cost Ratio Regional / Distributed
					Regional	Distributed	Regional	Distributed	
Edmonds	Edmonds 01	19%	98%	No	318,260	314,633	8.7	11.0	0.79
Highlands	Highlands 01	28%	39%	No	1,540,067	879,011	35.1	30.6	1.15
Highlands	Highlands 02	34%	83%	No	2,503,664	2,198,499	54.9	76.6	0.72
Highlands	Highlands 03	37%	100%	No	201,442	201,442	5.9	7.0	0.84
Innis Arden	Innis Arden North	21%	56%	No	1,425,617	985,251	32.7	34.3	0.95
Innis Arden	Innis Arden South	22%	91%	No	902,252	844,136	21.6	29.4	0.74
Lake Washington	Lake Washington North	22%	82%	No	542,905	474,595	13.8	16.5	0.83
Lyons Creek	Lyons Creek	25%	15%	No	1,359,180	547,674	31.3	19.1	1.64
McAleer Creek	Echo Lake	18%	95%	No	1,166,966	1,124,538	27.3	39.2	0.70
McAleer Creek	Lake Ballinger 01	15%	100%	No	398,964	398,964	10.5	13.9	0.76
McAleer Creek	Lake Ballinger 02	20%	100%	No	563,638	563,638	14.2	19.6	0.72
McAleer Creek	Lake Ballinger 03	31%	96%	No	2,058,083	1,993,838	45.8	69.5	0.66
McAleer Creek	South McAleer Creek 02	31%	17%	Yes	517,780	724,114	7.8	25.2	0.31
McAleer Creek	South McAleer Creek 03	40%	59%	No	1,826,030	1,297,033	41.0	45.2	0.91
McAleer Creek	South McAleer Creek 04	40%	16%	Yes	336,678	460,320	5.4	16.0	0.34
McAleer Creek	South McAleer Creek 05	22%	32%	No	1,092,092	574,017	25.7	20.0	1.28
McAleer Creek	South McAleer Creek 06	24%	78%	No	1,114,007	940,640	26.1	32.8	0.80
Richmond Beach	Richmond Beach 01	16%	53%	No	508,480	342,531	13.0	11.9	1.09
Richmond Beach	Richmond Beach 02	15%	81%	No	1,104,341	955,428	25.9	33.3	0.78
Richmond Beach	Richmond Beach 03	18%	42%	No	481,154	284,562	12.4	9.9	1.25
Storm Creek	Storm Creek 01	19%	48%	No	34,960	30,070	1.5	1.0	1.40
Storm Creek	Storm Creek 02	19%	48%	No	855,116	544,894	20.6	19.0	1.09

Table B-5. Stormwater Treatment and Flow Control Options Comparison by Subbasin

Basin	Subbasin	Increase in Impervious Percentage	Slope/Till Percentage	Regional Infiltration?	Required Storage Volume (ft^3)		Total Cost ($M)		Cost Ratio Regional / Distributed
					Regional	Distributed	Regional	Distributed	
Storm Creek	Storm Creek 03	58%	80%	No	413,550	367,876	10.9	12.8	0.85
Storm Creek	Storm Creek 04	25%	29%	No	455,854	228,990	11.8	8.0	1.48
Thornton Creek	Briarcrest	14%	99%	No	631,902	628,611	15.8	21.9	0.72
Thornton Creek	Hamlin	19%	66%	Yes	502,268	1,277,172	7.6	44.5	0.17
Thornton Creek	Littles Creek 01	16%	85%	Yes	88,082	263,531	1.8	9.2	0.19
Thornton Creek	Littles Creek 02	18%	59%	Yes	275,542	654,422	4.5	22.8	0.20
Thornton Creek	Littles Creek 03	23%	81%	No	1,354,406	1,172,796	31.2	40.9	0.76
Thornton Creek	Littles Creek 04	33%	98%	No	569,156	561,701	14.4	19.6	0.73
Thornton Creek	Littles Creek 05	27%	91%	No	398,437	373,535	10.5	13.0	0.81
Thornton Creek	Meridian 01	20%	98%	No	1,331,871	1,316,883	30.7	45.9	0.67
Thornton Creek	Meridian 02	21%	85%	No	660,728	593,078	16.4	20.7	0.79
Thornton Creek	Ronald Bog 01	20%	96%	No	1,546,645	1,501,240	35.2	52.3	0.67
Thornton Creek	Ronald Bog 02	28%	100%	No	580,526	580,526	14.6	20.2	0.72
Thornton Creek	Ronald Bog 03	34%	96%	No	888,429	862,140	21.3	30.0	0.71
Thornton Creek	Ronald Bog 04	34%	27%	Yes	562,820	915,554	8.4	31.9	0.26
Thornton Creek	Twin Ponds 01	16%	35%	Yes	227,297	413,734	3.9	14.4	0.27
Thornton Creek	Twin Ponds 02	27%	82%	Yes	503,769	1,466,417	7.7	51.1	0.15
Thornton Creek	Twin Ponds 03	48%	94%	No	1,436,220	1,376,883	32.9	48.0	0.69
						Total:	**998**	**1,428**	**0.70**

Appendix G: O&M Manual

FINAL

City of Shoreline Surface Water Operations and Maintenance Manual

Prepared for
City of Shoreline
Shoreline, Washington
April 27, 2018

City of Shoreline
Surface Water Operations and Maintenance Manual

Prepared for
City of Shoreline, Washington
April 27, 2018

FINAL

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List of Abbreviations

2014 SWMMWW	Stormwater Management Manual for Western Washington
BMP	best management practice
CB	catch basins
CCTV	closed-circuit television
CEMP	comprehensive emergency management plan
CIP	capital improvement project
CIPP	cured-in-place pipe
City	City of Shoreline
CMMS	computerized maintenance management system
CMP	corrugated metal pipe
CRT	Customer Response Team
EAP	emergency action plan
Ecology	Washington State Department of Ecology
EDM	Engineering Development Manual
ELM	equipment, labor and materials
ESA	Endangered Species Act
ft	foot/feet
ft^2	square foot/feet
ft^3	cubic foot/feet
GIS	geographic information system
HPA	Hydraulic Project Approval
IDDE	Illicit Discharge Detection and Elimination
in.	inch(es)
$in.^2$	square inch(es)
LOS	level(s) of service
Manual	Operations and Maintenance Manual
MHz	megahertz
MS4	municipal separate storm sewer system
N/A	not applicable
NASSCO	National Association of Sewer Service Companies
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
O&M	operations and maintenance
PACP	Pipeline Assessment and Certification Program
PPE	personal protective equipment
R/D	retention / detention
R&R	repair and replacement
RCW	Revised Code of Washington
Regional Road Guidelines	Regional Road Maintenance Endangered Species Act (ESA) Program Guidelines
ROW	right-of-way
SMC	City of Shoreline Municipal Code
SOP	standard operating procedure
SWES	Surface Water and Environmental Services
Utility	Surface Water Utility
WDFW	Washington Department of Fish and Wildlife

Section 1

Introduction

This Operations and Maintenance (O&M) Manual (Manual) is intended to inform and provide guidance to Surface Water Utility (Utility) staff and contractors responsible for maintaining and operating the City of Shoreline's (City) municipal stormwater system. The contents of this Manual will help O&M staff make Shoreline a safe and vibrant community. The procedures and processes contained in this Manual will help provide consistent, predictable levels of service (LOS) for Utility customers and protect City stormwater and environmental resources.

This Manual is organized by the various stormwater system asset and maintenance activity types. It presents maintenance practices and processes for Utility maintenance staff and contractors to help:

- Promote worker safety
- Prioritize and schedule needed maintenance activities
- Comply with federal and state requirements
- Achieve adopted performance standards and LOS
- Manage Utility assets
- Protect aquatic environmental resources
- Provide the City capital improvement projects (CIPs) and repair and replacement (R&R) programs with information regarding needed stormwater system improvements

This Manual may be referenced in answering questions regarding the Utility's operating obligations and processes. There are also associated documents to assist Utility maintenance staff and contractors performing stormwater system maintenance. Other supporting documents are referenced throughout this Manual.

This Manual should be updated as operations needs change to address new regulations, changing field conditions, new policies, or other changes affecting stormwater O&M activities. This document should be revised through a process of continuous improvement to ensure utilization of best practices. The information and processes contained in this Manual should be evaluated for efficiency and effectiveness in achieving desired results, and be evaluated against organizational goals. A review of this Manual should occur on a regular basis, and with any significant regulatory or policy change having the potential to affect stormwater operations or systems. Included in the preliminary portion of this document is a versioning section that includes space for the reason, date, and type of updates completed.

1.1 Purpose of the Manual

This Manual is intended to guide Utility staff in meeting stormwater systems O&M requirements under the *Stormwater Management Manual for Western Washington* (2014 SWMMWW) and National Pollutant Discharge Elimination System (NPDES) Phase II permit. It also will assist staff in complying with the requirements of the City of Shoreline Municipal Code (SMC), and adopted Utility LOS.

The City maintains and operates a municipal separate storm sewer system (MS4) and discharges to streams, lakes, wetlands, and the Puget Sound. The City MS4 includes ditches, detention ponds, catch basins, pump stations, filters, and other stormwater system components in addition to various types of storm drainage pipes. This Manual provides guidance in operating and maintaining these system components to meet regulatory requirements, control flooding, and reduce downstream impacts to aquatic habitat, fish, and wildlife outside of the MS4.

In addition to the NPDES Phase II permit maintenance standards and requirements, the Utility must also obtain and maintain a Hydraulic Project Approval (HPA) permit from the Washington Department of Fish and Wildlife (WDFW) for certain types of maintenance work. Construction projects or activities including routine maintenance work in or near waters of the state must be executed under the HPA. This Manual indicates which maintenance activities may trigger an HPA.

1.2 Purpose of Maintaining Stormwater Assets

Along with controlling flooding and properly maintaining stormwater system components, asset maintenance helps reduce surface water and groundwater pollution. Storm drainage maintenance is necessary to protect streams, lakes, wetlands, and groundwater.

Proper maintenance helps ensure that:

- Stormwater system components operate as they were designed to protect the public and environment from flooding and water pollution
- Stormwater system components are cleaned of pollutants, such as sediment and oils, so that those materials are not deposited into streams, lakes, and the Puget Sound
- Stormwater system pollutant removal capacity is not overwhelmed, with the system then becoming a source of pollutants
- Beneficial plant health and weed control within vegetated stormwater facilities

1.3 Reference Documents and Manuals

Reference documents and manuals used in the creation of this Manual include:

- *Western Washington Low Impact Development (LID) Operation and Maintenance (O&M)* (Herrera and Washington Stormwater Center 2013)
- *2016 Engineering Development Manual* (EDM) (City 2016)
- 2014 SWMMWW, including Volumes IV and V, which address maintenance intervals and best management practices (BMPs) during and post-construction (Ecology 2014)
- *Regional Road Maintenance Endangered Species Act Program Guidelines* (Regional Road Guidelines), which provide information for BMP use relating to road maintenance and Endangered Species Act (ESA) compliance (Tri-County Working Group 2000)
- *Cityworks Supplemental Training Manual* (Woolpert 2013)

1.4 Maintenance Zones

The Utility uses a maintenance map to divide the city into smaller sections. These zones are referenced as part of the inspection interval and portioning work. The Street Operations Division also uses this system, which helps to enhance greater communication between groups. See Figure 1-1 below for a depiction of City maintenance zones.

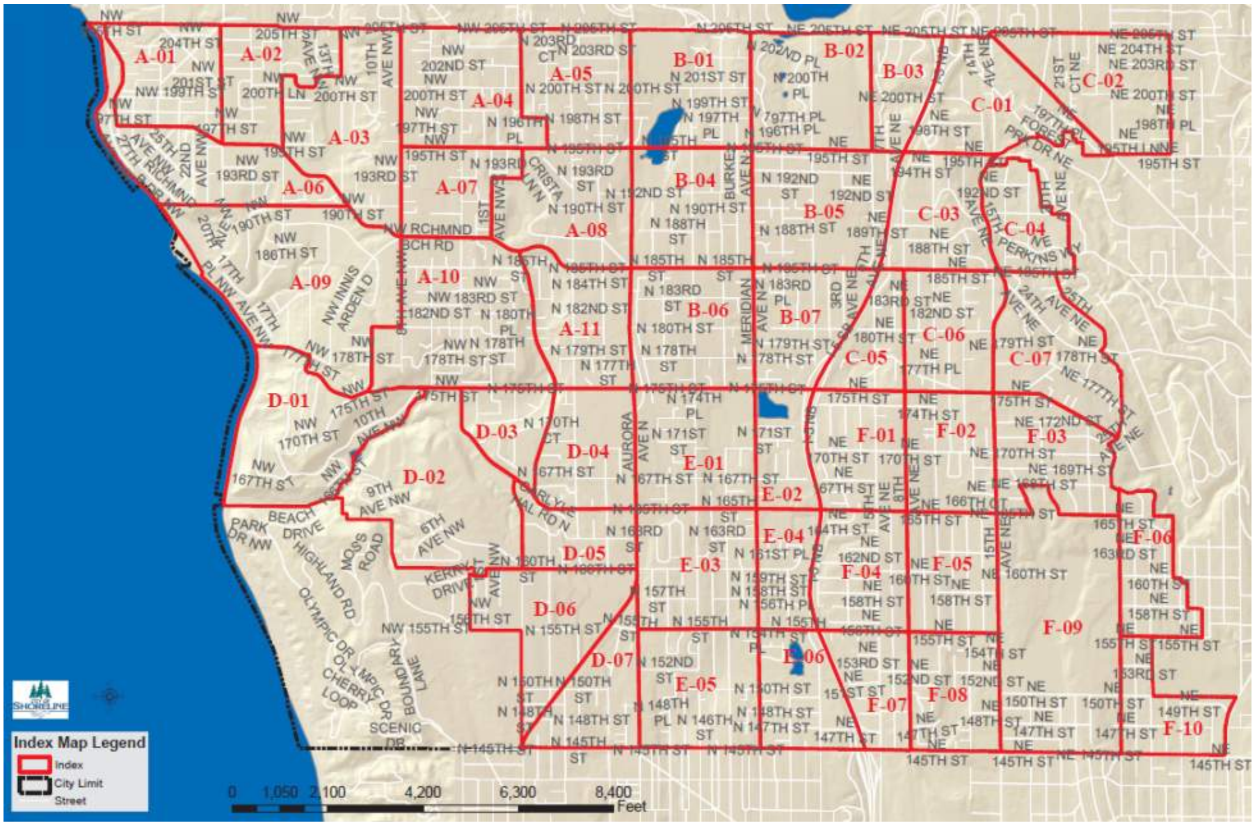


Figure 1-1. City Public Works maintenance zones

1.5 Stormwater Asset Inspection Program

The Utility's stormwater asset inspection program is designed to inspect surface water assets and facilities according to the *Stormwater Management Manual for Western Washington* (SWMMWW) and to meet the NPDES Phase II permit through the following programs:

- Right-of-way (ROW) inspections include catch basins, ditches, and ditch adjacent pipe (driveway culverts) networks that transfer surface water from ROW pavement. Each catch basin is inspected on a biennial cycle while each ditch is inspected every third year.
- Regional facility inspections involve visual checks of all stormwater infrastructure, access, and safety features associated with a regional site owned and operated by the City. The extent of infrastructures included in each regional facility is defined in a geographic information system (GIS) polygon shape.
- Residential facility inspections involve visual checks of all stormwater infrastructure on a biennial cycle (once every other year). Half of the facilities are inspected on even years and the other half are inspected on odd years.
- Commercial/private facility inspections involve visual checks of all stormwater infrastructure on privately owned sites on an annual or biennial cycle (depending on inspection history).
- Pipe and structure inspections include inspection of pipe and structures through closed-circuit television (CCTV) and handheld recording devices on a basin-wide scale on a 20-year frequency.

Table 1-1 presents the types of stormwater assets associated with each inspection program and the inspection frequency

Table 1-1. Surface Water Asset Inspection Program Summary

Inspection Program	Asset	Frequency of Inspection
ROW	Catch basins	Every 2 years (1/2 annually)
	Pipes (adjacent to ditches)	Every 3 years (1/3 annually)
	Ditches	Every 3 years (1/3 annually)
Regional Facilities	• Catch basins/manholes • Ponds, tanks, constructed wetlands, pump stations, infiltration facilities • Culverts, natural channels, pipes • Filterra, vaults, gauges, filters, gate valves, pipe	Annually
Residential Facilities	• Catch basins/manholes • Facilities (ponds, tanks, pump stations)	Biennially
Commercial/Private Facilities	• Catch basins/manholes • Ponds, vaults and tanks, bioretention	Annually or biennially (depending on inspection history)
Pipe and structures	• Pipe • Manholes	At least every 20 years
Hot spot locations	Facilities (pump stations, flooding locations)	Weekly (October-February) After major storms (March-September)

The components of the ROW, regional, residential, and commercial/private facility inspections are scheduled throughout the year as shown in Table 1-2, though inspection scheduling may be modified to address changing field conditions.

Table 1-2. Estimated Annual Inspection Scheduling

Inspection Type	Start	Finish
City and Park Facility	January 1	January 31
ROW Catch Basin	February 1	April 29
ROW Ditch	May 1	May 31
Commercial/Private Facility	May 1	August 31
ROW Pipe (adjacent to augured ditches only)	July 1	July 31
Regional Facility	August 1	August 31
Residential Facility	September 1	September 30

The Utility records all work performed on an asset in the Cityworks computerized maintenance management system (CMMS). A CMMS is a software package that maintains a computer database of information about an organization's maintenance operations. Cityworks is used to track work orders, inspections, and service requests related to assets. Cityworks can also be used to track work done at addresses, locations, and non-asset-specific work.

All work performed on assets (e.g., preventive, corrective, reactive, and predictive) is recorded in Cityworks. Equipment, labor, and materials are entered to varying degrees; contractor costs are entered as a lump sum; and equipment (truck) usage is logged for work orders when used. Refer to the *Cityworks Supplemental Training Manual* on procedures for recording work and inspections (Woolpert 2013). Inspection tables included in this Manual are representations of the CMMS inspection checklists.

1.6 Construction and Operations Water Quality BMP

The Utility references the Regional Road Guidelines as a primary source of construction BMPs for each asset type. When performing maintenance, repair or replacement activities, City staff should consider the use of the water quality BMPs based on the size and extent of the work type. Each asset maintenance description will include a reference to the most commonly used BMPs and the associated number within the Regional Road Guidelines for the maintenance/installation of an asset (Tri-County Working Group 2000).

1.7 Asset O&M Activity Summary

Table 1-3 provides a summary for the assets included in this O&M Manual.

Table 1-3. O&M Summary by Asset

Manual Section	Asset	O&M Activity	Accomplished by	Frequency	Timing
4.1	Bioretention	Inspection	City	Annually	August
		Maintenance	Contractor	Annually	February - December
4.2	Catch basin	Inspection	City	1/2 annually	February-April
		Vactoring	Contractor	Annually	March-November
		Repair/Replace	City/Contractor	Annually	Year round
4.3	Constructed Wetland	Inspection	City	Annually	August
4.4	Control structure	Inspection	City	Annually	Varies based on inspection program
4.5	Culvert	Inspection	City	Annually	Varies based on inspection program
4.6	Dam	Inspection	City/Ecology	Annually	August
4.7	Ditch	Inspection	City	1/3 annually	May
		Maintenance	City/Contractor	Annually	July
4.8	Drain	Inspection	City	Annually	Varies based on inspection program
4.9	Filter	Inspection	City	Annually	August
4.10	Filterra	Inspection	City	Annually	August
4.11	Floodwall	Inspection	City	Annually	August
4.12	Gate valve	Inspection	City	Annually	August
4.13	Gauge	Inspection	City	Annually	Varies based on inspection program
4.14	Hydrodynamic separator	Inspection	City	Annually	Varies based on inspection program
4.15	Infiltration Pipe	Maintenance	Contractor	Biennially	June
4.16	Manhole (part of other inspection)	Inspection	City	Annually	Varies based on inspection program
4.16	Manhole (condition assessment)	Inspection	Contractor	Every 20 years	Varies based on inspection program
4.17	Media filter drain	Inspection	City	Annually	August
4.18	Natural channel	Inspection	City	Annually	Varies based on inspection program
4.19	Oil/water separator	Inspection	City	Annually	Varies based on inspection program
4.20	Outfall	Inspection	N/A	Annually	Varies based on inspection program
4.21	Permeable pavement	Inspection	City	Annually	Varies based on inspection program

Table 1-3. O&M Summary by Asset					
Manual Section	Asset	O&M Activity	Accomplished by	Frequency	Timing
4.22	Pipe (part of inspection program)	Inspection	City	Annually	Varies based on inspection program
	Pipe (part of ditch inspection)	Inspection	City	Annually	July
	Pipe (part of ditch inspection)	Maintenance	Contractor	Annually	August-September
	Pipe (condition assessment)	Inspection	Contractor	Every 20 years	varies
4.23	Pipe inlet structure	Inspection	City	Annually	Varies based on inspection program
4.24	Pond	Inspection	City	Annually	Varies based on inspection program
4.25	Pump station	Hot spot	City	Weekly	October - February
		Regional inspection	City	Annually	Varies based on inspection program
4.26	Stormwater facility	Inspection	City	Annually	Varies based on inspection program
		Maintenance	City/Contractor	As-Needed	March-October
4.27	Swale	Inspection	City	Annually	Varies based on inspection program
4.28	Vault and tanks	Inspection	City	Annually	Varies based on inspection program
		Maintenance	Contractor	Annually	Varies based on inspection program
5.3					
5.6	Ronald Bog	Hot spot	City	Weekly	October - February
		Regional inspection	City	Annually	Varies based on inspection program

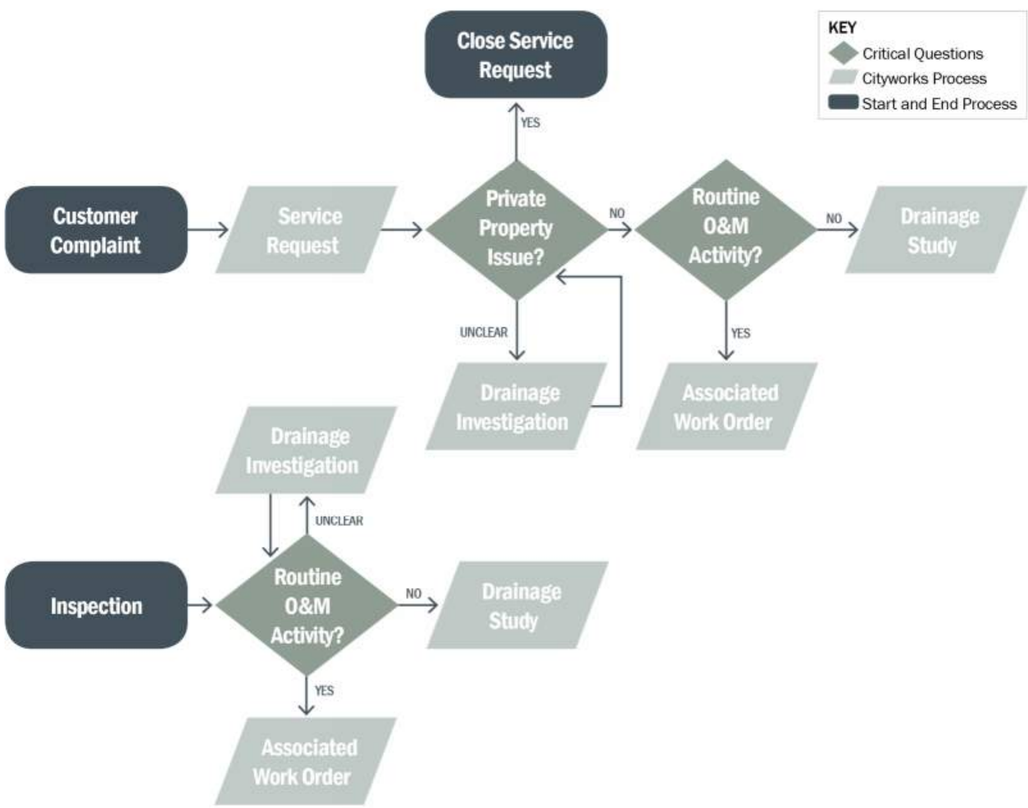
Section 2

O&M Work Flow Process

The work and workflow process for surface water O&M activities are tracked in Cityworks are illustrated in Figure 2-1.

Surface Water Utility O&M: Work Flow Process

The work and workflow process for surface water O&M activities are tracked in Cityworks and include the following:



Private property issue? - Questions to determine if private property or Utility (ROW) issue

I. Does this issue originate from a private property and only impacts private property? If yes, then It is a private property issue, inform the private property and close out Service Request

II. Does the issue originate from a private property and impacting the ROW, if Yes then it is unclear who is responsible for resolving the issue, generate a Drainage Investigation work order

III. Does the issue originate from ROW and impacting private property? Yes, it is not a private property issue, it is a ROW issue

Routine O&M Activity?

I. Can the issue be resolved with routine operations and maintenance activity i.e vactor, repair, replacement etc? if yes, then generate associated work order

II. Does the issue require additional analysis, if yes, then generate a drainage investigation

III. Does the issue require engineering analysis or activity beyond the O&M? if yes then generate a Drainage Study Work order

Drainage Investigation – Work Order to determine

I. Responsibility- if the Utility or Private Property is responsible

II. Cause - The cause of the issue

III. Resolution - Type of work to resolve the issue i.e O&M activity, Repair, replacement, engineering analysis

Figure 2-1. Work and workflow processes for surface water O&M activities

A summary of key activities presented in Figure 2-1 is provided below:

- Surface water staff respond to Customer Complaints related to surface water or storm water issues, including flooding, water quality or poor drainage. Upon receiving resident complaints, staff create a service request to track and document the complaints and associate activities. Most service requests related to the public infrastructure or ROW assets are followed-up with a field investigation. Some customer/ residents' complaints are related to private property issues and may require a field investigation to verify that the issue is not related or caused by the public or ROW system.
- Service Requests are used to track complaints/requests for services that come in from citizens, contractors, or other employees. Requests consist of a problem code, incident location, caller information, response information, and related work activities. Service requests originate from a customer calling in with a complaint, a submittal from a public web portal, or from direct communication with city staff. For more details on service requests please refer to the 2015CityworksServiceRequests.docx included as Appendix A.
- Field Investigations are required for most citizens and customer complaints associated with public infrastructure. Document all findings during field investigation in the service request, including pictures. In most cases, the field investigation is completed and recorded in the service request. If a complete investigation could not be accomplished, then a drainage investigation will be created.
- Work Orders are used primarily to track work history against assets and the cost related to the work activities. Utility staff generate work orders for surface water assets. Work orders are either Reactive or Preventative. For more details on Work Order refer to the 2015CityworksWorkOrders.docx
- Drainage Investigations may include researching easements and historical data. Upon completing a drainage investigation, generate a work order to resolve the issue (e.g., cleaning or repair). If the issue resolution requires an engineering analysis, a Drainage Study work order is initiated and assigned to the SW Engineer
- Drainage Study work orders are for issues that require engineering analysis or additional analysis beyond typical operations and maintenance activities to resolve. This could include, issues related to lack of drainage infrastructures, capacity issues that require design of larger systems, significant erosion issues that require geotechnical analysis, etc.

Section 3

Version History and Potential Updates

The purpose of this section is to track the version history of the Manual and to summarize known potential updates to the O&M process and data management. Table 3-1 provides a location for Manual versions to be recorded with a change reference. Table 3-2 summarizes potential updates to the City data management systems (GIS and CMMS) or other O&M planning efforts by Manual section.

Table 3-1. Document Control

Date	Author	Version	Change Reference

Table 3-2. Asset SOP Status and Potential Updates

Manual Section No.	Asset SOP/ Manual Section Name	Existing Inspection provides Condition Assessment Data	O&M Manual Status	Cityworks Status	Potential Updates to City Data Management Systems
4.1	Bioretention	Yes	Inspection	Feature class	• Update inspection form to indicate thin mulch is < 2 inches
4.2	Catch basin	Yes	Inspection	Feature class	-
4.3	Constructed wetland	No	Proposed Inspection	-	• Develop a feature or object class • Develop inspection form in Cityworks • Add to regional inspection program
4.4	Control structure	Yes	Inspection	Object class	-
4.5	Culvert	No	New Inspection	Feature class	• Add to regional inspection program
4.6	Dam	Yes	Inspection	Feature class	• Link Dam design drawings to inspection form or provide direction 10% of pond filled with sediment for dam ponding area.
4.7	Ditch	Yes	Inspection	Feature class	-
4.8	Drain	Yes	Inspection	Feature class	-
4.9	Filter	No	Proposed Inspection	Object class	• Develop inspection form in Cityworks • Add to regional inspection program

Manual Section No.	Asset SOP/ Manual Section Name	Existing Inspection provides Condition Assessment Data	O&M Manual Status	Cityworks Status	Potential Updates to City Data Management Systems
4.10	Filterra	Yes	Inspection	Feature class	• Add plant health to inspection form
4.11	Floodwall	No	Proposed Inspection	Feature class	• Develop inspection form in Cityworks • Add to regional inspection program • Use geotechnical engineer in inspection process
4.12	Gate valve	Yes	Inspection	Feature class	• Add exercise valve criterion to inspection form or work order
4.13	Gauge	No	Proposed Inspection	Feature class	• Develop inspection form in Cityworks • Add to regional inspection program
4.14	Hydrodynamic Separator	No	Proposed Inspection	Object class	• Develop inspection form in Cityworks • Add to regional inspection program
4.15	Infiltration Pipe	No	Proposed Inspection	Feature class	• Obtain photo or schematic
4.16	Manhole	Yes	Inspection	Feature class	
4.17	Media filter drain	Yes	Inspection	Feature class	
4.18	Natural channel	Yes	Inspection	Feature class	
4.19	Oil/water separator	Yes	Inspection	Object class	
4.20	Outfall	Yes	Inspection	Feature class	• Add erosion/rock pad to inspection form
4.21	Permeable pavement	Yes	Inspection	Feature class	
4.22	Pipe	Yes	Inspection	Feature class	
4.23	Pipe inlet structure	Yes	Inspection	Feature class	
4.24	Pond	Yes	Inspection	Feature class	
4.25	Pump station	Partial	Hot Spot work order	Feature class	• Update Inspection form in Cityworks based on recommendations from CAMP
4.25	Pump station	Yes	Inspection	Feature class	
4.26	Stormwater facility	Yes	Inspection	Feature class	
4.27	Swale	Yes	Inspection	Feature class	
4.28	Vault and tank	Yes	Inspection	Feature class	

Table 3-2. Asset SOP Status and Potential Updates

Section 4

Stormwater Assets: Standard Operating Procedures

This Manual provides descriptions of stormwater system maintenance work to be performed, including inspection, reporting, system cleaning, and repairs. For the purposes of this Manual, standard operating procedure (SOP) is defined to include not just facility operations, but inspection and maintenance procedures as well. This information is presented using:

- Asset description:
  - Associated SOPs are noted for drainage system components that may be associated with the work outlined in the section at hand
  - Asset photograph or sketch where available
- Asset inspection:
  - Inspection criteria provided for certain asset classes as appropriate, and indicating inspection frequency
  - Cityworks inspection tables provided where applicable to outline stormwater system inspection, and reporting criteria and results
  - Inspection general work method
- Asset maintenance:
  - Maintenance methods include SOPs and other considerations to be noted in performing maintenance
  - General work methods for routine and reactive maintenance activities
  - Washington State Department of Ecology (Ecology) maintenance tables included where applicable (from the 2014 SWMMWW) showing system component maintenance performance criteria for NPDES compliance
  - Construction BMPs providing references for construction activities as outlined in the Regional Road Guidelines (Tri-County Working Group 2000)

The SOPs for municipal stormwater system asset classes to which this Manual applies are provided below.

4.1 Bioretention Facility

A bioretention facility is an engineered facility that stores and treats stormwater by passing it through a specified vegetated soil profile for treatment, and typically retains or detains some volume of treated stormwater for flow attenuation.

Bioretention facilities provide water quality treatment through filtration and sediment deposition. Facilities are designed to retain surface water for up to 48 hours and provide some flow control.

Related SOPs include drains and swales. Figure 4-1 shows an example of a typical bioretention facility.

Figure 4-1. Bioretention facility

4.1.1 Bioretention Facility Inspection

Bioretention facilities are inspected annually, and typically in coordination with other assets associated with a regional inspection. Utility staff perform bioretention facility inspection and prepare corrective work orders for maintenance and R&R. Table 4-1 is a representation of the CMMS inspection checklist in Cityworks for bioretention facilities. The form is a simplification of Table V-4.5.2(21) Maintenance Standards – Bioretention Facilities", Section 4.6, Volume V of 2014 SWMMWW, included in Appendix B.

Table 4-1. Bioretention Facility Cityworks Inspection Form with Inspection General Work Method			
Criterion	Result	Explanation	General Work Method
Sediment	FAIL	Present on curb cut or in lowest point in facility	Visual inspection on presence and location of the sediment
	PASS	Absent on curb cut and in lowest point in facility	
Vegetation	FAIL	Poor vegetation coverage or weeds present	Visual inspection, typical coverage for an established facility
	PASS	Adequate vegetation coverage and weeds absent	
Weeds	FAIL	Weeds present	The facility should be free of weeds such as grass, ivy, dandelions, or non-design/post-construction plantings that would reduce facility function
	PASS	Weeds absent	
Trash and debris	FAIL	Present	Visual inspection
	PASS	Absent	
Mulch	FAIL	Thin coverage	Visual inspection of less than 2 in.
	PASS	Adequate coverage	
Erosion	FAIL	Present on bank or in low point	Visual inspection of rills or channelization areas where mulch has been eroded away
	PASS	Absent on bank or in low point	
Contamination	FAIL	Oil/gas/other pollution present	Visual inspection of oil sheen or darkened mulch or soil from oil spill
	PASS	Oil/gas/other pollution absent	
Overflow	FAIL	Blocked or plugged	Visual inspection of overflow structure (beehive or grated inlet)
	PASS	Clear	
Under drain	FAIL	Blocked or plugged	Visual inspection into structure, look for standing water or debris
	PASS	Clear	
Curb cut	FAIL	Opening restricted	Visual inspection of curb cut, flow through cut and into facility should not be restricted
	PASS	Opening not restricted	
Other	FAIL	Other, comment	Other means any condition that requires attention to remain or be returned to operation
	PASS	None	

4.1.2 Bioretention Facility Maintenance

If a bioretention facility has a facility-specific O&M manual, refer to the facility manual for maintenance frequency and activities.

Table 4-2 summarizes bioretention facility maintenance.

Table 4-2. Bioretention Facility Maintenance Summary	
Element	**Description**
Maintenance interval	Bioretention facilities shall be maintained monthly during the growing season (March–November).
Maintenance type/timing	• Routine maintenance varies with the growing season and occurs as frequently as monthly. Several maintenance activities are especially prone to cause soil compaction; avoid compacting soil during maintenance activities. Typical routine maintenance includes removing weeds, removing trash, and adding mulch. • Perform corrective maintenance within 1 year of inspection. Typical corrective maintenance includes plant replacement and underdrain flushing.
Reactive maintenance	Maintenance efforts to address conditions such as damage from storms, car accidents, pollutant spills, or construction may require special repairs or cleanup.
Permit requirements	NPDES: Inspection must occur annually. If a bioretention facility does not meet a maintenance standard, general repairs must be made in 1 year and capital repairs in 2 years.

Table 4-3 lists general work methods for bioretention facility routine maintenance.

Table 4-3. Bioretention Facility Routine Maintenance General Work Method		
Maintenance Activity	**Recommended Frequency**	**Notes**
Observation ports	• Visually check observation ports at least 2 times per year. • Check observation ports after 1 in. of rainfall in 24-hour period and record water level.	• Remove cap of observation port. Measure depth between observed water level and top of lid for port. Replace cap securely when done. Keep a record of measurements (including date) in maintenance log. • Check project-specific O&M manual for minimum distance between top of observation port and water surface level during dry and wet weather. • During rainy weather, ponding will occur in the bioretention and the water level will rise. After the rain event is over, the water level at the observation port should drop as the water drains out. • If water does not drain out of the observation port after 72 hours after the rain event has ceased, or ponding at surface does not dry out in 48 hours, the bioretention system will require remediation. See "Ponding" in 'Table 4-4 on triggered maintenance for bioretention facilities.
Inspect inflow and outflow points for clogging	• Monthly and as needed during wet season.	• If observed, remove sediment at surface, in pre-settling areas and at storm structure outfalls. • Remove any accumulated debris from inflow/outflow points (e.g., curb cuts, pipes, trench drains, storm structures, etc.).
Cleanouts and underdrains	• Visually check cleanouts and discharge points of underdrains pipes annually to determine if cleaning is necessary.	• Jet clean or rotary cut debris/roots from underdrains so that standing water is not present in pipes during dry weather.
Watering during 1st and 2nd growing seasons	• In the first 6 weeks, plantings may require approximately 1 in. of water twice per week to establish deep roots. After watering, confirm that the soil is moist 3–6 in. below surface. • Reduce watering frequency to once a week until the end of the first growing season (May–September).	• Intent of watering is to keep plant material sustained through establishment. • Monitor rainfall to determine irrigation/watering schedule. • Water regularly during the first 2 growing seasons. • Dry periods will need additional watering for establishing plants because of warmer temperatures and increased sunlight, both of which can stress vegetation. Wilted leaves and drooping stems are all indications of stress caused by dry soils and hot temperatures. • Optimal watering time is early in the morning or late in the evening to reduce evaporation. A preferred watering approach is to have repeated short cycles of watering and soaking into the ground. • Follow manufacturer's guidelines for O&M of irrigation system and its components.

Table 4-3. Bioretention Facility Routine Maintenance General Work Method		
Maintenance Activity	Recommended Frequency	Notes
Dry period watering for established bioretention	• Water infrequently but thoroughly: 0.5–1.0 in. every 2 weeks or when plants appear stressed. • Monitor rainfall and check weather updates and adjust watering accordingly.	• Established (more than 2 years) drought-tolerant plants may need water during prolonged dry periods (possibly late July–mid-September). Inspect plantings during dry periods and look for signs of stress. • Verify if any watering restrictions are in effect in the city for watering during dry periods/water shortages. If no restrictions, then note the following: • Optimal watering time is early in the morning or late in the evening to reduce evaporation. • Monitor rainfall to determine an irrigation schedule. • Do not apply water faster than the soil can absorb it. • Deeper and less frequent watering will encourage plants to develop a deep root system. • If present, inspect irrigation system components for breaks and blockages and repair as necessary.
Leaf, branch, and organic matter removal	• Inspect for organic matter or debris that are blocking inflow points or structures and causing ponding water. • Schedule frequent leaf removal in fall. • Frequent mowing may be required from spring–mid-July for turf biorention. • Monthly mowing may be required July–mid-November for turf retention.	• To prevent clogging, larger pieces of biodegradable landscape debris should be mulched or collected for composting, green waste pick up, or disposal to a recycling facility. • Maintaining a minimum height of 4–6 in. for turf grass within bioretention facilities (turf) will reduce weed invasion and encourage deep root growth, which strengthens drought resistance. • Mow with a mulch mower when grass is 10–18 in. or greater. • Sharpen mower blades frequently to reduce ragged cutting. • A thick layer of leaves, branches, and trash can prevent water and light from getting to lawn and other landscaped areas. Excessive leaf litter around plantings can provide cover for pests and allow mildew growth. Mulching organic matter (leaves) is recommended to facilitate decomposition for both turf and vegetated bioretention.
Trash and debris removal	• Remove trash and debris. • Inspect after large storm events (~more than 1 in. of rainfall in 24 hours or heavy downpour).	• Collect and properly dispose of trash/litter. • Pet waste is a serious concern and should not be left within a bioretention facility as it contains disease-causing organisms and flushes bacteria into the stormwater.
Pruning and removal of dead material	• In spring, remove dead or old plant material from previous season. • Mid-summer and fall, inspect and cut back any plant material that blocks sidewalks and utilities. • In fall, prune to maintain plant appearance.	• Trim and thin vegetation from prior season's growth, leaving 6–8 in. Allow dormant vegetation and old flower stalks to remain in winter to provide food and cover for birds. For early blooming shrubs/trees, prune in spring following bloom. • Plants may require pruning, pinching, and dead heading during the growing season to promote reflowering, direct growth, etc. • Native and/or ornamental grasses may appear dead but generally these plants are dormant during the winter months. Do not remove, prune dry material in spring as new material emerges. If appearing dead in mid-summer, remove and replace.
Weed control of invasive vegetation/weeds	• Remove as soon as observed. • During 3-year establishment period, inspect at least once per month in growing season. • Inspect at least 3 times per year once plants are established.	• Pay special attention to nuisance and invasive vegetation before it establishes a foothold. Particular threats to wet areas are reed canary grass and Japanese knot weed. Other threats include clover, scotch broom, horsetail, morning glory, alder seedlings, English ivy, and blackberry. Watch for any signs of these plants and remove them, including the root system. • See maintenance activity "Weed control of non-invasive vegetation/weeds" below for additional information. • Persistent and invasive vegetation that is located in a mass can be killed by covering the area with black plastic for several weeks during summer. • Disposal methods include bagging and dumpster disposal.

Table 4-3. Bioretention Facility Routine Maintenance General Work Method		
Maintenance Activity	**Recommended Frequency**	**Notes**
Weed control of non-invasive vegetation/weeds	• Inspect the full bed and remove weeds. • Minor weeding monthly. • See Mulch Maintenance Activity of this Table for more information to reduce weed establishment.	• Remove weeds manually before they go to seed by using pincer-type weeding tools, hoes, or hot water weeders. Remove the roots for best results. • Weeds should be pulled when first observed and especially before going to seed. • Weeds need to be pulled in early spring so that the desired plants can thrive. • Mulch immediately (no more than 5 days) following weeding to improve weed control. • When dealing with invasive plant material/weeds, attempt all other physical methods to remove before considering a more aggressive method. • It is important to note that chemicals can harm or kill beneficial or desirable plants, and also add pollutants to stormwater that can negatively impact water quality.
Bare spots and vegetation removal and replacement	• Inspect for bare spots and areas of disturbed vegetation every 6 months.	• Plants may die because of unsuitable conditions or microclimates, disease, pests, or other unforeseen issues. These plants must be removed/replaced to avoid the establishment of weeds in bare areas, the spread of disease, and the reduction in functionality. • Reseed or replant bare areas and replace poor performing plants. Vegetation should cover 90% of bioretention. • Replace vegetation with in-kind planting material or replace plants with high-mortality rate with appropriate plants. • Maintain 1 ft zone clear of vegetation around all inlets and outlets.
Mulch	• Add wood chip mulch in fall and/or spring, when necessary. • Replace or add wood chip mulch as needed to maintain 2–3 in. depth.	• 1 cubic yard of mulch will cover 100 square feet at a depth of 3-inches. 1 cubic yard = 27 cubic feet. Commercial mulch products generally are available in 2 cubic foot bags. 13.5 bags = 1 cubic yard. • Arborist wood chip, compost, and rock mulch helps to control weeds, conserve soil moisture, improve filtration, regulate soil temperatures, and adds nutrients to the soil as it decomposes. Apply wood chip mulch to slope and rim areas. Apply compost mulch to facility bottom and rock mulch for areas where high velocities may cause scouring.
Sediment removal	• Late fall and late spring. • After heavy downpour and rain events of 1 in. or more precipitation in 24-hour period.	• If more than 2 in. accumulation, remove sediment preferably when the bioretention facility/stormwater planter is dry. • Remove sediment manually, using shovels or rakes. Dispose of sediment in accordance with local requirements. • Replace damaged or destroyed vegetation with in-kind plant material.

Table 4-4 provides a general work method for bioretention-triggered maintenance.

Table 4-4. Bioretention Facility Triggered Maintenance General Work Method		
Triggered Maintenance	**Condition Observed**	**Instructions**
Ponding water	• Water is standing/ponding in bioretention and not draining within 48 hours after the rain event has stopped. The facility is not functioning properly due to blockage of sediment and/or debris in the soil strata, underdrain, or outlet structures.	• Check observation port to determine if underdrain pipe is blocked. Remove debris. • Check surface overflow, outlet pipe, or structure to determine if blocked. Remove debris. May need vactoring. • The soil may also be blocked by fine sediments. Rake mulch layer aside and remove sediment from top surface layer, aerate soil, and re-spread mulch.
Erosion of soils and sediment loading (attributable to temporary or extraneous conditions, not design defect)	• 2 in. (or greater in depth) gullies/rills are present, washing out soils and mulch. • Sediment washed downstream is clogging outlets and/or rock around outlet structures.	• Remove and store any desirable vegetation (to be used for replanting) from bioretention facility. Rake and remove fine sediments from surface. Add additional soil if necessary and regrade to direct water toward low point of bioretention, or level out bottom surface. Replant and/or replace vegetation and reapply mulch. • If slopes have been compromised, remove vegetation (reserve for replanting), re-grade, and re-contour area by hand tools where practical. Replant vegetation and install 2–3 in. of mulch. • Clear away rocks and sediment, and reinstall rock protection at structure inlets/outlets and add more rocks if needed.
Erosion of soils and sediment loading (attributable design defect)	• Erosion is caused by concentrated flows entering the facility from the side, because of small variations in the impervious surfaces immediately adjacent the facility. • 2 in. (or greater in depth) gullies/rills are present, washing out soils and mulch. • Sediment washed downstream is clogging outlets and/or rock around outlet structures.	• Hand-install small rock protection features at the erosion location • Remove and store any desirable vegetation (to be used for replanting) from bioretention regrade to direct water toward low point of bioretention, or level out bottom surface. Replant and/or replace vegetation and reapply mulch. • If slopes have been compromised, remove vegetation reserve for replanting), re-grade, and re-contour area by hand tools where practical. Replant vegetation and install 2–3 in. of mulch. • Clear away rocks and sediment, and reinstall rock protection at structure inlets/outlets and add more rocks if needed.
Soil settlement	• Soil has settled 2 in. or more below paving surface.	• Rake mulch aside for later use. Apply prepared bioretention soil mix (use soil mix design per original plans if possible or see reference below for information) to bring soil height within 1–2 in. of top of pavement. Add 1–2 in. of mulch to bring top of mulch flush with adjacent paving/surface. • Replant if necessary to provide vegetative cover over exposed soil.
Pest control	• Pests have been reported to cause extensive plant damage or death and have/could become a nuisance or public health concern. • Mosquitoes can breed in shallow stagnant ponding water.	• Remove all trash, fruit, and nuts that have fallen to the ground to avoid attracting rodents. • Mosquito larvae look like “wiggling sticks,” typically floating perpendicular to water’s surface. Mosquitoes take 5–7 days to mature. Bioretention facilities are designed to drain out within 24–48 hours after the rain event has ceased. If stagnant ponding and larvae are observed, then remove ponding (see paragraph on ponding). • Where rodent holes are present, fill with soil and lightly compact soil around the holes.

4.2 Catch Basin

A catch basin is a grated chamber or well, usually built along the runoff flow line of a street, for the admission of surface water to a storm pipe or subdrain, with a sediment sump at the base designed to retain grit and detritus below the point of overflow. The grit and detritus may contain pollutants that would otherwise discharge into downstream receiving waters.

Structures addressed in SOPs are those recorded in the City's GIS system as Type 1 and 2 catch basins and inlets. In the City's GIS, catch basins and inlets are included in the catch basin asset class. The manhole asset class erroneously includes Type 2 catch basins, which are inspected and maintained per this catch basin SOP.

An inlet is also a grated chamber that does not contain a sump, and is also maintained per this SOP. Many catch basins do not conform to the current standards for catch basin construction and dimensions. Some catch basins and inlets do not have a sump or may not have a bottom slab and are serving as drywells.

Related SOPs include control structure, manhole, and pipe. Figure 4-2 shows an example of the exterior of a catch basin.

Figure 4-2. Catch basin

4.2.1 Catch Basin Inspection

Catch basins and inlets must be inspected every 2 years per Phase II NPDES permit requirements. Basins must be cleaned, repaired, or replaced within 6 months of inspection that identifies the need to comply with maintenance standard unless the maintenance requires capital construction.

4.2.2 Catch Basin Inspection Procedure

Catch basin inspections require two staff members. Staff member one is responsible for driving the vehicle, routing, and completing the Cityworks Inspection Form. Staff member two is responsible for the visual inspection of the catch basin, which includes probing the catch basin for sediment depth. See Appendix C for a more detailed Catch Basin Procedure.

Table 4-5 is a representation of the CMMS inspection checklist in Cityworks for catch basins. The form is a simplification of Table V-4.5.2(5) “Maintenance Standards – Catch Basins”, Section 4.6, Volume V of 2014 SWMMWW, included in Appendix B.

Follow necessary safety and personal protection guidelines when inspecting, cleaning, and maintaining Type 2 catch basins. Type 2 catch basin inspections may require confined space entry.

Table 4-5. Catch Basin Cityworks Inspection Form with Inspection General Work Method

Criterion	Result	Explanation	General Work Method
Sediment	FAIL	Sediment is greater than 60% depth of sump at lowest invert	Use graduated rod to estimate sediment depth and total depth from invert to sump bottom. Estimate percent depth of sediment.
	PASS	Sediment is less than 60% depth of sump at lowest invert	
Frame/slab	FAIL	Holes larger than 2.00 in.^{2} or cracks larger than 0.25 in.	Visual inspection of the frame and slab and use hole size guidelines to determine FAIL, CONCERN, or PASS. If the structure has issues but does not require immediate repair, select CONCERN.
	CONCERN	Holes between 1 and 2 in. or cracks greater than 0.125 in. and less than 0.250 in.	
	PASS	No holes larger than 1 in.^{2} and cracks larger less than 0.125 in.	
Walls/bottom	FAIL	Judgment that structure is unsound and needs immediate repair or replacement; function of basin is severely compromised	Visual inspection of walls and bottom concrete, missing bricks or large cracks. If bottom is covered with sediment, flag catch basin for inspection during cleaning.
	CONCERN	Judgement that there are structural issues but basin is functioning; may need minor repair	
	PASS	No structural issues; function of basin is sound	
Grout fillet (pipe to wall)	FAIL	Crack greater than 0.5 in. and longer than 1 ft with evidence of sediment entering	Visual inspection of the connection of pipes to catch basin or inlet wall. Visually estimate width and length or cracks with graduated rod or tape measure.
	CONCERN	Cracks between 0.25 in. and 0.5 in. and length less than 1 ft with no evidence of sediment entering	
	PASS	Crack less than 0.25 in. and less than 1 ft long with no evidence of sediment entering	
Ladder	FAIL	Missing rungs, rust, cracks, sharp edges	Visual inspection of rungs above sediment or water level. If ladder is covered with sediment or water, flag catch basin for inspection during cleaning.
	PASS	No missing rungs, rust, cracks, sharp edges	
Grate/cover	FAIL	Unable to open, missing, and/or broken	Visual inspection of grate and cover.
	PASS	Able to open, present, and intact	
Contamination	FAIL	Oil/gas/other pollution present	Visual inspection of oily sheen or by smell of contaminates such as petroleum products or organic compounds (e.g., paint thinner or acetone) within the catch basin including on top of water or sediment, or along the interior wall.
	PASS	Oil/gas/other pollution absent	
Inlet/outlet	FAIL	Greater than 33% blocked	Visual inspection to estimate percent blocked or use graduated rod measure blockage and inlet diameter to calculate percent blocked.
	PASS	Less than 33% blocked	
Trash and debris	FAIL	Blocking inlet, or greater than 60% sump depth	Visual inspection to determine blockage.
	PASS	Not blocking inlet, and less than 60% sump depth	
Cannot locate	FAIL	Cannot locate	Visual inspection for locating relative to map/GIS representation and identifier.
	PASS	Can locate	

Table 4-5. Catch Basin Cityworks Inspection Form with Inspection General Work Method			
Criterion	**Result**	**Explanation**	**General Work Method**
Other	FAIL	Other, comment	Other can be used for any condition that is deemed unacceptable and is not covered by the other observation categories.
	PASS	None	
Lateral connection	Lateral	Indicates unmapped lateral is present and the origin appears to be from private property	Lateral is used to identify unmapped lateral connections. This criterion is important for IDDE screenings.
	Unknown	Indicates unmapped lateral is present but the origin is not known	
	Other	Other can be used for any connection that is not covered by the other observation categories	
	N/A	Did not find unmapped laterals.	
Maintenance recommendation	Repair	Recommend repair	Inspector indicates maintenance recommendation in field. Information used for generating work orders after field investigations and inspections.
	Replace	Recommend replacement	
	N/A	No recommendation for repair or replacement	
Priority	Yes	Repair or replacement have priority	Inspector indicates priority recommendation in field. Information used for generating work orders after field investigations and inspections.
	No	Repair or replacement are not a priority	

4.2.3 Catch Basin Maintenance and Construction BMPs

Table 4-6 summarizes maintenance for catch basins.

Table 4-6. Catch Basin Maintenance Summary	
Element	**Description**
Maintenance interval	Catch basins and inlets must be inspected or cleaned every 2 years.
Maintenance type	• Routine maintenance includes grout work and removing built-up materials and sediment with a vactor truck. After the cleaning, inspect each basin on a case-by-case basis for structural repair. • Non-routine maintenance includes lid replacement. Most hand-built brick basins no longer meet current design specifications. It is good practice to fully replace brick basins that are failing structurally. Failing cast catch basins may be able to be partially repaired.
Maintenance timing	• Perform cleaning in dry months to avoid washing sediment-laden water downstream, optimize sediment removal, and minimize possible water quality impacts. • For work done during wet periods or flowing water, the work is done with a vactor truck with vactoring occurring downstream of pipe work to control the escape of sediment-laden water.
Reactive maintenance	• Maintenance items such as damage from storms, car accidents, or construction may require special repairs or cleanup. Removal and replacement is the preferred method for failing hand-built basins. • Ensure minimum of 2 bolts are securing the covers.
Permit requirements	• NPDES: Cleaning, repair, or replacement of catch basins and inlets every 2 years. If a catch basin or inlet does not meet a maintenance standard, repairs must be made within 6 months. • HPA: If work is being done within a piped stream, then work is done in accordance with the HPA requirements.
Exceptions and outliers	Catch basins and inlets with no sump cannot be cleaned as there is no buildup to remove. There are some smaller than standard catch basins that are City responsibility and must be cleaned by hand.

Table 4-7 lists general work methods for catch basin cleaning by vacuum.

Table 4-7. Catch Basin Cleaning by Vacuum General Work Method

Activity Component	Activity Details and Description
Desired result	Catch basins are free of debris by vacuuming

Resources	• Crew:
	  • 2-person crew
	  • 2 flaggers (as needed)
	• Material: Water
	• Equipment:
	  • 1 vacuum truck
	  • 1 grate puller/T-bar
	  • 1 backup truck with overhead arrow for traffic control
	  • PPE (gloves, hardhat, safety glasses, rain gear, rubber boots, hearing protection)
	  • Laptop, charger, and cleaning sheets
	• Contractor/vendor costs:
	• Debris: decant spoils
	• City-approved decant location

General work method	1. Place traffic control signs and safety devices as required at job site 2. Use proper PPE 3. Apply all confined-space equipment 4. Crew persons 1 and 2 work together to remove catch basin lid and position equipment 5. Inspect for illicit discharge or connection (SMC 13.10.320); if illicit discharge observed initiate a water quality service request for IDDE investigation 6. Clean all surfaces, walls, brick, concrete, inlets and outfalls 7. Inspect condition of inlet, outfall, and brick/concrete structure 8. Clean inlets and outfalls if accumulated sediment is 20% or more of the pipe 9. Remove vacuum tube and replace lid or close hatch to avoid noise from traffic driving over it 10. Clean up job site, tools, and truck 11. Remove traffic control signs and safety devices as required at job site 12. Make notes about any further work that is needed 13. Decant vacuum truck in decant spoils bay 14. Accurately report in Cityworks

Table 4-8 lists general work methods for catch basin cleaning by hand.

Table 4-8. Catch Basin Cleaning by Hand General Work Method	
Activity Component	Activity Details and Description
Desired result	Manually remove leaves, debris, etc. from the inlets and outlets of culverts and pipes to improve drainage

Resources	• Crew: 2-person crew
	• Material: None
	• Equipment:
	  • 1 service truck
	  • 2 flat shovels
	  • 1 broom
	  • 1 grate puller
	  • PPE (gloves, hardhat, safety glasses, rain gear, rubber boots, hearing protection)
	  • Laptop, charger, and cleaning sheets
	• Contractor/vendor costs:
	• Debris: decant spoils
	• City-approved decant location

General work method	1. Place traffic control signs and safety devices as required at job site 2. Remove grate and inspect to determine if repairs are needed and can be done on site 3. Inspect for illicit discharge or connection (SMC 13.10.320); if illicit discharge observed, initiate a water quality service request for IDDE investigation 4. Clean inlets and outfalls if accumulated sediment is 20% or more of the pipe 5. Use shovel and broom to remove leaves and debris in and around catch basin grate and gutter line 6. Collect debris and place in service truck 7. If work is required, use proper PPE 8. Clean up job site, tools, and truck 9. Remove traffic control signs and safety devices as required at job site 10. Make notes about any further work that is needed 11. Accurately report in Cityworks

Regional Road Guidelines BMPs for catch basin construction including installation, repair, and replacement are provided in Table 4-9 (Tri-County Working Group 2000).

Table 4-9. Catch Basin Construction Regional Road Guidelines BMPs	
Name	BMP Number
Excelsior-filled log	2.63
Inlet protection	2.79
Sandbag	2.109
Straw bale barrier (for dam and protection, not filtration)	2.127–2.135
Straw log	2.138
Vactoring	2.166

4.3 Constructed Wetland

Constructed wetlands in Shoreline, such as the wetland mitigation areas in Cromwell Park, are engineered wetland areas to detain stormwater runoff.

Related SOPs include gauge, natural channel, outfall, and pipe. Figure 4-3 shows an example of a constructed wetland in Shoreline.

Figure 4-3. Constructed wetland

4.3.1 Constructed Wetland Inspection

Constructed wetland inspection is initiated through Cityworks preventive work orders for regional facility that contains a constructed wetland. Table 4-10 is a representation of the CMMS inspection checklist in Cityworks for constructed wetland.

Table 4-10. Constructed Wetland Cityworks Form with Inspection General Work Method

Criterion	Result	Explanation	General Work Method
Sediment (Pretreatment)	FAIL	Sediment in pretreatment pool or sediment storage area exceeds design volume by 60% or more	Determine sediment depth by consulting design plans and gathering relative elevations
	PASS	Sediment is less than 60% of design volume in pretreatment pool or sediment storage area.	
	N/A	Feature not present	
Sediment (Main Cell)	FAIL	Sediment in the main cell has exceeded design volume by 50% or more.	Determine sediment depth by gathering relative elevation data and consulting design plans.
	PASS	Sediment is less than 50% of design volume in the main cell.	
Trash and Debris	FAIL	Trash and debris accumulated in pretreatment or permanent pool	Visual inspection of debris and trash accumulation.
	PASS	No accumulation of trash or debris	
Erosion/Stability	FAIL	Erosion, animal burrows or sinkholes on side slopes or embankment	Visual inspection side slopes and embankment
	PASS	No erosion, burrow or sink holes	
Contamination	FAIL	Oil/gas/other pollution present	Visual inspection of oily sheen on pretreatment or permanent pool, side slopes, embankments or by smell such as petroleum products or organic compounds (e.g., engine oil, paint thinner or acetone). Visual inspection of discolored or soapy water.
	PASS	Oil/gas/other pollution absent	
Vegetation (Embankment)	FAIL	Invasive plants are present or trees/woody vegetation on embankment, or vegetation coverage on 50% of original surface area has been lost	Visual inspection of plant and tree growth. See Section 5.9 Vegetation Control.
	PASS	No invasive plants, trees on embankment or excessive vegetation loss.	
Vegetation (Pond)	FAIL	Invasive plants are present or a 50% reduction in original open water surface area.	Visual inspection of plant and tree growth. See Section 5.9 Vegetation Control.
	PASS	Invasive plants are absent and no 50% reduction in original open water surface area.	
Inlets/Outlets	FAIL	Inlets or outlet are blocked with trash, debris or vegetation. Erosion occurring to supporting soil	Visual inspection of inlets and outlets for blockage or erosion.
	PASS	Inlets/outlets are not blocked and surrounding area is not eroding	
Algae Bloom	FAIL	Algae bloom is present	Inspect constructed wetland in fall and spring or other times when algal blooms are common.
	PASS	Algae bloom is absent	
Pond Level	FAIL	Pool level is much higher or lower than typically observed	Dramatic changes in pool level indicate a problem with clogging, embankment leakage or leaking riser or pipe. Familiarity with typical pool levels is achieved through frequent observation and recording pool level measurements
	PASS	Pool level is typical	

4.3.2 Constructed Wetland Maintenance

Table 4-11 summarizes maintenance for constructed wetlands.

Table 4-11. Constructed Wetland Maintenance Summary

Element	Description
Maintenance interval	• Constructed wetlands are inspected annually.
Maintenance type	• Routine maintenance includes cleaning and removing debris, harvesting vegetation, repairing embankment and side slopes, and repairing control structure. • Maintenance every 5 to 20 years includes removing accumulated sediment from permanent pool, pretreatment pool, or sediment storage area.
Maintenance timing	• Perform cleaning in dry months to avoid washing sediment-laden water downstream, optimize sediment removal, and minimize possible water quality impacts. • For work done during wet periods or flowing water, the work is done with a vactor truck with vactoring occurring downstream of pipe work to control the escape of sediment-laden water.
Reactive maintenance	• Corrective maintenance is related to pool level changes such as removing clogging outlet, repairing gate valve, repairing leaks in pipes, liners, and embankments.
Permit requirements	• HPA: If work is being done within a piped stream, then work is done in accordance with the HPA requirements.

4.4 Control Structure

A control structure is a device contained within another asset (e.g., manhole, catch basin, or vault) that restricts flow for flow control or helps maintain water quality by solids settlement or oil/water separation.

Related SOPs include catch basin, manhole, and vault. Figure 4-4 shows a typical control structure.

Figure 4-4. Control structure

4.4.1 Control Structure Inspection

Control structure inspection and repair are typically initiated through Cityworks preventive work orders for a surface water facility that contains the control structure.

Table 4-12 is a summary of the Cityworks custom inspection observation form for control structures. The form is a simplification of Table V-4.5.2(4) Maintenance Standards – Control Structure/Flow Restrictor", Section 4.6, Volume V of 2014 SWMMWW, included in Appendix B.

Table 4-12. Control Structure Cityworks Form and Inspection General Work Method

Criterion	Result	Explanation	General Work Method
Sediment	FAIL	Greater than 25% of sump, or less than 1 ft below orifice plate	Use graduated rod or tape measure to measure sediment depth below orifice plate, and to estimate sediment depth and total depth from invert to sump bottom. Estimate percent depth of sediment. The sediment criterion for control structures overrides that of other structures such as catch basins or manholes.
	PASS	Less than 25% of sump, and greater than 1 ft below orifice plate	
Cleanout gate	FAIL	Damaged/missing	Visual inspection of the condition and intact nature of the cleanout gate.
	PASS	Intact/present	
Chain/handle	FAIL	Damaged/missing/inoperable	Visual inspection of the chain and handle of the control structure gate.
	PASS	Intact/present/operable	
Control structure intact	FAIL	Not intact	Visual inspection and use graduated rod, hand, or shovel to check control structure is intact with itself and its support structure.
	PASS	Intact	
Trash and debris	FAIL	Blocking outlet	Visual inspection to determine blockage from trash and debris.
	PASS	Not blocking outlet	
Other	FAIL	Other, comment	"Other, comment" means any condition that requires attention to remain or be returned to operation.
	PASS	None	

4.4.2 Control Structure Maintenance

Control structures are inspected and maintained on a varied basis depending upon the other surface water assets they are located within. The maintenance interval varies based on associate assets.

4.5 Culvert

A culvert is a pipe structure that conveys water under a road, trail, or similar obstruction from one side to the other. Driveway culverts are considered pipes and are inspected with the Pipe SOP.

Related SOPs include natural channel, pipe, pipe inlet structure, pond, and region facility. Figure 4-5 shows a typical culvert.

Figure 4-5. Culvert

4.5.1 Culvert Inspection

Culvert inspection is initiated through Cityworks preventative work orders under the regional inspection program. Large culverts under major roadways should also receive a specialized bridge inspection from bridge culvert trained technicians or engineers.

Table 4-13 provides details regarding the culvert Cityworks form and inspection general work method.

Table 4-13. Culvert Cityworks Form and Inspection General Work Method			
Criterion	Result	Explanation	General Work Method
Sediment	FAIL	Greater than 20% of cross-sectional diameter	Use graduated rod or measuring tape to measure sediment depth and culvert diameter to calculate the percent of sediment of cross-sectional diameter at culvert inlet and outlet (if accessible). Estimate percent cross-sectional diameter.
	PASS	Less than 20% of cross-sectional diameter	
Vegetation	FAIL	Blocking free movement of water	Visual inspection of vegetation density.
	PASS	Not blocking free movement of water	
Dent	FAIL	Greater than 20% reduction in cross-section area	Visual inspection and estimation of dent cross-section area, relative to culvert cross-section area.
	PASS	Less than 20% reduction in cross-section area	
Contamination	FAIL	Oil/gas/other pollution present	Visual inspection of oily sheen or by smell of contaminates such as petroleum products or organic compounds (e.g., paint thinner or acetone) within the culvert included above the current water level. Visual inspection of discolored or soapy water.
	PASS	Oil/gas/other pollution absent	
Trash and debris	FAIL	Blocking inlet or outlet	Visual inspection of trash or debris blocking inlet and outlet.
	PASS	Not blocking inlet or outlet	
Headwall	FAIL	Damaged	Visual inspection of headwall for significant cracking, buckling, bulging, or displaced headwall, or erosion behind or around ends of headwall.
	PASS	Intact	
Other	FAIL	Other, comment	"Other, comment" means any condition that requires attention to remain or be returned to operation.
	PASS	None	

4.5.2 Culvert Maintenance

Culverts should be cleaned when blockage by sediment, debris or other natural material exceeds 20 percent of the culvert cross-sectional area. Trash (non-natural materials) should be removed whenever encountered. Culvert inlet and outlet should be free of any vegetation blocking culvert flows, including volunteer trees. Maintenance activities for stream-bearing culverts must be coordinated with Washington Department of Fish and Wildlife HPA permitting (and any applicable "fish window").

Reactive maintenance (repairs) needed for headwall failures and any other issues which may compromise structural integrity of the culvert, and possibly for repeated excessive sedimentation issues.

Table 4-14 summarizes maintenance for culverts.

Table 4-14. Culvert Maintenance Summary

Element	Description
Maintenance interval	• Culvert inlet, outlet, and headwalls must be visually inspected every 2 years. • Large box culvert (such as the NE 196th St McAleer Creek culvert) interiors shall be visually inspected every 5 years by a qualified professional. • Culverts which exhibit visible signs of structural issues at inlet or outlet and/or sinking or settling of the surface above shall be scheduled immediately for emergency CCTV inspection. • High-priority pipe culvert interiors must be CCTV inspected every 5 years. High priority culverts meet three or more of the following criteria: • Conveys stream flow • 24 inches or greater in diameter • Crosses an arterial • Older than 40 years (or age unknown) • Other culverts can be CCTV inspected at regular stormwater pipe CCTV inspection intervals (20 years)
Maintenance type	• Routine maintenance includes removing vegetation, debris, and sediment. After the cleaning, re-inspect culvert structural condition. • Non-routine maintenance may include repair or replacement of defective trash racks and grouting or other minor headwall repairs.
Maintenance timing	• For work done within stream-bearing culverts, timing of work shall be per HPA permit. • Perform cleaning in dry months to avoid washing sediment-laden water downstream, optimize sediment removal, and minimize possible water quality impacts.
Reactive maintenance	Maintenance items such as damage from storms, car accidents, or construction may require special repairs or cleanup.
Permit requirements	HPA: If work is being done within a piped stream, then all work shall be done in accordance with the HPA requirements.

4.6 Dam

Dams within the city were primarily installed for flow control. When water is impounded, sediment and gross materials settle out. Dams help to lessen downstream erosion and water quality degradation. Dams do not generally impound low to moderate flows and may not improve flow control or water quality at these flows.

Related SOPs include control structure and gate valve. Figure 4-6 shows a dam within the city.

Figure 4-6. Dam

4.6.1 Dam Inspection

Dams within the city are also regional facilities subject to annual inspection. In addition, any major storms require a subsequent site visit and inspection of the dam. Table 4-15 is a representation of the CMMS inspection checklist in Cityworks for dams.

High hazard dams are inspected by the Department of Ecology (DOE) every 5 years. These inspections are conducted to identify deficiencies, and to reasonably assure safe operation and verify maintenance is adequately being performed. DOE provides a comprehensive report of the dam inspection directing any work needed to remediate deficiencies. Additionally, the City reports the results of its annual high hazard dam inspections to the DOE.

Table 4-15. Dam Cityworks Inspection Form		
Criterion	**Result**	**Explanation**
Dam names	• Boeing Creek M1 Dam • Boeing Creek North Pond • McAleer Creek R/D Pond • Pan Terra Pump Station • Hidden Lake Outfall • Firelane Ballinger Creek	User selects dam name for inspection form
Owner name	• City of Shoreline • Other	User selects owner
Address	• 17500 Midvale Avenue N, Shoreline, WA 98133-4905 • Other	User selects owner address
Telephone number	• 206.801.2700 • Other	User selects owner phone number
Weather	Describe weather at the time of inspection	User types comment
Reservoir level at time of inspection	Drained or estimate the elevation below dam crest	User types comment
Reservoir outflow at time of inspection	Estimate water depth in inches exiting in pipe	User types comment
Crest	• Cracks in the crushing surface • Depressions in the surface • Evidence of burrowing animals • All pass	User selects any or all options and can add comment
Upstream face	• Evidence of slope movement such as surface cracking and depressions • Animal runs • All pass	User selects any or all options and can add comment
Downstream face	• Wet soft areas • Seepage • All pass	User selects any or all options and can add comment
Emergency spillway, low-level inlet pipe	• N/A • Crack in of the headwall • Debris obscuring the trash rack • Slide gate is properly lubricated and the gate can be operated • All pass	User selects any or all options and can add comment
Emergency spillway drop inlet	• N/A • Debris accumulation on the grates of the trash rack • Loose or missing bolts securing grate to concentric ring • Seepage at the joints of through cracks in the concrete rings of the riser • Vandals have plugged the air vent pipe or thrown debris into the riser structure • All pass	User selects any or all options and can add comment
Principal spillway inlet pipe	Fail	Debris accumulating on grating
	Pass	No debris accumulating on grating
Principal spillway control structure	Fail	Improper lubrication and position of canal grate
	Pass	Proper lubrication and position of canal grate

Table 4-15. Dam Cityworks Inspection Form		
Criterion	**Result**	**Explanation**
Principal spillway catch basin	N/A	A principal spillway catch basin was not incorporated into the design
	Fail	Catch basin piping is obstructed
	Pass	Catch basin piping is not obstructed
Principal spillway plunge pool	Erosion damage the impedes proper drainage	User selects any or all options and can add comment
	Vegetation growth that impedes proper drainage	
	All pass	
	N/A	
Contra Costa stilling basin (outlet structure)	Fail	Cracking at the head wall
	N/A	
	Pass	No cracking at the head wall

High hazard dams are inspected by Ecology every 5 years. These inspections are conducted to identify deficiencies, and to reasonably assure safe operation and verify maintenance is adequately being performed. Ecology provides a comprehensive report of the dam inspection directing any work needed to remediate deficiencies.

Additionally, the City reports the results of its annual high hazard dam inspections to the Ecology.

4.6.2 Dam Maintenance

Table 4-16 summarizes the maintenance for dams.

Table 4-16. Dam Maintenance Summary	
Element	**Description**
Maintenance type	The primary maintenance of dams is vegetation control and sediment removal. The dam area must remain clear of trees and shrubs. Pipes, inlets, and other structures will require sediment removal periodically.
Maintenance timing	• Maintenance work on dams is primarily done during dry months. All dams within the city have streams flowing through them, and have components with HPA-related restrictions. Sediment removal should be done in July or August with no flowing water, and no rain expected during the work window. If necessary, erosion control materials should be used above the ordinary high water mark where soils are exposed. Clearing of grates, inlets, and outfalls may occur year-round. • Emergency work in proximity to a stream requires an emergency HPA, and other maintenance should refer the EAP (explained below).
Reactive maintenance	Slope failure (including water seepage) is evidence that the dam may require significant repair. The pipe structures may need restoration or repair such as replacing rusted sections of large CMP or grouting within catch basins or manholes. The Ecology Office of Dam Safety conducts an inspection every 5 years. This inspection and subsequent report may instruct maintenance items for the City to complete.
Permit requirements	• The Ecology Office of Dam Safety requires that the City maintain an EAP related to the high-hazard dams. The EAP is required and must be updated as needed. Updates include reconstruction of the dam, change or ownership, and significant land use changes downstream. • All the dams within the city contain streams, and in-water work requires abiding by the maintenance HPA. • Facilities must be inspected annually and after a 10-year rain event. When an inspection identifies an exceedance of the maintenance standard, maintenance shall be performed within 1 year for typical maintenance and within 2 years for maintenance that requires capital construction of less than $25,000. Catch basins within regional facilities must have maintenance conducted within 6 months.
Exceptions and outliers	There are 2 high-hazard dams within the city (North Pond and M1). These facilities are complex with different assets and needs. Each site should be treated as independent assets and have management adapted to site conditions. M1 has minimal public access while North Pond is surrounded by Boeing Creek Park.

4.7 Ditch

Ditches act primarily as conveyance assets. Some ditches may provide some level of flow control, water quality treatment, or infiltration. The vegetation within a ditch slows water and traps suspended sediment. As water flows through a ditch line it also infiltrates into the surrounding soil.

Related SOPs include pipe inlet structure and pipe. Figure 4-7 shows a typical ditch.

Figure 4-7. Ditch

4.7.1 Ditch Inspection

The City completed a full circuit of City-owned ditches from 2008–13. Since 2014, approximately one-third of the City ditches are inspected each year. Figure 4-8 shows the ditch maintenance zones. See Appendix D for more detailed ditch inspection and maintenance procedure.

Table 4-17. Ditch Cityworks Inspection Form with Inspection General Work Method

Table 4-17 is a representation of the CMMS inspection checklist in Cityworks for ditches.

Figure 4-8 shows the ditch maintenance zones. See Appendix D for more detailed ditch inspection and maintenance procedure.

Table 4-17. Ditch Cityworks Inspection Form with Inspection General Work Method

Criterion	Result	Explanation	General Work Method
Sediment	FAIL	Greater than 33% of design depth	Visual inspection of the slope of the ditch channel bottom. Using inlet and outlet pipe inverts as references look for a low or high spots that are approximately 1/3 higher or lower the rest of the ditch.
	PASS	Less than 33% of design depth	
Vegetation	FAIL	Blocking free movement of water	Visual inspection of vegetation density.
	PASS	Not blocking free movement of water	
Contamination	FAIL	Oil/gas/other pollution present	Visual inspection of oily sheen on vegetation or soil or by smell of contaminates such as petroleum products or organic compounds (e.g., paint thinner or acetone).
	PASS	Oil/gas/other pollution absent	
Trash and debris	FAIL	Present	Visual inspection of presence of trash or debris.
	PASS	Absent	
Inlet/outlet	FAIL	Greater than 33% blocked	Visual inspection to estimate percent blocked or use graduated rod measure blockage and inlet diameter to calculate percent blocked.
	PASS	Less than 33% blocked	
Sediment	FAIL	Does not meet design specifications	Visual inspection of sediment deposits.
	PASS	Meets design specifications	
Flow spreader	FAIL	Flows are not evenly distributed	Visual inspection of shoulder to allow roadway drainage sheet flow evenly to ditch.
	PASS	Flows are evenly distributed	
Vegetation condition	Residential maintained	The ditch appears to be maintained by adjacent property owner	Visual observation of ditch vegetation condition. Ditch appears to be mown or otherwise maintained by owner. Estimate vegetation height and use judgement for safety (line of sight for vehicles) or functional issues.
	Not maintained	The ditch does not have vegetation requiring maintenance	
	Vegetation substantial	The ditch is overgrown, but this does not represent a safety or a functional issue; vegetation 24 in. or higher	
	Vegetation minimal	The ditch does not appear to be resident maintained, but the vegetation is minimal; vegetation shorter than 24 in.	
Lateral Connection	Lateral	Indicates unmapped lateral is present and origin is from private property	Lateral is used to identify unmapped lateral connections. The criterion is important for IDDE screenings.
	Unknown	Indicates unmapped lateral is present but the origin is not known	
	Other	Other can be used for any connection that is not covered by the other observation categories	
	N/A	Did not find any unmapped laterals	
Weir	FAIL	Not intact	Check pass or fail if ditch has weir (most ditches do not have a weir). If the weir would not cause water to pond behind it and slow water down, it is considered not intact.
	PASS	Intact	
Erosion	FAIL	Bank or channel erosion present	Visual inspection of channelization (localized deepening of channel at center) or bank erosion.
	PASS	Bank or channel erosion absent	
Cannot locate	FAIL	Cannot locate	Visual inspection for locating relative to map/GIS representation and identifier.
	PASS	Can locate	
Other	FAIL	Other, comment	"Other, comment" means any condition that requires attention to remain or be returned to operation.
	PASS	None	

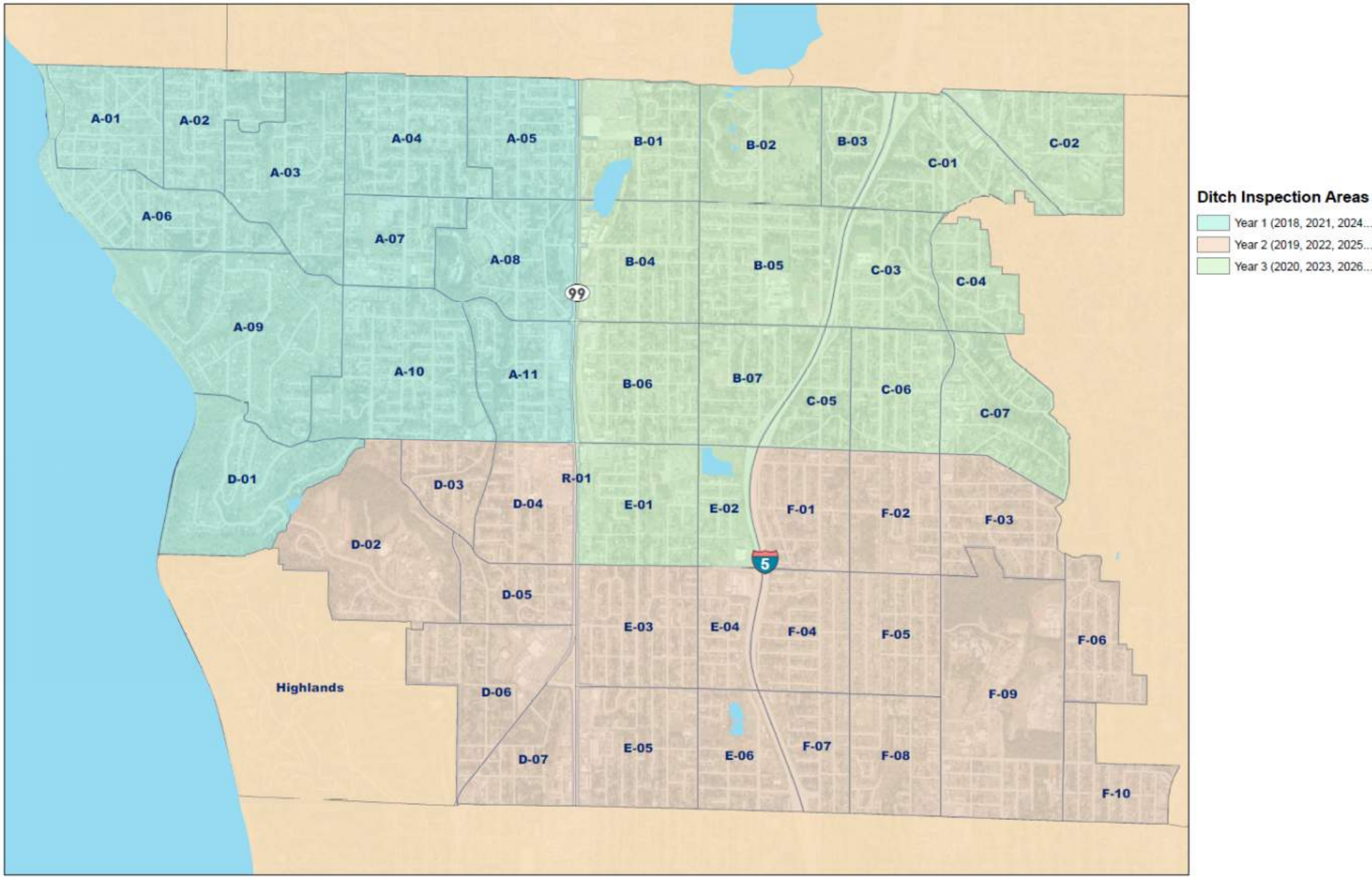


Figure 4-8. Ditch maintenance zones

4.7.2 Ditch Maintenance and Construction BMPs

Table 4-18 summarizes ditch maintenance.

Table 4-18. Ditch Maintenance Summary

Element	Description
Maintenance timing	Ditch maintenance is done primarily during dry months to avoid washing turbid water downstream. Routine work is scheduled for the driest periods to optimize sediment removal and minimize possible water quality impacts. Emergency work may be done during wet periods but erosion control must be employed to prevent erosion.
Maintenance type	Of the 1/3 of ditches inspected annually, only ditches out of specification (e.g., sediment is built up to the point of restricting flow) are cleaned using a truck-mounted auger. Where ditches cannot be cleaned by auger, the ditch may be reshaped by hand, backhoe, or hydro-excavation. Vegetation control occurs only if it will inhibit the auger operation. The inlet and outlet of the ditch are also inspected and associated culverts are cleaned as necessary.
Reactive maintenance	Ditches may be cleared out of sequence because of excessive sediment buildup. Restoration may be required if a ditch slope fails. Material may need to be removed from a ditch where shoulder materials have been pushed into them as part of a road project. Shoulder work is done to reshape and clean roadside to reconnect the shoulder flow spreader to ditch.
Permit requirements	Permit regulations related to ditches focus primarily on the inlet and outlet. However, when an inspection identifies an exceedance of the maintenance standard, maintenance shall be performed within 1 year for typical maintenance and within 2 years for maintenance that requires capital construction of less than $25,000. In addition, there may be HPA requirements if the ditch is classified as a stream.
Exceptions and outliers	• Ditches are only maintained when flow or function are impaired. General mowing and vegetation maintenance are not part of the maintenance envelope and do not impede the function of the ditch. • Ditches that carry perennial flows may be classified as a stream and must be treated as such.

Most ditches are maintained with an auger. Ditches with access limitations may require a backhoe to perform the necessary maintenance. Smaller ditches may be maintained with a small amount of hand digging. Table 4-19 describes ditch maintenance using an auger.

Table 4-19. Ditch Maintenance with Auger General Work Method

Activity Component	Activity Details and Description
Desired result	Remove sediment, leaves, and debris with auger machine to improve flow. Clear inlet and outfall pipes, if needed.

Resources	• Crew:
	  • 2-person crew
	  • 2 flaggers, if needed
	• Material:
	  • Quarry rock
	  • Coir logs with stakes
	• Equipment:
	  • 1 auger mounted truck with dump body
	  • PPE (gloves, hardhat, safety glasses, rain gear, rubber boots, hearing protection)
	• Contractor/vendor costs:
	• Debris: ditching
	• City-approved disposal method

General work method	1. Place traffic control signs and safety devices as required at job site 2. Use proper PPE 3. Notify front desk who will email police, fire, and public works if access to road will be impacted 4. Inspect for illicit discharge or connection (SMC 13.10.320); if illicit discharge observed, initiate a water quality service request for IDDE investigation 5. Remove accumulated sediment in ditch that exceeds 20% of designed ditch depth 6. Remove debris from ditch to provide adequate flow 7. Quarry rock outfalls and around outlet pipe from ditch as needed 8. Install coir logs with stakes as needed 9. Clean up job site, tools, and truck 10. Remove traffic control signs and safety devices as required at job site 11. Notify front desk who will email police, fire, and public works that access to road has been returned 12. Accurately report in Cityworks

Table 4-20 describes ditch maintenance using a back hoe.

Table 4-20. Ditch Maintenance with Back Hoe General Work Method

Activity Component	Activity Details and Description
Desired result	Remove sediment, leaves, and debris with backhoe or excavator to improve flow. Clear inlet and outfall pipes, if needed.

Resources	• Crew:
	  • 2-person crew
	  • 2 flaggers, if needed
	• Material:
	  • Quarry rock
	  • coir logs with stakes
	• Equipment:
	  • 1 dump truck
	  • 1 equipment trailer
	  • 1 service truck
	  • 1 excavator or backhoe with ditching bucket
	  • PPE (gloves, hardhat, safety glasses, rain gear, rubber boots, hearing protection)
	• Contractor/vendor costs:
	• Debris: ditching
	• City-approved disposal Method

General work method	1. Place traffic control signs and safety devices as required at job site 2. Use proper PPE 3. Notify front desk who will email police, fire, and public works if access to road will be impacted 4. Inspect for illicit discharge or connection (SMC 13.10.320); if illicit discharge observed, initiate a water quality service request for IDDE investigation 5. Remove accumulated sediment in ditch that exceeds 20% of designed ditch depth 6. Remove noxious vegetation that may constitute a hazard to City personnel or public according to applicable regulations 7. Clean inlets and outfalls if accumulated sediment is 20% or more of the pipe; if pipe needs rodding, initiate a rodding request 8. Remove debris from ditch to provide adequate flow 9. Straw or seed as needed 10. Quarry rock outfalls and around outlet pipe from ditch as needed 11. Install coir logs with stakes as needed 12. Clean up job site, tools, and truck 13. Remove traffic control signs and safety devices as required at job site 14. Notify front desk who will email police, fire, and public works that access to road has been returned 15. Accurately report in Cityworks

Table 4-21 describes ditch maintenance by hand.

Table 4-21. Ditch Maintenance by Hand General Work Method

Activity Component	Activity Details and Description
Desired result	Remove sediment, leaves, and debris manually to improve flow. Clear inlet and outfall pipes, if needed.

Resources	• Crew: 2-person crew
	• Material:
	  • Quarry rock
	  • coir logs with stakes
	• Equipment:
	  • 1 service truck
	  • PPE (gloves, hardhat, safety glasses, rain gear, rubber boots, hearing protection)
	  • 2 shovels
	• Contractor/vendor costs:
	• Debris: ditching
	• City-approved disposal method

General work method	1. Place traffic control signs and safety devices as required at job site; use proper PPE 2. Notify front desk who will email police, fire, and public works if access to road will be impacted 3. Inspect for illicit discharge or connection (SMC 13.10.320); if illicit discharge observed, initiate a water quality service request for IDDE investigation 4. Remove accumulated sediment in ditch that exceeds 20% of designed ditch depth 5. Remove noxious vegetation that may constitute a hazard to City personnel or public according to applicable regulations 6. Clean inlets and outfalls if accumulated sediment is 20% or more of the pipe 7. Remove sediment and debris from ditch to provide adequate flow 8. Straw or seed as needed 9. Quarry rock outfalls and around outlet pipe from ditch as needed 10. Install waddles with stakes as needed 11. Clean up job site, tools, and truck 12. Remove traffic control signs and safety devices as required at job site 13. Notify front desk who will email police, fire, and public works that access to road has been returned 14. Accurately report in Cityworks

Regional Road Guidelines BMPs for ditch construction including installation, repair, and replacement are included in Table 4-22 (Tri-County Working Group 2000).

Table 4-22. Ditch Construction Regional Road Guidelines BMPs

Name	BMP Number
Cofferdam	2.26
Coir log	2.31
Dewatering	2.50
Ditch lining	2.54
Excelsior-filled log	2.63
Grass-lined channel	2.67
Hand seeding	2.75
Hydro seeding	2.77
Inlet protection	2.79
Rip rap	2.103
Rock check dam	2.105
Sandbag	2.109
Silt fence	2.114
Soil stabilization (blankets and matting)	2.122
Straw bale barrier	2.127–2.135
Straw log	2.138
Stream bypass	2.142
Triangular silt dike	2.162
Vegetative buffer	2.168

4.8 Drain

Drain assets are either trench, French, or underdrains, and are a component of other assets (e.g., bioretention facility, Filterra™ unit).

SOPs associated with drains include bioretention facility, stormwater facility, and Filterra.

4.8.1 Drain Inspection

Drain inspection and repair are typically initiated through Cityworks preventive work orders for surface water assets that contain or are connected to a drain. Table 4-23 is a representation of the CMMS inspection checklist in Cityworks for drains.

Table 4-23. Drain Cityworks Inspection Form with Inspection General Work Method

Criterion	Result	Explanation	General Work Method
Sediment	FAIL	Greater than 33% of pipe diameter	Where accessible for viewing, visually inspection drain and estimate amount of sediment within pipe.
	PASS	Less than 33% of pipe diameter	
Vegetation	FAIL	Blocking free movement of water	Visual inspection of vegetation blocking inlet or outlet.
	PASS	Not blocking free movement of water	
Contamination	FAIL	Oil/gas/other pollution present	Visual inspection of oily sheen or by smell of contaminates such as petroleum products or organic compounds (e.g., paint thinner or acetone).
	PASS	Oil/gas/other pollution absent	
Trash and debris	FAIL	Blocking Inlet/outlet	Visual inspection to determine blockage.
	PASS	Not blocking Inlet/outlet	
Cannot locate	FAIL	Cannot locate	Visual inspection for locating relative to map/GIS representation and identifier.
	PASS	Can locate	
Other	FAIL	Other, comment	“Other, comment” means any condition that requires attention to remain or be returned to operation.
	PASS	None	

4.8.2 Drain Maintenance

Drain maintenance is typically a corrective maintenance and is due to sediment accumulation or flow obstruction caused by vegetation growth or trash and debris.

4.9 Filters

Stormwater filters, housed in either vaults or catch basin structures contain media in either cartridges or bags. The media filters the runoff, removing pollutants prior to entering the downstream stormwater system. The City has two such types of filter systems: The Aqua-Filter System by AquaShield which comprises of an Aqua-Swirl chamber combined with Aqua-Filter bagged media and the CONTECH StormFilters which are comprised of media-fill cartridges.

Refer to Table 4-24 for type, location, and number of filters for each structure

Table 4-24. Filter System Information

Type	Address	No. Cartridges/Bags
CONTECH StormFilter	16053 Aurora Ave N	114
	16503 Aurora Ave N	25
	1201 N 175st	6
	17500 Midvale Ave N	6
	15235 Aurora Ave N	51
AquaFilter by AquShield	15801 Aurora Ave N	1

Related SOPs include catch basin, manhole and vault. Figure 4-9 shows illustrations of the two types of filters.

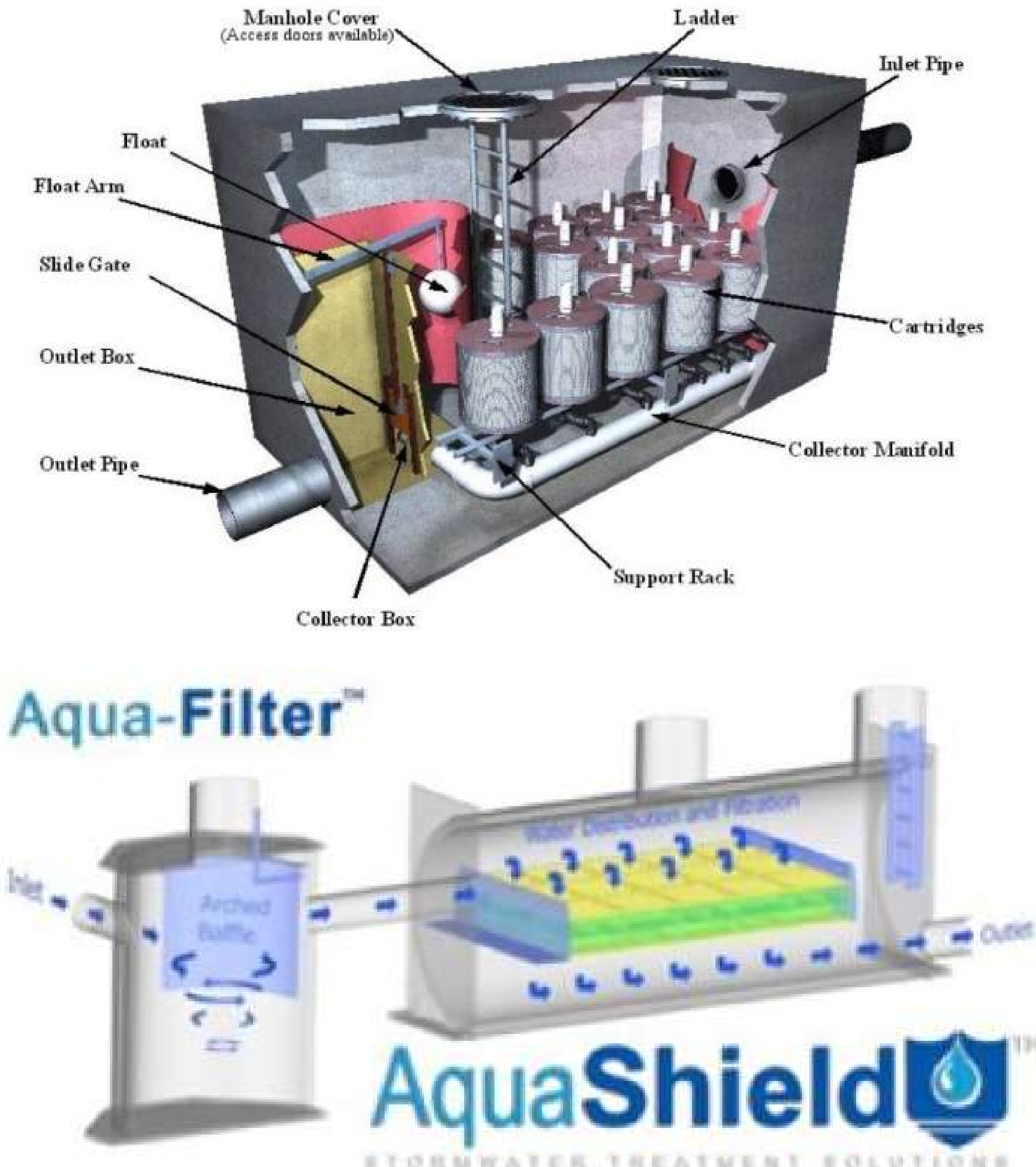


Figure 4-9. Filters

Top: StormFilter, bottom: Aqua-Filter™.

4.9.1 Filter Inspection

Filters and the structures that contain them (i.e., vaults and catch basins) are inspected at least once a year during Facility or Regional stormwater inspection, depending on their location. As a part of a proprietary system with a separate facility-based O&M manual, filters may be inspected more frequently.

Although filters do not have a separate inspection form in Cityworks, a failed inspection is recorded in the "Other" criterion for the structure asset and replacement work order is submitted for the filters. Table 4-25 is a representation of the inspection criterion from the CONTECH StormFilters operations and maintenance manual.

Table 4-25. CONTECH StormFilter with Inspection General Work Method

Criterion	Result	Explanation	General Work Method	Frequency
Sediment	FAIL	Greater than 4in. in Vault or greater than ¼" on top of cartridge	Visual inspection of thickest sediment deposits within structure.	Annually
	PASS	Less than 4in. in Vault or Less than ¼" on top of cartridge		
Submerged Cartridges	FAIL	Greater than 4" of static water in cartridge bay for more than 24" after end of rain event	Visual inspect structure for static water near 24 hours after rain event. Rain event should be greater than 1" in 12 hour period.	Annually after major rain event producing greater than 1" of rain within 12 hour period
	PASS	Less than 4" of static water in cartridge bay for more than 24" after end of rain event		
Bypass Condition	FAIL	Constant state of bypass with cartridges submerged	Visual Inspect structure during average rainfall event of 0.05" per hour	Annually during average rainfall event
	PASS	Bypass is not being utilized and cartridges are not submerged		
Scum Line	FAIL	Greater than ¼" is present above top cap	Visual inspect scum line in chamber	Annually
	PASS	Scum line below top cap		
Calendar Lifecycle	FAIL	Greater than 3 years since maintenance	Verify last maintenance on Stormfilters	Annually
	PASS	Less than 3 years since maintenance		

The Aqua-Filter system has two components to inspect and maintain. The first being the Aqua-Swirl chamber, a type of hydrodynamic separator and the Aqua-Filter media vault. Table 4-26 list the inspection criteria for the Aqua-Filter Media taken from the Aqua-Filter O&M manual (see Appendix E). The inspection and maintenance of the Aqua-Swirl chamber are covered in Section 4.14 Hydrodynamic Separator and Appendix E. Ecology maintenance standards for manufactured media filters are included in Appendix B, Table V-4.5.2(15) "Maintenance Standards – Manufactured Maintenance Standards", Section 4.6, Volume V of 2014 SWMMWW.

Table 4-26. Aqua-Filter Media Inspection General Work Method

Criterion	Result	Explanation	General Work Method	Frequency
Sediment	FAIL	Greater than 1/4 in. on top of filter media bags	Use pole or rod to determine distance from sediment to surface of water in chamber	Annually
	PASS	Less than 1/4 in. on top of filter media bags		
Media	FAIL	Media is dark brown or black	Visually inspect media in bags for color	Annually
	PASS	Media is whitish color		

Appendices E and F to this manual, for the AquaSheild Aqua-Filter System and the CONTECH StormFilter, respectively, are the inspection and maintenance procedures from the manufacturer's O&M Manuals for these systems.

4.9.2 Filter Maintenance

Table 4-27 summarizes filter maintenance.

Table 4-27. Filter Maintenance Summary

Element	Description
Maintenance timing	Filter maintenance should be done during dry months from June to September.
Maintenance type	Maintenance includes removing sediment from the vault by vactor and replacing media cartridges or bags. Confined space is necessary to replace media in vaults or Type 2 catch basins.
Reactive maintenance	Maintenance should be conducted when a large illicit spill is observed which could impact the performance of the filters immediately.
Permit requirements	Permit regulations related to stormwater BMPs focus primarily on performance. Where an inspection identifies an exceedance of the maintenance standard, maintenance shall be performed within 1 year for typical maintenance and within 2 years for maintenance that requires capital construction of less than $25,000.

Refer to the respective O&M manuals for guidelines on the work method for replacing and maintaining filters.

4.10 Filterra ™

Filterra facilities are like other biofiltration facilities but are generally smaller and offer more tightly set water quality features.

Biofiltration acts as water quality and flow control. These facilities impound water in a shallow depression, and as water infiltrates it encounters soil media and plant roots, which improve the general parameters of water quality. The designed infiltration rate acts as flow control. The soil media for Filterra facilities appears to release less phosphate than other bioinfiltration facilities, leading to different BMPs relating to water release.

Related SOPs include catch basin, drain, and pipe. Figure 4-10 shows a Filterra biofilter installation.

Figure 4-10. Filterra

4.10.1 Filterra Inspection

Filterra units should be inspected on a bi-annual basis, with routine maintenance occurring annually. In addition to the maintenance of units, the inlets to the Filterra should be cleared on a routine basis occurring quarterly as a minimum. Table 4-28 is a representation of the CMMS inspection checklist in Cityworks for Filterra.

Table 4-28. Filterra Cityworks Inspection Form with Inspection General Work Method			
Criterion	**Result**	**Explanation**	**General Work Method**
Sediment	FAIL	Present in curb cut or planter area	Visual inspection of sediment in planter area.
	PASS	Absent in curb cut or planter area	
Vegetation	FAIL	Weeds present	Visual inspection.
	PASS	Weeds absent	
Plant health	FAIL	Unhealthy, dying	Visual inspection of plant health.
	PASS	Healthy	
Trash and debris	FAIL	Present	Visual inspection of trash or debris in Filterra unit.
	PASS	Absent	
Mulch	FAIL	Thin coverage	Visual inspection of mulch depth less than 2 in.
	PASS	Adequate coverage	
Contamination	FAIL	Oil/gas/other pollution present	Visual inspection of oily sheen on mulch or plant, or by smell of contaminates such as petroleum products or organic compounds (e.g., paint thinner or acetone).
	PASS	Oil/gas/other pollution absent	
Under drain	FAIL	Blocked or plugged	Visual inspection of underdrain or signs of ponding from blocked underdrain.
	PASS	Clear	
Curb Cut	FAIL	Opening restricted	Visual inspection of curb cut opening.
	PASS	Opening not restricted	
Other	FAIL	Other, comment	"Other, comment" means any condition that requires attention to remain or be returned to operation.
	PASS	None	

4.10.2 Filterra Maintenance

Table 4-29 summarizes Filterra maintenance. See Appendix G for Filterra maintenance steps from the Filterra manufacturer O&M Manual.

Table 4-29. Filterra Maintenance Summary	
Element	**Description**
Maintenance timing	Maintenance is broken down into growing season and dormant season (non-growing). During the growing season (March–September), general upkeep is conducted along with any other reactive maintenance. During the dormant season (October–February), maintenance includes sediment removal at inlets and clearing of debris from outfalls.
Maintenance type	During the annual inspection: place dissipater stones to the side, replace mulch, remove trash, clear the inlet, and evaluate the plant and media per the Filterra O&M manual.
Reactive maintenance	If the plant/tree is failing to thrive or dies, it should be replaced. Filter media should be replaced if infiltration rates appear too slow or fast. Replace energy dissipater stones as needed.
Permit requirements	Facilities must be inspected annually and after a 10-year rain event. When an inspection identifies an exceedance of the maintenance standard, maintenance shall be performed within 1 year for typical maintenance and within 2 years for maintenance that requires capital construction of less than $25,000. Catch basins within regional facilities must have maintenance conducted within 6 months.

4.11 Floodwall

Floodwalls are walls constructed at a design elevation and water pressure capacity to keep floodwaters on the downstream or flood side of the wall. Current recorded floodwall assets are contained within a regional facility delineation. SOPs associated with Floodwalls include Ronald Bog.

4.11.1 Floodwall Inspection

Floodwalls should be inspected annually as part of a Regional Stormwater Inspection. Table 4-30 is a representation of the CMMS inspection checklist in Cityworks for floodwalls.

Table 4-30. Floodwall Cityworks Inspection Form with Inspection General Work Method

Criterion	Result	Explanation	General Work Method
Structure	FAIL	Wall exhibits visible structural damage	Visual inspection along entire extent of wall on both sides
	PASS	Wall exhibits no visible structural damage	
Settlement	FAIL	Wall has settled 4 in. lower than design elevation	Survey elevation of top of wall and compare to design elevation.
	PASS	Wall is within 4 in. of design elevation	
Sinkhole/Burrow	FAIL	Present on either side of wall	Visual inspection along entire extent of wall on both sides.
	PASS	Absent on either side of wall	
Erosion	FAIL	Present on either side of wall	Visual inspection along entire extent of wall on both sides.
	PASS	Absent on either side of wall	
Seepage	FAIL	Present on either side of wall	Visual inspection along entire extent of wall on both sides.
	PASS	Absent on either side of wall	
Vegetation	FAIL	Overgrown, restricting access, or noxious weeds present	Visual inspection along entire extent of wall on both sides.
	PASS	Not overgrown, unrestricted access, and noxious weeds absent	

4.11.2 Floodwall Maintenance

The primary maintenance of floodwalls is vegetation control and sediment removal. The floodwall area must remain clear of trees and shrubs.

4.12 Gate Valve

Gate valves are a component of other assets that detain surface water such as ponds and vaults. Gate valve operation helps control flows .

Related SOPs include control structure. Figure 4-11 shows an example of a gate valve.

Figure 4-11. Gate valve

4.12.1 Gate Valve Inspection

Gate valve inspection and repair are typically initiated through Cityworks preventive work orders for a surface water facility that contains a gate valve. Table 4-31 is a representation of the CMMS inspection checklist in Cityworks for gate valves.

Table 4-31. Gate Valve Cityworks Inspection Form with Inspection General Work Method

Criterion	Result	Explanation	General Work Method
Wheel	FAIL	Seized, broken, or bent	Visual inspection wheel element
	PASS	Not seized, broken or bent	
Frame	FAIL	Broken or bent	Visual inspection of frame
	PASS	Not broken or bent	
Shaft	FAIL	Broken or bent	Visual inspection of shaft
	PASS	Not broken or bent	

4.12.2 Gate Valve Maintenance

For preventative maintenance, gate valves should be exercised and greased at least annually to ensure moving parts are clean and operating smoothly. Valve exercise should follow manufacturer's recommendations and typically includes checking that seats are clean and provide a tight seal. Reactive gate valve maintenance includes repairing or replacing equipment that is broken, bent, or seized. s.

Gate valves can be located in confined space. Follow necessary safety and personal protection guidelines when inspecting, cleaning and maintaining gate valve.

4.13 Gauge

Gauges are a component of other assets that measure water flow or level in surface water assets that hold or convey water. Gauges can be connected to recording devices or simply measure information to be read during inspections.

Related SOPs include natural channel, and pond and Ronald Bog. Figure 4-12 shows a stream gauge.

Figure 4-12. Stream gauge

4.13.1 Gauge Inspection

Gauge inspection and repair are typically initiated through Cityworks preventive work orders for a surface water facility that contains a gauge. Table 4-32 is a representation of the CMMS inspection checklist in Cityworks for gauge.

Table 4-32. Gauge Cityworks Inspection Form with Inspection General Work Method

Criterion	Result	Explanation	General Work Method
Access	FAIL	Access is blocked or difficult	Visual inspection of access.
	PASS	Accessible	
Intact	FAIL	Broken or bent, detached	Visual inspection that gauge and housing is intact and attached to intended connection
	PASS	Not broken or bent or detached	
Operational	FAIL	Not recording or measuring	Visual inspection of operation and reading
	PASS	Recording or measuring	
Verified Results	FAIL	Recorded information not verified or does not calibrate	Where applicable compare gauge reading with reported or recorded values on separate device or system.
	PASS	Recorded information is verified or calibrated	

4.14 Hydrodynamic Separator

Hydrodynamic separators are stormwater features that provide stormwater treatment in areas where high urban pollution stormwater runoff may be present. The separators function to capture trash, sediment, debris, and hydrocarbons from runoff, often placed as pretreatment to filters, bioretention, and other Low Impact Development water quality treatment.

The City has three proprietary types of hydrodynamic separators throughout the City used as primary treatment or pretreatment. Table 4-33 shows the manufacturer, model, location, function of each type of separator and reference to the appendix in this Manual of the manufacturer's O&M manual.

Table 4-33. Hydrodyanamic Separators

Manufacturer	Model	Address	Function	Appendix
AquaShield	AquaSwirl	15720 Aurora Ave N	Pretreatment	Appendix E
CONTECH	CDS System	17840 5th Ave NE	Pretreatment	Appendix F
Hydro International	First Defense	1125 N 152nd St	Primary	Appendix I

4.14.1 Hydrodynamic Separator Inspection

Separators are housed in catch basin-like structures and are inspected as such during the regional facility inspections. Table 4-34 shows the inspection criteria for separators.

Table 4-34. Separator Inspection General Work Method

Criterion	Result	Explanation	General Work Method	Frequency
Sediment	FAIL	Greater than 48 in. from surface of the water to sediment in chamber	Use pole or rod to determine distance from sediment to surface of water in chamber	Annually
	PASS	Less than 42 in. from surface of the water to sediment in chamber		
Trash Debris	FAIL	Debris or trash visible in chamber	Visually inspect for trash and debris.	Annually
	PASS	No debris or trash observed		
Oil	FAIL	Greater than 0.5 in. of oil layer present	Visual inspect and measure using rod or pole	Annually
	PASS	Less than 0.5 in. of oil layer present		

If catch basins with separators fail one or more of the criteria in Table 4-34, a 'Vactor Sediment' work order for the vault or catch basin is created to clean the structure and the separator. See Section 2, O&M Work Flow Process

4.14.2 Hydrodynamic Separator Maintenance

Maintenance for hydrodynamic separators are conducted when a failure is indicated during the inspection. Maintenance consists of washing down the separator and cleaning out the structure which it is performed by vactor.

4.15 Infiltration Pipe

An infiltration pipe is a perforated pipe that allows water to infiltrate directly into the surrounding soil. Infiltration pipes are located in stormwater facilities and roadway shoulders.

SOPs associated with infiltration pipes include control structure and catch basin.

4.15.1 Infiltration Pipe Inspection

The infiltration pipes located within City operated facilities are visually inspected during facility inspections. The roadside infiltration pipes are inspected during the City's basin planning programs. Infiltration pipes are on a 20-year pipe condition assessment schedule.

4.15.2 Infiltration Pipe Maintenance

Infiltration pipe cleaning and repair help maintain infiltration rates and mitigate localized flooding. Roadside infiltration pipes are on a two-year maintenance schedule initiated through a Cityworks preventative pipe jet work order. CCTV inspection is recommended for infiltration pipes whenever cleaning is ineffective in restoring function.

4.16 Manhole

Manholes primarily serve as junctions for storm or sanitary sewer systems when a change in horizontal or vertical alignment must occur. Manholes can also serve as access points to the pipe system for maintenance purposes. Manholes differ from catch basins in that the overall maximum depth may be greater and there is no sump provided below the outlet pipe invert.

SOPs associated with manholes include control structure and pipe. Figure 4-13 shows a typical manhole cover.

Figure 4-13. Manhole

4.16.1 Manhole Inspection

Type 1 and 2 manholes are generally inspected as part of a facility inspection, or are maintained reactively. Table 4-35 is a representation of the CMMS inspection checklist in Cityworks for manholes. The form is a simplification of the maintenance standards for “Table No. 5–Catch Basins” from Section 4.6, Volume V of 2014 SWMMWW (Ecology 2014). Manhole inspection may require confined space entry. Follow necessary safety and personal protection guidelines when inspecting, cleaning and maintaining manholes.

Table 4-35. Manhole Cityworks Inspection Form with Inspection General Work Method			
Criterion	Result	Explanation	General Work Method
Sediment	FAIL	Greater than 60% at lowest invert	Use graduated rod to estimate sediment depth and total depth from invert to sump bottom. Estimate percent depth of sediment. If this criterion fails, create a vactor sediment work order.
	PASS	Less than 60% at lowest invert	
Frame/slab	FAIL	Holes larger than 2.00 $in.^2$ or cracks larger than 10.25 in.	Visual inspection of the frame and slab and use hole size guidelines to determine FAIL, CONCERN or PASS. If the structure has issues but does not require immediate repair, select CONCERN.
	CONCERN	Holes between 1.00 and 2.00 in. or cracks greater than 0.125 in. and less than 0.250 in.	
	PASS	No holes larger than 1.00 $in.^2$ and cracks less than 0.125 in.	
Walls/bottom	FAIL	Judgment that structure is unsound and needs immediate repair or replacement; function of basin is severely compromised	Visual inspection of walls and bottom concrete, missing bricks or large cracks. If bottom is covered with sediment, flag manhole for inspection during cleaning.
	CONCERN	Judgement that there are structural issues but basin is functioning; may need minor repair	
	PASS	No structural issues; function of basin is sound	
Grout fillet (pipe to wall)	FAIL	Crack greater than 0.5 in. and longer than 1 ft with evidence of sediment entering	Visual inspection of the connection of pipes to manhole wall. Visually estimate width and length or cracks with graduated rod or tape measure.
	CONCERN	Cracks between 0.25 in. and 0.5 in. and length less than 1 ft with no evidence of sediment entering	
	PASS	Crack less than 0.25 in. and less than 1 ft long with no evidence of sediment entering	
Ladder	FAIL	Missing rungs, rust, cracks, sharp edges	Visual inspection of rungs above sediment or water level. If ladder is covered with sediment or water, flag manhole for inspection during cleaning.
	PASS	No missing rungs, rust, cracks, sharp edges	
Contamination	FAIL	Oil/gas/other pollution present	Visual inspection of oily sheen or by smell of contaminates such as petroleum products or organic compounds (e.g., paint thinner or acetone) within the manhole including on top of water or sediment, or along the interior wall.
	PASS	Oil/gas/other pollution absent	
Inlet/outlet	FAIL	Greater than 33% blocked	Visual inspection to estimate percent blocked or use graduated rod measure blockage and inlet diameter to calculate percent blocked.
	PASS	Less than 33% blocked	
Trash and debris	FAIL	Blocking inlet, or greater than 60% sump depth	Visual inspection to determine blockage.
	PASS	Not blocking inlet, and less than 60% sump depth	
Cannot locate	FAIL	Cannot locate	Visual inspection for locating relative to map/GIS representation and identifier.
	PASS	Can locate	
Other	FAIL	Other, comment	"Other, comment" means any condition that requires attention to remain or be returned to operation.
	PASS	None	
Lateral connection	Lateral		Lateral is used to identify unmapped lateral connections. This criterion important for IDDE investigations.
	Unknown		
	Other		
	N/A		

4.16.2 Manhole Maintenance and Construction BMPs

Table 4-36 summarizes the maintenance for manholes.

Table 4-36. Manhole Maintenance Summary

Element	Description
Maintenance type	• Routine maintenance includes removing built-up materials and sediment with a vactor truck. After the cleaning, inspect each basin on a case-by-case basis for structural repair. • Non-routine maintenance includes grouting and lid replacement. Most hand-built brick basins no longer meet current design specifications and should be replaced if significant repair is required, while cast basins may be able to be partially repaired.
Maintenance timing	• Perform cleaning in dry months to avoid washing of sediment-laden water downstream, optimize sediment removal and minimize possible water quality impacts. • For work done during wet periods or flowing water, the work is done with a vactor truck with vactoring occurring downstream of pipe work to control the escape of sediment-laden water.
Reactive maintenance	• Maintenance items such as damage from storms, car accidents, or construction may require special repairs or cleanup. Removal and replacement is the preferred method for failing hand-built basins. • Locking lids should be used if the lid is in the travel lane or any location on an arterial street.

Table 4-37. Manhole Cleaning General Work Method

Table 4-37 summarizes the general work method for cleaning manholes by vacuuming.

Table 4-37. Manhole Cleaning General Work Method

Activity Component	Activity Details and Description
Desired result	manholes are cleaned and free of debris by vacuuming.
Resources	• Crew: • 2-person crew • 2 flaggers (as needed) • Material: • Water • Equipment: • 1 vactor truck • 1 J-Hook/Manhole Cover Puller • 1 backup truck with overhead arrow for traffic control (if needed) • PPE (gloves, hardhat, safety glasses, rain gear, rubber boots, hearing protection) • Laptop, charger, and cleaning sheets • Contractor/vendor costs: • Debris: decant spoils • City-approved decant location
General work method	1. Place traffic control signs and safety devices as required at job site 2. Use proper PPE 3. Apply all confined space equipment 4. Senior maintenance and Utility person work together to position equipment, remove manhole lid, and insert rod to measure sediment level 5. Inspect for illicit discharge or connection (SMC 13.10.320); if illicit discharge observed, initiate a water quality service request for IDDE investigation 6. Vacuum debris from storm manhole; clean all surfaces, walls, brick, concrete, inlet and outfall 7. Inspect condition of inlet, outfall, and brick/concrete structure 8. Clean inlets and outfalls if accumulated sediment is 20% or more of the pipe 9. Replace and secure lid to avoid noise from traffic driving over it 10. Clean up job site, tools, and truck 11. Remove traffic control signs and safety devices as required at job site 12. Decant vactor truck in decant spoils bay 13. Make notes about any further work that is needed 14. Accurately report in Cityworks

Regional Road Guidelines BMPs for manhole construction including installation, repair, and replacement are included in Table 4-38 (Tri-County Working Group 2000).

Table 4-38. Manhole Construction Regional Road Guidelines BMPs

Name	BMP Number
Excelsior-filled log	2.63
Inlet protection	2.79
Sandbag	2.109
Straw bale barrier	2.127–2.135
Straw log	2.138
Vactoring	2.166

4.17 Media Filter Drain

A media filter drain is a linear flow-through stormwater runoff treatment device that can be sited along highway side slopes (conventional design) and medians (dual-media filter drains), borrow ditches, or other linear depressions. Media filter drains provide water quality treatment through filtration and sediment deposition.

Related SOPs include control structure. Figure 4-14 shows the plan and profile for a media filter drain.

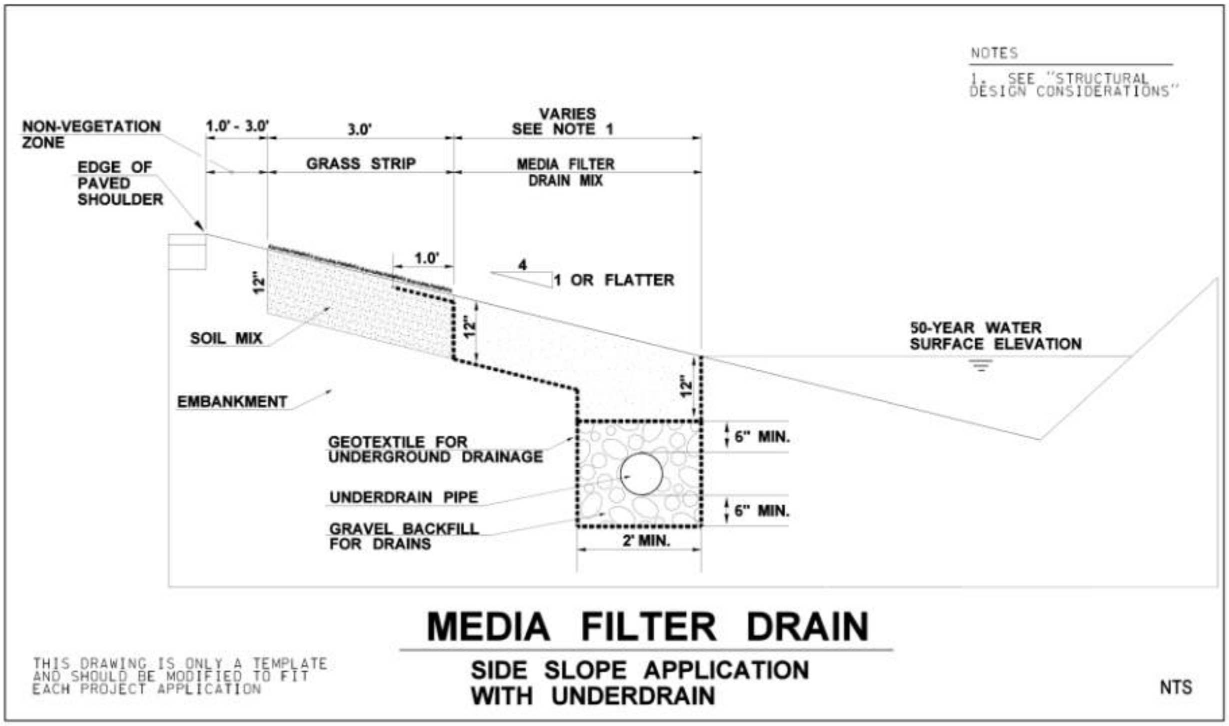


Figure 4-14. Media filter drain

4.17.1 Media Filter Drain Inspection

Media filter drains are inspected annually and typically in coordination with other assets associated with a stormwater facility. Table 4-39 is a representation of the CMMS inspection checklist in Cityworks for media filter drains. The form is a simplification of Table V-4.5.2(19) Maintenance Standards – Media Filter Drain (MFD)", Section 4.6, Volume V of 2014 SWMMWW, included in Appendix B.

Table 4-39. Media Filter Drain Cityworks Inspection Form with Inspection General Work Method

Criterion	Result	Explanation	General Work Method
Sediment	FAIL	Greater than 2 in. on grass	Visual inspection of sediment on grass.
	PASS	Less than 2 in. on grass	
Vegetation	FAIL	Grass greater than 10 in. high, poor vegetation coverage, or weeds present	Visual inspection of grass height.
	PASS	Grass less than 10 in. high, adequate vegetation coverage, and weeds absent	
Trash and debris	FAIL	Present	Visual inspection of trash or debris.
	PASS	Absent	
Excessive shading	FAIL	Overhanging limbs or brushy vegetation on slopes	Visual inspection of nearby vegetation.
	PASS	No overhanging limbs and no brushy vegetation on slopes	
Flow spreader	FAIL	Uneven	Visual inspection of sediment on grass.
	PASS	Even	
Contamination	FAIL	Oil/gas/other pollution present	Visual inspection of oily sheen on gravel or grass, darkened soil, or by smell of contaminates such as petroleum products or organic compounds (e.g., paint thinner or acetone).
	PASS	Oil/gas/other pollution absent	
Cannot locate	FAIL	Cannot locate	Visual inspection for locating relative to map/GIS representation and identifier.
	PASS	Can locate	
Curb cut	FAIL	Opening restricted	Visual inspection of curb cut openings.
	PASS	Opening not restricted	
Other	FAIL	Other, comment	"Other, comment" means any condition that requires attention to remain or be returned to operation.
	PASS	None	

4.17.2 Media Filter Drain Maintenance

Table 4-40 summarizes maintenance for media filter drains.

Table 4-40. Media Filter Drain Maintenance Summary

Element	Description
Maintenance type	Maintenance will consist of routine roadside management. Excessive vegetation should be cleared from the no-vegetation zone (vegetation-free zone) as this area acts as level spreader to promote sheet flow and a deposition area for coarse sediments.
Reactive maintenance	• Maintenance items such as damage from storms, car accidents, pollutant spills, or construction may require special repairs or cleanup. • Do not allow vehicles or traffic on the media filter drain to minimize rutting and maintenance repairs.

4.18 Natural Channel

Natural channels have inherent value as natural systems, which offer habitat and can, when healthy, offer some water quality and storage functions. Natural channels are heavily protected by regulations, and are the primary beneficiaries of water quality and flow control provided outside of the natural channel itself.

Related SOPs associated with natural channels include ditch, culvert, outfall, and pipe inlet structure.

Figure 4-15. Natural channel

4.18.1 Natural Channel Inspection

Natural channels are not inspected or maintained on a regular interval. Portions of the natural channels that are located near or intersect a stormwater facility, such as a wetland or pond, are inspected as part of a regional stormwater facility inspection. Natural channels are managed through environmental assessments and regulatory processes, applied by various means (basin planning and both public and private projects, which are within critical area buffers).

Natural channels may be evaluated during basin studies or other types of analysis. During a study, flow and function are primary points of interest. The Utility may only have an interest related to a natural channel within public property, ROW, and private property with easements. Table 4-41 is a representation of the CMMS inspection checklist in Cityworks for natural channels.

Table 4-41. Natural Channel Cityworks Inspection Form with Inspection General Work Method			
Criterion	**Result**	**Explanation**	**General Work Method**
Vegetation	FAIL	Blocking free movement of water	Visual inspection of vegetation density.
	PASS	Not blocking free movement of water	
Contamination	FAIL	Oil/gas/other pollution present	Visual inspection of oily sheen on water, channel bank or by smell such as petroleum products or organic compounds (e.g., paint thinner or acetone). Visual inspection of discolored, or soapy water.
	PASS	Oil/gas/other pollution absent	
Trash and debris	FAIL	Present	Visual inspection of presence of trash or debris.
	PASS	Absent	
Inlet/outlet	FAIL	Greater than 33% blocked	Visual inspection to estimate percent blocked or use graduated rod measure blockage and inlet diameter to calculate percent blocked.
	PASS	Less than 33% blocked	
Weir	FAIL	Not intact	Check pass or fail if ditch has weir (most ditches do not have a weir). If the weir would not cause water to pond behind it and slow water down, it is considered not intact.
	PASS	Intact	
Erosion	FAIL	Bank or excessive channel erosion present	Visual inspection excessive channel erosion or bank erosion.
	PASS	Bank or excessive channel erosion absent	
Cannot locate	FAIL	Cannot locate	Visual inspection for locating relative to map/GIS representation and identifier.
	PASS	Can locate	
Other	FAIL	Other, comment	"Other, comment" means any condition that requires attention to remain or be returned to operation.
	PASS	None	

4.18.2 Natural Channel Maintenance and Construction BMPs

Table 4-42 summarizes the maintenance for natural channels.

Table 4-42. Natural Channel Maintenance Summary	
Element	**Description**
Maintenance timing	Natural channel maintenance is explicitly done during dry months unless permitted otherwise by a site-specific HPA. Routine work is scheduled within the work window specified by permit to minimize potential water quality impacts. Work done outside of the work window must be explicitly covered by permit or as part of an emergency response that also has authorization
Maintenance type	The primary maintenance related to natural channels is at the junction of other assets such as a culvert going under a street. At times sediment removal or erosion repair may be necessary depending on location or severity of impact to City infrastructure.
Reactive maintenance	Sediment removal and erosion repair are the most common but infrequent type of maintenance on natural channels. There may be work related to assets adjoining natural channels such as culverts that do not directly impact the channel, but precautions must be made to prevent the release of turbid water or debris.
Permit requirements	Natural channels may have multiple overlaying permit requirements. HPA permit restrictions may limit the time frame or scope of work to be done. Any significant work would require submissions for separate permits and is not covered under the City general HPA permit. Because of the complexity of permitting surrounding work on/over/around natural channels, it must be assumed that any work related to this asset requires permit coverage.
Exceptions and outliers	Many natural channels flow through private property with no easement. Changes to the channel are not always documented and impacts may be in place for long periods prior to failing or being reported. When a change is noted, it is important to reach out to the property owner and work with them to restore the channel as needed under current laws and regulations.

Regional Road Guidelines BMPs for natural channel construction including installation, repair, and replacement are included in Table 4-43 (Tri-County Working Group 2000).

Table 4-43. Natural Channel Construction Regional Road Guidelines BMPs

Name	BMP Number
Coir log	2.26
Dewatering	2.31
Ditch lining	2.50
Diversion channel	2.54
Excelsior-filled log	2.58
Grass-lined channel	2.63
Hand seeding	2.67
Hydro seeding	2.75
Inlet protection	2.77
Large woody material	2.79
Live staking	2.88
Mulching	2.93
Rip rap	2.97
Rock check dam	2.103
Sandbag	2.105
Silt fence	2.109
Soil stabilization (blankets and matting)	2.114
Straw bale barrier	2.122
Straw log	2.127–2.135
Stream bypass	2.138
Streambed gravel	2.142
Triangular silt dike	2.146
Vegetative buffer	2.162

4.19 Oil/Water Separator

An oil/water separator is a device that is designed to remove oil, grease, and similar floatable pollutants from stormwater runoff.

Related SOPs include catch basin, manhole, and vault. Figure 4-16 shows a typical oil/water separator.

Figure 4-16. Oil/water separator

4.19.1 Oil/Water Separator Inspection

Oil/water inspection and repair are typically initiated through Cityworks preventive work orders for a surface water facility that contains the oil/water separator, or during a routine annual or biennial inspection.

Table 4-44. Oil/Water Separator Cityworks Inspection Form with Inspection General Work Method

Table 4-44 is a summary of the Cityworks custom inspection observation form for oil/water separator. The form is a simplification of Table V-4.5.2(16) “Maintenance Standards – Baffle Oil/Water Separators (API)” and Table V-4.5.2(17) “Maintenance Standards – Coalescing Plate Oil/Water Separators”, Section 4.6, Volume V of 2014 SWMMWW, included in Appendix B.

Table 4-44. Oil/Water Separator Cityworks Inspection Form with Inspection General Work Method

Criterion	Result	Explanation	General Work Method
Sediment	FAIL	Greater than 6 in. depth in bottom of vault, or sediment on plates	Use a graduated rod to measure depth of sediment. Visual inspection of sediment on plates.
	PASS	Less than 6 in. depth in bottom of vault, and no sediment on plates	
Oil Accumulation	FAIL	Greater than 1 in. at water surface	Use a graduated rod to measure depth oil accumulation at water surface.
	PASS	Less than 1 in. at water surface	
Baffles	FAIL	Corroding, cracking, or warping	Visual inspection of baffles.
	PASS	No corrosion, cracking, or deformation	
Coalescing plates	FAIL	Plate media broken, deformed, or cracked	Visual inspection of plates.
	PASS	Plate media intact	
Contamination	FAIL	Oil/gas/other pollution present	Visual inspection of oily sheen on mulch or plant, or by smell of contaminates such as petroleum products or organic compounds (e.g., paint thinner or acetone).
	PASS	Oil/gas/other pollution absent	
Other, comment	Other, comment	Other, comment	“Other, comment” means any condition that requires attention to remain or be returned to operation.
PASS	None	None	

4.19.2 Oil/Water Separator Maintenance

Vaults and manholes that house oil/water separators should be cleaned of sediment, debris, and oil. The oil/water separator components such as baffles, vault structures, and access equipment should be cleaned and not broken or bent.

Refer to manufacturer’s O&M Manual for cleaning of coalescing plates and hazardous waste disposal. See Appendix J for VortClarex brand Oil/Water Separator inspection and maintenance guidelines. Liquid hazardous waste can be transported and disposed of at a King County Industrial Waste Facility. Spill kits and other spill response BMPs should be implemented during maintenance activities to prevent contamination.

Follow necessary safety and personal protection guidelines when inspecting, cleaning and maintaining oil/water separators.

4.20 Outfall

An outfall is a downstream discharge point from any stormwater to any body of water (Puget Sound, pond, etc.) or ditch.

Related SOPs include control structure, culvert, ditch, natural channel, and pond. Figure 4-17 shows a typical outfall discharge.

Figure 4-17. Outfall

4.20.1 Outfall Inspection

Outfall inspection and repair are typically initiated through Cityworks preventive work orders for other stormwater assets that contain or upstream of an outfall. Table 4-45 is a summary of the Cityworks custom inspection observation form for outfalls.

Table 4-45. Outfall Cityworks Inspection Form with Inspection General Work Method

Criterion	Result	Explanation	General Work Method
Outlet	FAIL	Greater than 33% blocked	Use graduated rod or measuring tape to measure sediment depth and outfall pipe diameter to estimate the percent of sediment of cross sectional diameter at pipe outlet.
	PASS	Less than 33% blocked	
Contamination	FAIL	Oil/gas/other pollution present	Visual inspection of oily sheen on water, channel bank or by smell such as petroleum products or organic compounds (e.g., paint thinner or acetone). Visual inspection of discolored or soapy water.
	PASS	Oil/gas/other pollution absent	
Trash and Debris	FAIL	Present	Visual inspection of trash and debris.
	PASS	Absent	
Cannot locate	FAIL	Cannot locate	Visual inspection for locating relative to map/GIS representation and identifier.
	PASS	Can locate	
Other	FAIL	Other, comment	"Other, comment" means any condition that requires attention to remain or be returned to operation.
	PASS	None	

4.20.2 Outfall Maintenance

Outfalls should be kept clean of vegetation, debris, and sediment. Many outfalls will need a rock pad to prevent erosion. Those outfalls with a rock pad will require maintenance of the rock (e.g., fresh rock replacement upon inspection). Outfalls without a rock pad and showing signs of erosion will also need one.

4.21 Permeable Pavement

Permeable pavements allow water to infiltrate through surfaces that would normally be impermeable. These pavements provide a smooth, stable surface for walking or driving, yet allow water to filter through them and into the soils or bedding material below. The most common two are pervious concrete and porous asphalt. The most common permeable pavements in Shoreline are sidewalks, park trails, and parking cut ins. Many permeable pavement installations in Shoreline are adjacent to bioinfiltration facilities and are a component of a surface water facility.

Figure 4-18 shows a typical example of permeable pavement sidewalk usage.

Figure 4-18. Permeable pavement

4.21.1 Permeable Pavement Inspection

Table 4-46 is a summary of the Cityworks custom inspection observation form for permeable pavements. The form is a simplification of Table V-4.5.2(22) “Maintenance Standards – Permeable Pavement”, Section 4.6, Volume V of 2014 SWMMWW, included in Appendix B. Based on results from the Cityworks visual inspection (such as sediment, gravel or moss in the pores of pavement or between pavers), follow-up infiltration tests according to the ASTM C1701/C1701M, see Appendix K, can be conducted to determine if the permeable pavement is functioning within the required range.

Table 4-46. Permeable Pavement Cityworks Inspection Form with Inspection General Work Method

Criterion	Result	Explanation	General Work Method
Sediment	FAIL	Sediment in pores of pavement or between pavers	Visual inspection of sediment on pavement.
	PASS	No sediment in pores of pavement or between pavers	
Trash and debris	FAIL	Present	Visual inspection of trash and debris.
	PASS	Absent	
Weeds/moss	FAIL	Present	Visual inspection of weeds or moss growing on the permeable pavement.
	PASS	Absent	
Gravel fill	FAIL	Missing or sparse	Visual inspection of extent of gravel fill.
	PASS	Present and adequate	
Contamination	FAIL	Oil/gas/other pollution present	Visual inspection of oily sheen or darkened surface on permeable pavement or by smell such as petroleum products or organic compounds (e.g., paint thinner or acetone).
	PASS	Oil/gas/other pollution absent	
Other	FAIL	Other, comment	"Other, comment" means any condition that requires attention to remain or be returned to operation.
	PASS	None	

4.21.2 Permeable Pavement Maintenance and Construction BMPs

Permeable pavement sidewalks are maintained by keeping them clean and free of soil, weeds, and other debris. Routine maintenance may include raking or sweeping once in the year in the fall, or as needed, to prevent clogging.

Vacuuming and/or pressure washing is recommended once a year, or as needed, based on infiltration testing. Reactive maintenance includes removal of moss, ground cover, and washout from planted areas based on observed or tested clogging.

Table 4-47 lists the general work method recommended for routine maintenance for permeable pavement in general and by specific type of permeable pavement.

Table 4-47. Permeable Pavement Routine Maintenance General Work Method		
Maintenance Activity	Recommended Frequency	Notes
Observation ports	Visually check observation ports, if available at least twice annually.	• Remove cap of observation port. Measure depth between observed water level and top of lid for port. Replace cap securely when done. Keep a record of measurements (including date) in maintenance log. • Check project-specific O&M manual for minimum distance between top of observation port and water surface level during dry and wet weather. • During rainy weather, the water level will rise within the observation port. However, after the rain event has ceased, the water level at the observation port will drop as the water drains out of the pavement section. If water does not drain out of the observation port after 72 hours after rain has ceased, then the pavement base materials may be clogged or the groundwater table is high.
Inspect system for clogging	• Inspect for ponding water (clogging) after heavy rain events (more than 1 in. of rainfall in 24 hours). • Inspect pavement in early fall.	• Check for clogging and reduced permeability. If clogged, clean pavement as described below. • If inspecting during dry weather, spray water (e.g., use garden hose) onto areas that appear clogged. If water runs off and does not filter into the pavement, pavement may be clogged. Implement cleaning measures to remove sediment such as using dry broom, pavement vacuum sweepers, or other tools. • Remove finer debris with vacuum equipment. Follow manufacturer guidelines for when vacuuming is most effective (e.g., when pavement is dry). • With open-celled paver systems, remove debris as described above and replace gravel.
Permeable cement and porous asphalt		
Manually sweep large debris and leaves	Once per year in fall or as needed.	• Sweep porous pavement manually to maintain appearance and remove large debris such as leaves from pavement. • Sweep and rake leaves as soon as leaves drop, preferably when surface and debris is dry.
Vacuum sweep	Vacuum sweep twice per year.	• Keep porous pavement surfaces clean to decrease sediment clogging. • Vacuum sweep porous pavement to maintain appearance, remove sediment, and provide positive infiltration through pavement. • Sweep porous pavement to maintain appearance and remove leaves and other debris as required to maintain positive infiltration rate.
Moss removal	As needed if water is unable to infiltrate through the moss covering.	• Moss is a common occurrence in the Pacific Northwest. Some moss will not affect the overall performance of porous pavement; however, if it grows thick and covers a large area, it can possibly reduce infiltration rates. • Test infiltration and removal techniques on a small area before proceeding. • Use any of the following options: scrubber washing, weed burner, sweeping, vacuum sweeping, or a combination of all.
Trim ground covers along porous pavement edge	Bimonthly (minimum) from March–September.	• Regularly trim plants along porous pavement edge. • Time trimming as needed to keep plants from rooting in adjacent porous pavement. • Replace invasive ground covers with non-invasives and re-establish plantings.
Porous pavement restoration	5–30 years.	• If wearing course needs to be replaced, remove wearing course and reinstall porous pavement section. • Review with geotechnical engineer if original subbase can be reused for the pavement section or repair/replace as needed.

Table 4-47. Permeable Pavement Routine Maintenance General Work Method		
Maintenance Activity	**Recommended Frequency**	**Notes**
Permeable Pavers		
Moss removal	As needed if water is unable to infiltrate through the moss covering.	• Moss is a common occurrence in the Pacific Northwest. Some moss will not affect the overall performance of permeable pavers; however, if it grows thick and covers a large area, it can possibly reduce infiltration rates. • Test infiltration and removal techniques on a small area before proceeding. • Use any of the following options: scrubber washing, weed burner, sweeping, vacuum sweeping, or a combination of all.
Manually sweep large debris and leaves	Once per year in fall or as needed.	• Sweep manually to maintain appearance and remove large debris such as leaves from pavement. • Sweep and rake leaves as soon as leaves drop, preferably when surface and debris is dry.
Vacuum sweep	Vacuum sweep twice per year.	• Keep surfaces clean to decrease sediment clogging. • Vacuum sweep to maintain appearance, remove sediment, and provide positive infiltration through pavement.
Vegetative Paver System		
Mow	As needed to maintain a height of 3 in. (usually 1 time per week during summer).	• Mow with a mulching mower. Clippings can be left in place.
Open Celled Pavers – Gravel		
Remove trash and debris	• Remove trash and debris. • Inspect after large storm events (~more than 1 in. of rainfall in 24 hours or heavy downpour).	• Collect and properly dispose of trash/litter. • Pet waste is a serious concern and should not be left within a pavement system as it contains disease-causing organisms and flushes bacteria into the stormwater.
Weed	Bimonthly from March–October.	• Remove weeds manually by roots with pincer-type weeding tools, or hot water weeders.
Sweep gravel	Once per month or as needed.	• Remove and dispose of litter/debris and sweep clean gravel back into gravel pavers areas.
Topdress gravel	Inspect for bare spots and areas of disturbed vegetation every 6 months.	• Refill cells with clean gravel per original designs to top of or slightly above geogrid surface. • Follow manufacturer's guidelines for repair of structural components of pavement system grid.
Check for cracking, settlement, or structure damage	Inspect once per year or as needed.	• Replace the confinement cells if damaged. • Follow manufacturer guidelines for replacing sections of cells.

Regional Road Guidelines BMPs for permeable pavement construction including installation, repair, and replacement are included in Table 4-48 (Tri-County Working Group 2000).

Table 4-48. Permeable Pavement Construction Regional Road Guidelines BMPs	
Name	BMP Number
Dust control	2.61
Inlet protection	2.79
Concrete containment (1)	2.34
Concrete containment (2)	2.37
Sweeping	2.152
Vactoring	2.166

4.22 Pipe

Pipes provide conveyance of stormwater to other structures including catch basins, manholes, vaults, tanks and ponds.

Related SOPs include control structure, catch basin, manhole, and ditch. Figure 4-19 shows pipe used as a flow control device.

Figure 4-19. Pipe

4.22.1 Pipe Inspection

Visual pipe inspection is accomplished by a variety of methods that include simply looking into the end of a pipe (i.e., candling) using a pole-mounted zoom camera, or a CCTV inspection device. Pipes adjacent to ditches or serving as driveway culverts are visually inspected. Pipes less than 8 inches (in.) are likely to have blockages and may be more difficult to clean because of the size of vactor equipment. Pipes less than these sizes and lengths either pose too low of risk to warrant the cost of inspection/cleaning, or can be done via candling (e.g., driveway culverts). Table 4-49 is a summary of the Cityworks custom inspection observation form for pipes with a visual inspection.

Table 4-49. Pipe Cityworks Inspection Form (non-CCTV inspection) with Inspection General Work Method			
Criterion	**Result**	**Explanation**	**General Inspection Method**
Sediment	FAIL	Greater than 33% of pipe diameter	Use graduated rod or measuring tape to measure sediment depth and outfall pipe diameter to estimate the percent of sediment of cross sectional diameter at pipe outlet.
	PASS	Less than 33% of pipe diameter	
Vegetation	FAIL	Blocking free movement of water	Visual inspection of vegetation at pipe inlet or outlet.
	PASS	Not blocking free movement of water	
Dent	FAIL	Greater than 20% reduction in cross-section area	Visual inspection and estimation of dent cross section area, relative to pipe cross-section area.
	PASS	Less than 20% reduction in cross-section area	
Contamination	FAIL	Oil/gas/other pollution present	Visual inspection of oily sheen or by smell of contaminates such as petroleum products or organic compounds (e.g., paint thinner or acetone) within the culvert included above the current water level. Visual inspection of discolored or soapy water. Visual inspection of oily sheen in pipe. Visual inspection of discolored or soapy water.
	PASS	Oil/gas/other pollution absent	
Trash and debris	FAIL	Blocking Inlet/outlet	Visual inspection of trash and debris at pipe inlet or outlet.
	PASS	Not blocking Inlet/outlet	
Cannot Locate	FAIL	Cannot locate	Visual inspection for locating relative to map/GIS representation and identifier.
	PASS	Can locate	
Other	FAIL	Other, comment	"Other, comment" means any condition that requires attention to remain or be returned to operation.
	PASS	None	

Pipes are inspected with CCTV inspection equipment to investigate pipe failure or a basin-wide condition assessment inspection. These pipes are inspected on a 20-year cycle and use the National Association of Sewer Service Companies (NASSCO) Pipeline Assessment and Certification Program (PACP) structure and maintenance scoring system. PACP-certified inspectors populate an inspection results database while viewing CCTV pipe inspection video. Cityworks has a CCTV interface for a PACP add-on feature that allows Cityworks to read directly from a PACP database. PACP inspection procedures are a repeatable inspection process that documents the condition of the pipe in a standard fashion to allow an assessment of degradation over time and comparison of assets against each other.

4.22.2 Pipe Maintenance and Construction BMPs

Table 4-50 summarizes the maintenance activities for pipes.

Table 4-50. Pipe Maintenance Summary

Element	Description
Maintenance timing	Pipe cleaning is done primarily during dry months to avoid washing turbid water downstream. Routine work is scheduled for the driest periods to optimize sediment removal and minimize possible water quality impacts. If there is work conducted during wet periods or flowing water, the work is performed via vactor truck with vactoring occurring downstream of pipe work to control the escape of sediment-laden water.
Maintenance type	Pipes are cleaned using a vactor truck to flush the lines using a hose-mounted jetting head. Built-up roots are removed with a vactor truck and a hose-mounted root cutter.
Reactive maintenance	CIPP is the preferred pipe repair method to address cracks, small holes, and joint displacements for end-to-end pipe lengths. Severe defects, such as deformation, large holes, and large displacements require open-cut replacement of the damaged portion.
Permit requirements	Pipes are not directly required to be cleaned or inspected as part of the NPDES permit.
Exceptions and outliers	There are pipes 6 in. and under at several locations in the city. Conventional vactor equipment may be too destructive to clean these small-diameter pipes. Blind connections between pipes exist and should be replaced with a basin/manhole if discovered.

Regional Road Guidelines BMPs for pipe construction including installation, repair, and replacement are included in Table 4-51 (Tri-County Working Group 2000).

Table 4-51. Pipe Construction Regional Road Guidelines BMPs

Name	BMP Number
Inlet protection	2.79
Sandbag	2.109
Dewatering	2.5

4.23 Pipe Inlet Structure

Pipe inlet structures (i.e., trash racks) are typically a grated structure that limit unauthorized and unwanted access to a drainage structure of debris or larger animals.

Related SOPs include control structure, pipe, and ditch. Figure 4-20 shows a typical pipe inlet structure.

Figure 4-20. Pipe inlet structure

4.23.1 Pipe Inlet Structure Inspection

Pipe inlet structure inspection and repair are typically initiated through Cityworks work orders. Table 4-52 is a representation of the CMMS inspection checklist in Cityworks for drains.

Table 4-52. Pipe Inlet Structures Cityworks Inspection Form with Inspection General Work Method

Criterion	Result	Explanation	General Work Method
Trash/debris	FAIL	Trash or debris plugging greater than 20% of openings	Visual inspection of trash or debris plugging opening. Visually estimate the percent blockage.
	PASS	Trash or debris plugging less than 20% of openings	
Structure	FAIL	Structure is bent, missing pieces or not attached	Visual inspection of structure condition.
	PASS	Structure is not bent, is intact and attached	

4.23.2 Pipe Inlet Structure Maintenance

Pipe inlet structures should be free of trash or debris. The structure should be whole and not deformed.

4.24 Pond

Ponds are natural or constructed open-detention features that provide water quality benefits from habitat and sediment settlement.

Related SOPs include control structure, dam, gate valve, natural channel, and stormwater facility. Figure 4-21 shows a detention pond.

Figure 4-21. Pond

4.24.1 Pond Inspection

Ponds are inspected annually and typically in coordination with other assets associated with a stormwater facility.

Table 4-53 is a representation of the CMMS inspection checklist in Cityworks for ponds. The form is a simplification of Table V-4.5.2(1) “Maintenance Standards – Detention Ponds” and Table V-4.5.2(11) “Maintenance Standards – Wetponds”, Section 4.6, Volume V of 2014 SWMMWW, included in Appendix B.

Table 4-53. Pond Cityworks Inspection Form with Inspection General Work Method			
Criterion	**Result**	**Explanation**	**General Work Method**
Sediment	FAIL	Greater than 10% of designed pond depth	Estimate depth of sediment from linked design drawings.
	PASS	Less than 10% of designed pond depth	
Rodent holes	FAIL	Located on dam or located on berm	Visual inspection of dam and berm.
	PASS	Not located on dam and not located on berm	
Emergency spillway	FAIL	Missing rock	Visual inspection of rock at spillway.
	PASS	No missing rock	
Poisonous/ invasive vegetation	FAIL	Restricting access or noxious weeds present	Visual inspection of weeds or access limited by invasive plants.
	PASS	Unrestricted access and noxious weeds absent	
Contamination	FAIL	Oil/gas/other pollution present	Visual inspection of oily sheen on water, pond bank or tributaries or by smell such as petroleum products or organic compounds (e.g., engine oil, paint thinner or acetone). Visual inspection of discolored or soapy water.
	PASS	Oil/gas/other pollution absent	
Tree growth	FAIL	Inhibiting access or present on bank/berm	Visual inspection of tree growth on bank/berm and access areas.
	PASS	Not Inhibiting access, and absent on bank/berm	
Slope erosion	FAIL	Present	Visual inspection of slope erosion. Look for bare dirt or new bare areas on slope.
	PASS	Absent	
Inlet/outlet	FAIL	Blocked	Visual inspection of pond inlet and outlet.
	PASS	Clear	
Access road	FAIL	Passable	Visual inspection of access to, from, and on access road.
	PASS	Impassable	
Trash and debris	FAIL	Greater than 1 ft^3/1,000 ft^2	Visual estimate of trash and debris on pond surface, bank, or access areas.
	PASS	Less than 1 ft^3/1,000 ft^2	
Cannot locate	FAIL	Cannot locate	Visual inspection for locating relative to map/GIS representation and identifier.
	PASS	Can locate	
Other	FAIL	Other, comment	"Other, comment" means any condition that requires attention to remain or be returned to operation.
	PASS	None	

4.24.2 Pond Maintenance

Table 4-54 summarizes the maintenance of ponds.

Table 4-54. Pond Maintenance Summary	
Element	**Description**
Maintenance type	Primary maintenance requires sediment removal from stormwater assets and vegetation control to allow for clear access and flow.
Maintenance timing	Maintenance work on ponds is done primarily during dry months. Sediment removal should be done in July or August with no flowing water, and no rain expected during the work window. If necessary, erosion control materials should be used above the ordinary high water mark where soils are exposed. Clearing of grates, inlets, and outfalls may occur year-round.
Reactive maintenance	Ponds may have many types of stormwater assets contained within them. Most reactive maintenance relates to the individual assets. There may also be site-specific maintenance such as tree removal and fence repair.
Permit requirements	Ponds must be inspected annually and after a 10-year rain event.

Table 4-55 presents a general work method for pond maintenance.

Table 4-55. Pond Maintenance General Work Method	
Activity Component	**Activity Details and Description**
Desired result	Remove noxious weeds, contamination, and pollutant materials from the pond. Clean inlets and outlets. Remove vegetation, grass, leaves, debris, and trees by hand or use machinery.

Resources	• Crew: 2-person crew
	• Material: None
	• Equipment:
	  • 1 dump truck
	  • 1 service truck
	  • 2 weed eaters
	  • 1 chainsaw
	  • 1 various hand tools
	  • 1 track hoe with mower if needed
	  • PPE (gloves, hardhat, safety glasses, rain gear, rubber boots, hearing protection)
	• Contractor/vendor costs:
	• Debris: decant spoils

General work method	1. Place traffic control signs and safety devices as required at job site 2. Use proper PPE 3. Notify front desk who will email police, fire, and public works if access to road will be impacted 4. Inspect for illicit discharge or connection (SMC 13.10.320); if illicit discharge observed, initiate a water quality service request for IDDE investigation 5. Remove accumulated sediment in ditch that exceeds 10% of designed pond depth 6. Remove noxious vegetation which may constitute a hazard to City personnel or public according to applicable regulations 7. Clean inlets and outfalls if accumulated sediment is 20% or more of the pipe; if pipe needs rodding, initiate a rodding request 8. Remove debris from channels to provide adequate flow 9. Straw or seed as needed 10. Quarry rock outfalls and around outlet pipe from ditch as needed 11. Install waddles with stakes as needed 12. Clean up job site, tools, and truck 13. Remove traffic control signs and safety devices as required at job site 14. Notify front desk who will email police, fire, and public works that access to road has been returned 15. Accurately report in Cityworks

4.25 Pump Station

Pump stations collect water from large areas and are generally set in closed depressions; therefore, failure of a pump station poses risks to immediate properties. Pump stations are used to prevent flooding of private property and critical infrastructure. Pump stations have wet wells and/or ponds associated with them that act as sediment control and lessen the frequency that the pumps may turn on.

Related SOPs include control structure and stormwater facility. Figure 4-22 shows pump station 26.

Figure 4-22. Pump station

4.25.1 Pump Station Inspection

Pump stations have several types of routine maintenance and inspections. During wet months, pump stations are inspected for flow and general operation on a weekly basis as a hot spot work order-based inspection. During dry months, pump stations are inspected before/during large rain events. Pump stations have comprehensive system inspections on an annual basis performed by a specialist. Table 4-56 is a representation of the CMMS inspection checklist in Cityworks for pump station control. Included in the hot spot inspection work order is a reminder for the inspector to check the work complete box in the asset panel if the hot spot is left in functional condition.

Table 4-56. Pump Station Controls Cityworks Inspection Form with Inspection General Work Method			
Criterion	Result	Explanation	General Work Method
Floats	FAIL	Broken, missing, or Nonfunctional	Visual inspection of floats.
	PASS	Intact, present, and functional	
Motor	FAIL	Nonfunctional or excessive noise	Auditory inspection of pump motor. Pump motor should be smooth and consistent. There should be no grinding or knocking noise.
	PASS	Functional and normal noise	
Pump inlet	FAIL	Blocked	Visual inspection of pump inlet of from any blockage.
	PASS	Clear	
Wetwell	FAIL	Excessive trash or debris	Visual inspection of excessive trash or debris inside the wet well.
	Pass	No excessive trash or debris	
Pump hours		Input pump hours	Inspector tests the pump by turning it on for a short period (less than 1 minute) (a.k.a. as "bump the pump").
Other	FAIL	Other, comment	"Other, comment" means any condition that requires attention to remain or be returned to operation.
	PASS	None	

4.25.2 Pump Station Maintenance

Table 4-57 summarizes the maintenance for pump stations.

Table 4-57. Pump Station Maintenance Summary	
Element	Description
Maintenance timing	Routine maintenance is conducted in the spring and fall. During the spring, all pump stations are reviewed for run time, general function, and inspected for maintenance (see Section 5.2 Hot Spot Inspections). In early fall (i.e., September) pump stations have the wetwell cleaned if necessary and any other maintenance is done at the same time.
Maintenance type	Routine maintenance is conducted in the spring and fall. During the spring, all pump stations are reviewed for run time, general function, and inspected for maintenance (see Section 5.2 Hot Spot Inspections). In early fall (i.e., September) pump stations have the wetwell cleaned if necessary and any other maintenance is done at the same time.
Reactive maintenance	• At times, a pump may require major repair and need to be removed from the wetwell. Depending on the severity of the repair, the pump may have to be rebuilt at the contractor's shop. The control panel may require maintenance of controls (etc.) contained within the electrical panel. Work will be completed by a contractor. • Other assets related to the pump station may require maintenance such as pipe repair. Please see specific asset descriptions for more information.
Permit requirements	Facilities must be inspected annually and after a 10-year rain event. When an inspection identifies an exceedance of the maintenance standard, maintenance shall be performed within 1 year for typical maintenance and within 2 years for maintenance that requires capital construction of less than $25,000. Catch basins within regional facilities must have maintenance conducted within 6 months.
Exceptions and outliers	• Pump stations collect water from large areas and are the lowest point water can reach without physical movement; therefore, failure of a pump station poses risks to immediate properties. Pump station failure and downtime poses significant risk to public safety and property damage. • Pump stations may be part of a regional facility and must be maintained and inspection on a site-by-site basis. Because these sites are expansive and complicated, efficient use of contracted work in conjunction with City crews is vital for continuous operation.

4.26 Stormwater Facility (General Site Conditions)

Stormwater facilities are regional or residential facilities that are inspected and maintained by the Utility. Regional facilities receive large amounts of stormwater from the ROW. Residential stormwater facilities control stormwater for homes on separate tax lots that have also granted easements to the City. Both the regional and residential stormwater facilities operate with a variety of assets and associated grouping of assets that are intended to treat, control, or convey water collected from a large area. Stormwater facilities include pump stations, dams, large stormwater vaults/tanks, bioretention facilities, and large collections of other stormwater assets.

SOPs associated with stormwater facilities include catch basin, control structure, dam, gate valve, manhole, pond, pump, and vault/tank. Figure 4-23 shows the site security measures and general conditions surrounding a pump station facility.

Figure 4-23. Stormwater facility

4.26.1 Stormwater Facility Inspection

Stormwater facilities are inspected on an annual basis and are maintained as needed. The assets associated with the facility are included in the annual inspection. In addition, there are facilities that require vegetation maintenance more than once per year. Table 4-58 is a representation of the CMMS inspection checklist in Cityworks for stormwater facilities.

Table 4-58. Stormwater Facility Cityworks Inspection Form with Inspection General Work Method			
Criterion	Result	Explanation	General Work Method
Vegetation	FAIL	Overgrown, restricting access, or noxious weeds present	Visual inspection of weeds or access limited by invasive plants.
	PASS	Not overgrown, unrestricted access, and noxious weeds absent	
Trash and debris	FAIL	Present	Visual inspection of trash and debris.
	PASS	Absent	
Fence	FAIL	Broken or missing	Visual inspection of fence. Walk perimeter.
	PASS	Intact, present, and functional	
Gate	FAIL	Broken or missing	Visual inspection of gate.
	PASS	Intact, present, and functional	
Locks	FAIL	Broken or missing	Visual inspection of locks.
	PASS	Intact, present, and functional	
Signs	FAIL	Broken, missing, or not visible	Visual inspection of signs.
	PASS	Intact, present, and visible	
Contamination	FAIL	Oil/gas/other pollution present	Visual inspection of oily sheen on surfaces near surface water sources or by smell of petroleum products or organic compounds (e.g., paint thinner or acetone). Visual inspection of discolored or soapy water.
	PASS	Oil/gas/other pollution absent	
Other	FAIL	Other, comment	"Other, comment" means any condition that requires attention to remain or be returned to operation.
	PASS	None	

4.26.2 Stormwater Facility Maintenance

Table 4-59 summarizes maintenance for stormwater facilities.

Table 4-59. Stormwater Facility Maintenance Summary	
Element	Description
Maintenance timing	Maintenance timing will be based on the timing requirements of the associated facility outlets.
Maintenance type	Primary maintenance requires sediment removal from stormwater assets and vegetation control to allow for clear access and flow.
Reactive maintenance	Regional facilities may have many types of stormwater assets contained within them; therefore, the most reactive maintenance relates to the individual assets. There may also be site-specific maintenance such as tree removal and fence repair.
Permit requirements	Regional facilities must be inspected annually and after a 10-year rain event.
Exemptions and outliers	These facilities can present many challenging situations that may need to be taken on a case-by-case basis. Each facility has site-specific design or layout plans and some have O&M manuals that describe maintenance pertaining to site needs.

4.27 Swale

Grass swales are densely vegetated trapezoidal or triangular channels designed to slow runoff, promote infiltration, and facilitate sedimentation while limiting erosion.

Relevant SOPs include bioretention facility and infiltration facility. Figure 4-24 shows the arrangement of a typical swale.

Figure 4-24. Swale

4.27.1 Swale Inspection

Swales are inspected annually and typically in coordination with other assets associated with a stormwater facility. Utility staff perform bioretention facility inspection and prepare corrective work orders for maintenance, repairs, and replacements.

Table 4-60 is a representation of the CMMS inspection checklist in Cityworks for bioretention facilities. The form is a simplification of Table V-4.5.2(8) “Maintenance Standards –Typical Biofiltration Swale” and Table V-4.5.2(9) “Maintenance Standards – Wet Biofiltration Swale”, Section 4.6, Volume V of 2014 SWMMWW, included in Appendix B.

Table 4-60. Swale Cityworks Inspection Form with Inspection General Work Method			
Criterion	**Result**	**Explanation**	**General Work Method**
Sediment	FAIL	Greater than 2 in.	Visual inspection of thickest sediment deposits within the swale.
	PASS	Less than 2 in.	
Vegetation	FAIL	Blocking free movement of water	The facility should be free of weeds such as grass, ivy, dandelions, or non-design/post-construction plantings that would reduce facility function.
	PASS	Not blocking free movement of water	
Inlet/outlet	FAIL	Clogged with debris	Visual inspection of debris blockage at inlet/outlet.
	PASS	Clear	
Grass	FAIL	Greater than 10 in. high	Visual inspection of grass height.
	PASS	Less than 10 in. high	
Poor vegetation coverage	FAIL	Bare patches greater than 10% of swale bottom	Visual estimate of grass coverage of swale bottom.
	PASS	Bare patches less than 10% of swale bottom	
Erosion	FAIL	Bank, channel erosion present	Visual inspection of channelization in swale bottom.
	PASS	Bank, channel erosion absent	
Contamination	FAIL	Oil/gas/other pollution present	Visual inspection of oily sheen on soil or vegetation sources or by smell of petroleum products or organic compounds (e.g., paint thinner or acetone). Visual inspection of discolored or soapy water.
	PASS	Oil/gas/other pollution absent	
Flow spreader	FAIL	Not intact	Visual inspection of connection of flow spreader to swale.
	PASS	Intact	
Weir	FAIL	Not intact	Check pass or fail if swale has weir. If the weir would not cause water to pond behind it and slow water down, it is considered not intact.
	PASS	Intact	
Trash and debris	FAIL	Present	Visual inspection of debris accumulation within swale.
	PASS	Absent	
Cannot locate	FAIL	Cannot locate	Visual inspection for locating relative to map/GIS representation and identifier.
	PASS	Can locate	
Other	FAIL	Other, comment	"Other, comment" means any condition that requires attention to remain or be returned to operation.
	PASS	None	

4.27.2 Swale Maintenance

Table 4-61 provides summary information for swale maintenance.

Table 4-61. Swale Maintenance Summary	
Element	**Description**
Maintenance interval	Swales shall be maintained monthly during the growing season (March–September).
Maintenance timing	Perform corrective maintenance within 1 year of inspection. Typical corrective maintenance includes, soil replacement, plant replacement, and underdrain flushing.
Maintenance timing	Routine maintenance varies with the growing season and occurs as frequently as monthly. Several maintenance activities are especially prone to cause soil compaction. Avoid compacting soil during maintenance activities. Typical routine maintenance for Utility staff includes removing weeds, removing trash, and adding mulch.
Reactive maintenance	Maintenance efforts to address conditions such as damage from storms, car accidents, pollutant spills, or construction may require special repairs or cleanup.
Permit requirements	NPDES: Inspection must occur annually. If a swale does not meet a maintenance standard, general repairs must be made in 1 year and capital repairs in 2 years.

Table 4-62 provides a general work method for swale routine maintenance.

Table 4-62. Swale Routine Maintenance General Work Method		
Maintenance Activity	Recommended Frequency	Notes
Inspect inflow and outflow points for clogging	• Monthly and as needed during wet season	• If observed, remove sediment at surface, in pre-settling areas and at storm structure outfalls. • Remove any accumulated debris from inflow/outflow points (curb cuts, pipes, trench drains, storm structures, etc.).
Watering during first and second growing seasons	• In the first 6 weeks, plantings will require approximately 1 in. of water twice per week to establish deep roots. After watering, confirm the soil is moist 3–6 in. below surface. • Reduce watering frequency to once a week until the end of the first growing season (May–September).	• Intent of watering is to keep plant material sustained through establishment. • Monitor rainfall to determine irrigation/watering schedule. • Water regularly during the first two growing seasons. • Dry periods will need additional watering for establishing plants because of warmer temperatures and increased sunlight—both of which can stress vegetation. Wilted leaves and drooping stems are all indications of stress caused by dry soils and hot temperatures. • Optimal watering time is early in the morning or late in the evening to reduce evaporation. A preferred watering approach is to have repeated short cycles of watering and soaking into the ground. • Follow manufacturer's guidelines for O&M of irrigation system and its components.
Dry period watering for established bioretention	• Water infrequently but thoroughly: 0.5 in.–1.0 in. every 2 weeks or when plants appear stressed. • Monitor rainfall and check weather updates and adjust watering accordingly.	• Established (more than 2 years) drought-tolerant plants may need water during prolonged dry periods (possibly late July–mid-September). Inspect plantings during dry periods and look for signs of stress. • Verify if any watering restrictions are in effect in the city for watering during dry periods/water shortages. If no restrictions, then note the following: • Optimal watering time is early in the morning or late in the evening to reduce evaporation. Monitor rainfall to determine an irrigation schedule. • Do not apply water faster than the soil can absorb it. • Deeper and less frequent watering will encourage plants to develop a deep root system. • If present, inspect irrigation system components for breaks and blockages and repair as necessary.
Leaf, branch, and organic matter removal	• Inspect for organic matter or debris that are blocking inflow points or structures and causing ponding water. • Schedule frequent leaf removal in fall. • Frequent mowing may be required from spring–mid-July for turf swales. • Monthly mowing may be required July–mid-November for turf swales.	• To prevent clogging, larger pieces of biodegradable landscape debris should be mulched or collected for composting, green waste pick up, or disposal to a recycling facility. • Maintaining a minimum height of 4 in. for turf grass within bioretention facilities (turf) will reduce weed invasion and encourage deep root growth, which strengthens drought resistance. • Mow with a mulch mower when 10 in. or greater. • Sharpen mower blades frequently to reduce ragged cutting. • A thick layer of leaves, branches, and trash can prevent water and light from getting to lawn and other landscaped areas. Excessive leaf litter around plantings can provide cover for pests and allow mildew growth. Mulching organic matter (leaves) is recommended to facilitate decomposition for both turf and vegetated swales.
Trash and debris removal	• Remove trash and debris. • Inspect after large storm events (~more than 1 in. of rainfall in 24 hours or heavy downpour).	• Collect and properly dispose of trash/litter. • Pet waste is a serious concern and should not be left within a swale as it contains disease-causing organisms and flushes bacteria into the stormwater.

Table 4-62. Swale Routine Maintenance General Work Method

Maintenance Activity	Recommended Frequency	Notes
Pruning and removal of dead material	• In spring, remove dead or old plant material from previous season. • Mid-summer and fall, inspect and cut back any plant material that blocks sidewalks and utilities. • In fall, prune to maintain plant appearance.	• Trim and thin vegetation from prior season's growth, leaving 6–8 in. Allow dormant vegetation and old flower stalks to remain in winter to provide food and cover for birds. For early blooming shrubs/trees, prune in spring following bloom. • Plants may require pruning, pinching, and dead heading during the growing season to promote reflowering, direct growth, etc. • Native and/or ornamental grasses may appear dead but generally these plants are dormant during the winter months. Do not remove, prune dry material in spring as new material emerges. If appear dead in mid-summer, remove and replace.
Weed control of invasive vegetation/weeds	• Remove as soon as observed. • During 3-year establishment period, inspect at least once per month in growing season. • Inspect at least 3 times per year once plants are established.	• Pay special attention to nuisance and invasive vegetation before it establishes a foothold. Particular threats to wet areas are reed canary grass and Japanese knot weed. Other threats include clover, scotch broom, horsetail, morning glory, alder seedlings, English ivy, and blackberry. Watch for any signs of these plants and remove them, including root system. • Persistent and invasive vegetation that is located in a mass can be killed by covering the area with black plastic for several weeks during summer.
Weed control of non-invasive vegetation/weeds	• Inspect the full bed and remove weeds February, June, and September. • Minor weeding monthly. • See mulch section of this manual for more information to reduce weed establishment.	• Remove weeds manually before they go to seed by using pincer-type weeding tools, hoes, or hot water weeders. Remove the roots for best results. • Weeds should be pulled when first observed and especially before they go to seed. • Weeds need to be pulled in early spring so that the desired plants can thrive. • Mulch immediately (no more than 5 days) following weeding to improve weed control. • When dealing with invasive plant material/weeds, attempt all other physical methods to remove before considering a more aggressive method. • It is important to note that chemicals can harm or kill beneficial or desirable plants, and also add pollutants to stormwater that can negatively impact water quality.
Bare spots and vegetation removal and replacement	• Inspect for bare spots and areas of disturbed vegetation every 6 months.	• Plants may die because of unsuitable conditions or microclimates, disease, pests, or other unforeseen issues. These plants must be removed/replaced to avoid the establishment of weeds in bare areas, the spread of disease, and the reduction in functionality. • Reseed or replant bare areas and replace poor performing plants. Vegetation should cover 90% of swale. • Replace vegetation with in-kind planting material or replace plants with high mortality rate with appropriate plants. • Maintain 1 ft zone clear of vegetation around all inlets and outlets.
Mulch	• Add wood chip mulch in fall and/or spring. • Replace or add wood chip mulch as needed to maintain 2–3 in. depth.	• 1 cubic yard of mulch will cover 100 ft^2 at a depth of 3 in. 1 cubic yard = 27 ft^3. Commercial mulch products generally are available in 2 cubic foot bags. 13.5 bags = 1 cubic yard. • Wood chip mulch helps to control weeds, conserve soil moisture, improve filtration, regulate soil temperatures and adds nutrients to the soil as it decomposes.
Sediment removal	• Late fall and late spring. • After heavy downpour and rain events of 1 in. or more precipitation in 24-hour period.	• If more than 2 in. accumulation, remove sediment preferably when the swale is dry. • Remove sediment manually, using shovels or rakes. Dispose of sediment in accordance with local requirements. • Replace damaged or destroyed vegetation with in-kind plant material.

Table 4-63 provides a general work method for swale triggered maintenance.

Table 4-63. Swale Triggered Maintenance General Work Method

Triggered Maintenance	Condition Observed	Instructions
Ponding water	• Water is standing/ponding in swale and not draining within 48 hours after the rain event has stopped. • The facility is not functioning properly due to blockage of sediment and/or debris in the soil strata, underdrain or outlet structures.	• Check observation port, if available, to determine if underdrain pipe is blocked. Remove debris. • Check surface overflow, outlet pipe, or structure to determine if blocked. Remove debris. May need suction vacuum. • The soil may also be blocked by fine sediments. Rake mulch layer aside and remove sediment from top surface layer, aerate soil, and respread mulch.
Erosion of soils and sediment loading	• 2 in. (or greater in depth) gullies/rills are present, washing out soils and mulch. • Sediment washed downstream is clogging outlets and/or rock around outlet structures.	• Remove and store any desirable vegetation (to be used for replanting) from swale. Rake and remove fine sediments from surface. Add additional soil if necessary and regrade to direct water toward low point of swale, or level out bottom surface. Replant and/or replace vegetation and reapply mulch. • If slopes have been compromised, remove vegetation (reserve for replanting), re-grade, and re-contour area by hand tools where practical. Replant vegetation and install 2–3 in. of mulch. • Clear away rocks, sediment, and reinstall rock protection at structure inlets/outlets and add more rocks if needed.
Soil settlement	• Soil has settled 2+ in. below paving surface.	• Rake mulch aside for later use. Apply prepared swale soil mix (use soil mix design per original plans if possible or see reference below for information) to bring soil height within 1–2 in. of top of pavement. Add 1–2 in. of mulch to bring top of mulch flush with adjacent paving/surface. • Replant if necessary to provide vegetative cover over exposed soil.
Pest control	• Pests have been reported to cause extensive plant damage or death and have/could become a nuisance or public health concern. • Mosquitoes can breed in shallow stagnant ponding water.	• Remove all trash, fruit, and nuts that have fallen to the ground to avoid attracting rodents. • Mosquito larvae look like "wiggling sticks" typically floating perpendicular to water's surface. Mosquitoes take 5–7 days to mature. Swales are designed to drain out within 24–48 hours after the rain event has ceased. If stagnant ponding and larvae are observed, then remove ponding. • Where rodent holes are present, fill with soil, and lightly compact soil around the holes.

4.28 Vault and Tank

Vaults and tanks are used primarily as a means of flow and sediment control. These facilities function by storing large volumes of water and metering the release of water. As water is stored, sediment suspended in the water column can settle. These facilities do not treat soluble constituents such as household chemicals and metals.

Relevant SOPs include control structure, filter, and oil/water separator. Figure 4-25 shows a typical vault/tank.

Figure 4-25. Vault/tank

4.28.1 Vault and Tank Inspection

Vault and tank inspections are performed as part of Stormwater Facility inspections; they are inspected for sediment accumulation and other maintenance deficiencies. Inspection generally includes assets such as a control structure.

Table 4-64. Vault and Tank Cityworks Inspection Form with Inspection General Work Method

Table 4-64 is a representation of the CMMS inspection checklist in Cityworks for vaults and tanks. The form is a simplification of Table V-4.5.2(3) “Maintenance Standards – Closed Detention Systems (Tanks/Vaults)” and Table V-4.5.2(12) “Maintenance Standards – Wetvaults”, Section 4.6, Volume V of 2014 SWMMWW, included in Appendix B.

Table 4-64. Vault and Tank Cityworks Inspection Form with Inspection General Work Method			
Criterion	Result	Explanation	General Work Method
Sediment	FAIL	Greater than 10% of the tank diameter for half the length of storage area, or greater than 15% at any point	Use graduated rod to estimate sediment depth, inlet/outlet pipe diameter and vault depth and diameter. Example 1: A 72 in. diameter storage tank would require cleaning when sediment reaches a depth of approximately 7 in. for more than half the length of the tank. Example 2: A
	PASS	Less than 10% of the tank diameter for half the length of storage area, and less than 15% at any point	

Table 4-64. Vault and Tank Cityworks Inspection Form with Inspection General Work Method			
Criterion	Result	Explanation	General Work Method
			72 in. storage tank would require cleaning when sediment at any point reaches a depth of approximately 11 in.
Air vents	FAIL	Blocked or bent	Visual inspection of vents for blockage or bent condition.
	PASS	Not blocked and not bent	
Grout fillet (pipe to wall)	FAIL	Cracks wider than 0.5 in. with evidence of soil particles entering the structure	Visual inspection of the connection of pipes to vault or tank wall. Visually estimate width and length or cracks with graduated rod or tape measure.
	PASS	Cracks less than 0.5 in. with no evidence of soil particles entering the structure	
Vault structure wall/bottom/ side/slab/ frame	FAIL	Cracks wider than 0.5 in. with evidence of soil particles entering the structure	Visual inspection of walls, bottom, side, slab and frame concrete, missing bricks or large cracks. If bottom is covered with sediment, flag catch basin for inspection during cleaning.
	PASS	Cracks less than 0.5 in. with no evidence of soil particles entering the structure	
Contamination	FAIL	Oil/gas/other pollution present	Visual inspection of oily sheen or by smell of contaminates such as petroleum products or organic compounds (e.g., paint thinner or acetone) within the vault/tank including on top of water or sediment, or along the interior wall. Visual inspection of discolored or soapy water.
	PASS	Oil/gas/other pollution absent	
Inlet/outlet	FAIL	Blocked	Visual inspection of inlet and outlet for blockage.
	PASS	Clear	
Trash and debris	FAIL	Present	Visual inspection for trash and debris within the vault or tank.
	PASS	Absent	
Cannot locate	FAIL	Cannot locate	Visual inspection for locating relative to map/GIS representation and identifier.
	PASS	Can locate	
Grate/cover	FAIL	Unable to open, missing, and/or broken	Inspector opens grate/cover to perform inspection.
	PASS	Able to open, present, and intact	
Other	FAIL	Other, comment	“Other, comment” means any condition that requires attention to remain or be returned to operation.
	PASS	None	

4.28.2 Vault and Tank Maintenance

Table 4-65 provides summary information for maintenance of vaults and tanks.

Table 4-65. Vault and Tank Maintenance Summary	
Element	**Description**
Maintenance type	Vault and tank maintenance is done during dry months to avoid washing of sediment-laden water downstream and ease the work process. Routine work is scheduled for the driest periods to optimize sediment removal and minimize possible water quality impacts. If there is work done during wet periods, water must be routed around the vault while the work is completed. If a significant rain event is predicted, the work must be postponed.
Maintenance timing	The primary means of maintenance is sediment removal. At junctures between tank and outfall structures there may be grouting repairs.
Reactive maintenance	Large CMPs may rust and need to be patched or replaced. Large tanks with structural repairs can be drained and repaired as needed.
Permit requirements	Facilities must be inspected annually and after a 10-year rain event. When an inspection identifies an exceedance of the maintenance standard, maintenance shall be performed within 1 year for typical maintenance and within 2 years for maintenance that requires capital construction of less than $25,000.
Exceptions and outliers	Cleaning of a large vault can be expensive and time consuming. The cleaning interval may be decades apart. If a cleaning is to occur, then a thorough inspection should be conducted at the same time, bringing the entire structure up to full function.

Table 4-66 provides a general work method for the maintenance of vaults and tanks.

Table 4-66. Vault and Tank Cleaning General Work Method

Activity Component	Activity Details and Description
Desired result	Storm vaults are cleaned and free of debris by vacuuming.

Resources	• Crew: 2-person crew
	• Material: Water
	• Equipment:
	  • 1 vactor truck
	  • PPE (gloves, hardhat, safety glasses, rain gear, rubber boots, hearing protection)
	  • Laptop, charger, and cleaning sheets
	• Contractor/vendor costs:
	• Debris: decant spoils
	• City-approved decant location

General work method	1. Place traffic control signs and safety devices as required at job site 2. Use proper PPE 3. Apply all confined space equipment 4. Crew members work together to position equipment, remove vault lid, and insert vacuum tube to clean sediment out of vault 5. Inspect for illicit discharge or connection (SMC 13.10.320); if illicit discharge observed, initiate a water quality service request for IDDE investigation 6. Crew cleans all areas within structure so that base of manhole is exposed; vacuum debris from tank/vault, and clean all surfaces, walls, brick, concrete, inlets, and outfalls 7. Inspect condition of inlet, outfall, and brick/concrete structure 8. Fill vault with water to operating level of vault 9. Replace and secure lid to avoid noise from traffic driving over it 10. Clean up job site, tools, and truck 11. Remove traffic control signs and safety devices as required at job site 12. Decant vactor truck in decant spoils bay 13. Make notes about any further work that is needed 14. Accurately report in Cityworks

Section 5

Other Surface Water Utility Responsibilities

This section provides information regarding other stormwater operations.

5.1 Commercial/Private Facility Inspections

The City's Commercial/Private Facility Inspections fall under element S.5.C.5, Municipal Operations and Maintenance of the NPDES Phase II Western Washington Municipal Stormwater Permit (Permit). The City of Shoreline currently inspects almost 300 private storm water facilities. The Permit requires that "inspections must be conducted annually unless there is sufficient data to justify a different frequency." The annual inspection schedule of a facility may be changed to a lesser frequency "based on maintenance records of double the length of time of the proposed inspection frequency." Based on an analysis conducted by the City, SWM staff currently inspects a total of 190 facility inspections conducted in even years and 187 facility inspections in odd years.

Currently, the City's Commercial/Private Facility Inspection program is based on compliance/enforcement through covenants and the City's Code for illicit discharges (SMC 13.10.320-13.10.340, SMC 20.30.720-790). See the Commercial/Private Facility Inspection Procedures in Appendix K for Cityworks work flow.

5.2 Easements and Covenants

The following section summarizes easements and covenants.

5.2.1 Easements

An easement is a portion of land for which the use has been granted to the public, corporation or person for a specific purpose. Easements related to the Utility are generally granted at the time of private property development. The easement recording documents dictate the responsibilities of the City and property owner and contain language describing access, conveyance, and maintenance of stormwater assets contained within the property boundary and subsequent easement. Because each easement is unique, it is recommended the City staff do the following prior to accessing an easement:

- Read the easement language to verify that all special restrictions and requirements are understood prior to proceeding with access or maintenance activities.
- Even if notification is not required, it is good practice to attempt to contact the property owner or tenant prior to exercising any easement rights.

In situations where no easement is available, complete a private access permission form contained in Appendix L.

5.2.2 Covenants

Covenant is a legal document between the city and persons holding title to the property requiring the title holder to perform required maintenance and repairs on drainage facilities necessary to meet the city's specified standards within a reasonable time limit. Covenants is a development requirement in the Surface Water Code and EDM for private property development where stormwater assets are installed and must be maintained and includes a provision for City inspection.

Covenants are generally used to instruct a property owner of their obligations to maintain stormwater assets constructed as part of development for the property and as described in their associated maintenance manuals. The utility can use covenants to enforce the maintenance obligation to the property owner.

An example of a covenant is provided in Appendix M.

5.3 Hot Spot Inspections

The Utility performs hot spot inspections during the rainy season for facilities and locations that demonstrate flooding threat to private property, critical infrastructure, or the environment. These facilities include all of the City-operated pump stations, high-hazard dams, and areas prone to preventable flooding (clearing of basins, etc.). See Appendix N for the current list of surface water hot spots. Table 5-1 shows the current inspection frequency based on season and storm.

Table 5-1. Seasonal and Storm Triggered Hotspot Inspection Frequencies

Season	Frequency	Storm Type
Summer	Monthly	Major storms
Mid-October–late February	Weekly	Moderate and major storms
Spring	Monthly	Major storms

Hot spots include sites such as high-hazard dams or pump stations will not be removed from the hot spot list for the foreseeable future. These sites require a physical site visit to confirm function of the facility and to ensure any maintenance is conducted. However, other sites that may be removed from regular inspection may be taken off the list after improvements have been made and the risk has demonstrably lessened.

General Guidelines for Initiating Hot Spots Inspections. During the rainy season (approximately October-February) the weather must be monitored closely to best judge when to conduct hot spot inspections. The following general guidelines can be used to determine when to conduct inspections.

- If an off season storm event is forecasted, hot spots should be checked prior to the event.
- During the transition from summer to fall, hots spots should be checked before we receive any significant rain.
- If approximately two inches of rain has fallen since the last inspections, inspect hot spots before the next forecast rainfall.
- If it is approaching the end of the work week and two inches of rain has not fallen since the last hot spot inspections, but we are expecting to accumulate the two inch threshold over the weekend, inspect hot spots prior to the beginning of the weekend.
- If we receive significant snowfall during the winter, inspect hot spots prior to and after the snowmelt.
- If high winds have occurred, inspect hot spots.

Procedure for Adding a Hot Spot. If we are alerted to or observe areas that continually experience flooding or standing water and have the potential to cause property damage or present a safety issue, we may opt to temporarily or permanently add the area to the hot spot list. The following criteria will be considered when determining whether to add a new hot spot to the list.

- Identify the location of drainage issue
- Determine if there is stormwater infrastructure in the area
- Identify the cause of the issue or blockage
- Determine if it is an infrastructure blockage/clogging or capacity issue
- Determine if the issue can be resolved with routine maintenance
- New critical infrastructure is constructed (e.g. pump station or dam)

5.4 Illicit Discharge Detection and Elimination

Illicit Discharge Detection and Elimination (IDDE) investigations are a response to water quality service requests. Water quality service requests are generated from hotline calls as well as routine ROW, regional, residential, and commercial/private facility inspections. The investigation is a part of the Utility's ongoing IDDE program designed to prevent, detect, characterize, trace, and eliminate illicit connections and discharges into the City's stormwater drainage system.

Figure 5-1. Illicit discharge of wet concrete in manhole

5.4.1 IDDE Inspection and Investigation

IDDE inspection and investigation forms are initiated and completed as part of a Cityworks illicit discharge investigation work order. An inspection form is completed for each asset in which the illicit discharge is detected. Table 5-2 provides details regarding the Cityworks inspection checklist for IDDE.

Table 5-2. IDDE Cityworks Inspection Form with Inspection General Work Method

Criterion	Result
Pollutant present	Yes
	No

Table 5-3 shows how the IDDE Cityworks *Work Order Investigative Form*, which is accessed electronically, might appear in hard copy format. Typically, one investigative form is completed for each incident.

Table 5-3. IDDE Cityworks Work Order Investigation Form		
Investigation Question	**Selection**	
1. How was incident discovered? (*User chooses)*	☐ Business ☐ ERTS ☐ Field investigation (explain) __________ __________ ☐ Interconnected MS4 referral ☐ Multiple (explain) __________ __________	☐ O&M Inspection ☐ Other (explain) __________ __________ ☐ Other agency ☐ Other public ☐ Pollution hotline ☐ Staff referral
2. Explanation of how discovered/learned (*User enters explanation)*		
3. Source tracing method *(User chooses)*	☐ Dye testing ☐ Multiple (explain) __________ __________ ☐ Other (explain) __________ __________	☐ Smell/odor ☐ Smoke testing ☐ TV'ing line ☐ Visual ID ☐ Water testing (explain) __________ __________
4. Explain tracing method *(User enters explanation)*		
5. Materials identified *(User chooses)*	☐ Construction waste ☐ Dumping/ trash ☐ Food waste/oil ☐ Industrial waster ☐ Multiple (explain) __________ __________ ☐ Natural source ☐ None found	☐ Other (explain) __________ __________ __________ ☐ Paint ☐ Pet waste ☐ Sediment/soil ☐ Sewage/septage ☐ soap/detergent ☐ Vehicle fluids ☐ Yard clippings
6. Explain materials identified (*User enters explanation)*		

Table 5-3. IDDE Cityworks Work Order Investigation Form

Investigation Question	Selection			
7. Property type of source? (*User chooses*)	☐ Commercial – Drive-thru ☐ Commercial – Mobile business ☐ Commercial – Other ☐ Commercial – Restaurant ☐ Commercial – Retail ☐ Construction ☐ Industrial ☐ Multi-family ☐ Multiple (explain) ____________ ____________	☐ Other (explain) ____________ ____________ ☐ Public Entity ☐ Residential ☐ Source not identified ☐ Vehicle		
8. Explanation of material source (*User enters explanation*)				
9. Corrective/elimination methods? (*User chooses*)	☐ Administrative action- legal notice ☐ Administrative action – penalty or fine ☐ Education/technical assistance ☐ Multiple (explain) ____________ ____________ ☐ No action needed (explain) ____________ ____________	☐ Other (explain) ____________ ____________ ☐ Problem not abated (explain) ____________ ____________ ☐ Source control BMP ☐ Verbal notice ☐ Written warning		
10. Explanation of correction and elimination *(User enters explanation)*				
11. Discharged continued threat? *(User chooses)*	☐ No		☐ Yes-G3/ERTS notifications	
12. Investigated with 7 days	☐ No	☐ No – document delay	☐ Referred	☐ Yes
13. Referred to: (*User enters referral*)				
14. Illicit connection discovered?	☐ NA	☐ No	☐ Yes	
15. Date connection discovered *(User enters date)*				
16. Investigated connection in 21 days?	☐ NA	☐ No	☐ Yes	
17. Final resolution (*User enters final resolution)*				

5.5 Pest and Animal Control

Shoreline has diverse animal fauna that from time to time may generate complaints from residents. The Utility does not act to control animals unless they pose a risk to life, public safety, or the integrity of public infrastructure.

In a life-threatening animal related emergency, call 9-1-1. For all other animal control related issues, contact the Regional Animal Services of King County at 206-296-7387. To the greatest extent possible, the Utility lets nature run its course within the built environment. Several examples are given below.

5.5.1 Animal Holes

When animal holes are discovered on the face of any dam, the animals are removed as appropriate to avoid risks to dam structural integrity and subsequent risks to life and public safety.

5.5.2 Beaver Management

Beavers damming up sections of Boeing Creek cause capacity issues at the outfall of Hidden Lake and threaten public infrastructure. This procedure is to define appropriate response to reports of beavers causing problems.

The presence of beavers is generally regarded as a sign of a healthy natural environment. However, there are occasions where allowing the population of beavers to grow and build dams could cause a threat to infrastructure, listed salmon, and/or public safety. When beaver-related issues arise, the following procedures are to be followed.

Criteria for Utility Response. The criteria for Utility response include:

- Existing or potential culvert blockage, and roadway or structure flooding.
- Significant migration blockage of Chinook salmon or other listed species to spawning habitat.
- A significant migration blockage is defined as the presence of migratory fish below the dam and not above because of the dam acting as a barrier to upstream navigation. Typically, these dams are greater than 3 to 4 feet high and have no side channels during high flow.

Note: Fish passage blockages associated with beaver activity usually occur where the natural stream channel is constrained and limited in width, and flows through a very low-gradient and wide-floodplain area with no side channels formed around the dam.

Criteria for Problem Identification. When a call or a report of a beaver dam is received, the following steps actions are to be taken:

- Identify location of problem and property address if available.
- If a dam is present, document the location.
- Determine if structures or roadways are at risk of flooding, and if those locations are public or privately owned.
- Determine if Chinook or other listed species migration routes are potentially being blocked.
- Determine if the public is in danger of falling trees from beaver damage close to trails, buildings, or roads.
- Determine the potential for damage from falling trees. If tree damage has occurred, identify the tree owner and attempt to notify of the situation. Share information with the owner appropriate for protecting trees (i.e., using wire mesh around the trunk).

When a beaver dam is on private property and only affecting the private property, information and advice should be shared with the property owner to assist with the permit acquisition process and inform the property owner of other information and considerations that they should be aware of, such as fish passage, potential flooding, etc.

5.5.3 Wasps, Hornets, and Bees

When wasps, hornets, or bees are located within a ditch or other stormwater facility, action may be taken if they are threatening residents or if the ditch or other facility is scheduled for have maintenance.

5.5.4 Nuisance Wildlife Control

Beavers, coyotes, moles, mountain beavers, opossums, raccoons, waterfowl, and other species can be destructive to stormwater facilities, park lands, and natural areas when their activities are excessive. Generally, interference with wildlife is undesirable. If control of wildlife is deemed necessary, the City will work with the state agency (Department of Wildlife) to formulate a control solution.

Examples of past wildlife incidents for which City action was not required include:

- Otter is eating ducklings at Echo Lake: no risk to life, safety, or infrastructure.
- Raccoon or cat goes into pipe inlet and resident requests their removal or installing a trash rack: no risk to life, safety, or infrastructure. Animals generally vacate after a rain event.
- Beaver damming up section of McAleer Creek but impoundment is on private property and there is no risk of flooding to a living space: no risk to life, safety, or infrastructure.

5.5.5 Mosquito Control

For Mosquito Control, the City has adopted the most recent Best Management Practices for Mosquito Control developed by Ecology, and has an Aquatic Mosquito Control General Permit that allows for the management of mosquitos in the City stormwater facilities and within the City's ROW (Ecology 2004, 2015). All mosquito management activities must comply with the requirements of the current version of the Aquatic Mosquito Control General Permit, Phase II Permit, and State Waste Discharge General Permit issued by Ecology.

The City has developed an Integrated Mosquito Management Plan to guide staff on implementing BMPs to control adult mosquitos and how to document and report mosquito control implementation, see Appendix O.

5.6 Ronald Bog

Ronald Bog is a pond and wetland area at the headwaters of Thornton Creek. The Utility monitors the water level of the pond at the pond outlet pipe as part of its one flood warning system called the Ronald Bog Early Warning system located at Ronald Bog (adjacent to 2304 N 172nd Street). The system automatically updates a City website (City 2017) The website includes information related to the current bog level, alert activation, reverse 911, and flooding elevation. The flood warning system utilizes a pressure transducer system to correlate water elevations, which are triggered by predetermined status levels. If the monitor is triggered, the flood warning system begins automatically calling City staff until it receives confirmation and the alarm is turned off.

5.6.1 Ronald Bog Inspection

Key assets related to the flood warning system are monitored weekly as a hot spot inspection location from October to February—and periodically during dry months—including the drain pipe outlet, pump, and associated manholes and catch basins. Additional assets such as pipes, manholes, and catch basins are inspected annually as part of the regional inspection program for the larger Ronald Bog drainage area. Specific assets to be inspected or monitored for the hot spot and annual regional inspection are included in the respective work order forms.

5.6.2 Ronald Bog Emergency Flooding Plan

The following is an emergency plan for Ronald Bog during a large storm event. This section contains information on bog elevation, the early warning system, reverse 911, and the street pump system. Figure 5-2 shows the elevations of the monitoring system.

The Ronald Bog monitoring station can be viewed at the City website,

http://www.shorelinewa.gov/government/departments/public-works/surface-water-utility/services/ronald-bog-early-warning

or by calling 206.364.1868 and following these steps :

- Press 1 to hear the bog elevation
- Press 2 to hear the battery voltage

Normal levels are less than 365 feet with the alarm calling out at 365.1+ feet.

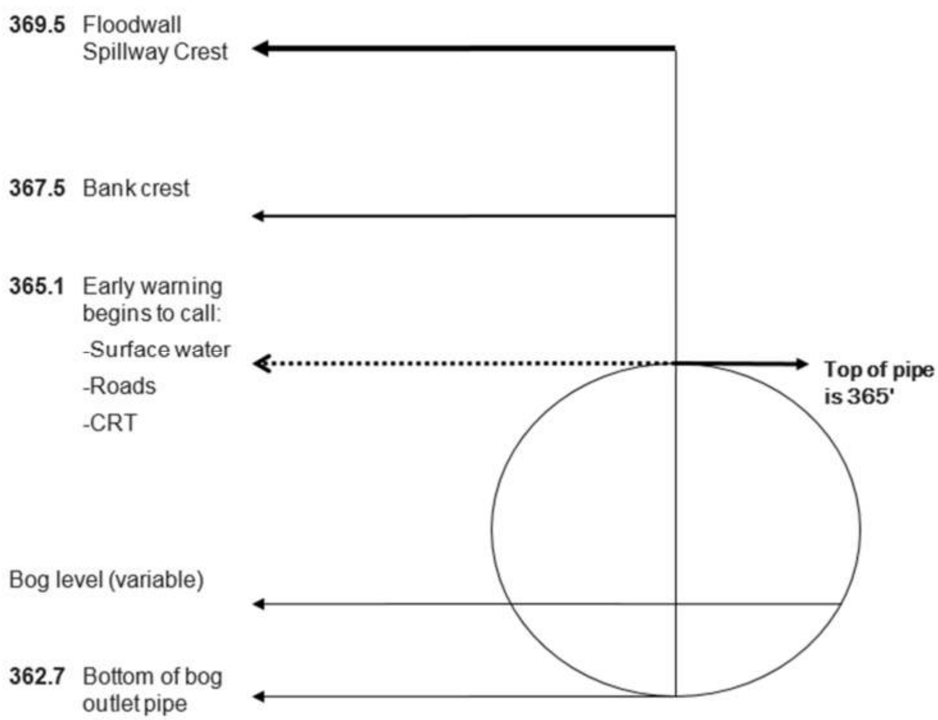


Figure 5-2. Ronald Bog key monitoring system elevations

What to Do if Bog Calls You:

- Follow the directions to hear the alert and water level:
  - Turn off alarm
  - Alert staff to monitor Bog

- You have 9-10 hours before the Bog may crest the floodwall spillway during high rainfall rates [Based on inflow rates analyzed from the December 3-4, 2007 rain event, it would take approximately 9-10 hours for the Bog level to crest the floodwall spillway. This calculation takes into account the highest observed flowrates from that storm over a 9-10 hour period]
- Activate Reverse 911 if there is an increasing risk of overtopping and local flooding

How to activate Reverse 911. Follow the directions to activate reverse 911:

- Call the Fire Department Emergency Battalion at 206.795.3350
- Alert Fire Department of the situation
- Provide area to be called, N 171st and N 172nd on both sides of the street from Meridian Avenue N east to I-5

Hot Spot Check for the Early Warning System

- The Early Warning System has two components to check during the hotspot inspection: Water level calibration and verifying the website is updating current data.
- The water level should be checked and calibrated if necessary. The water level is checked on the staff gauge adjacent to the bog outlet. This level is compared to the monitor readings. If the observed level differs from the monitor readings, the monitor must have its offset changed to reflect its elevation. To alter the offset, open the monitor > Press Menu > Real Time Data > Public > scroll down to offset hit ENTER and reset the offset so that the bog level = 361.75 + staff reading.
- Staff verifies the website is updating with the current water level readings. If the water level needs to be adjusted on the monitor based on staff gauge observations, the website should be re-checked to confirm data is continuing to update. Below is the website address to check water levels: http://cityofshoreline.com/government/departments/public-works/surface-water-utility/ronald-bog-early-warning

Below are instruction to remotely connect to the monitor to make changes to the water level or collect the most recent data.

Connecting to the Ronald Bog Monitor

The monitor is set to automatically gather data, but if you choose to connect first hit the button on the task bar.

5.7 Severe Weather Response

Large natural events (precipitation and wind) that result in flooding or power outages must be managed in a predictable and scalable manner with known responsibilities and means of escalation to include additional City response staff.

5.7.1 Preparation

All severe weather response actions will be performed in accordance with the Shoreline Comprehensive Emergency Management Plan (CEMP) and incident command protocols. Surface Water Utility will conduct severe weather preparations when severe weather is forecasted by the National Weather Service or Weathernet which may impact public stormwater infrastructure or pose a threat to property, life, or the environment.

- Initial severe weather preparations include:
  - Surface Water and Environmental Services (SWES) staff continuously monitoring WeatherNet and National Weather Service for forecast and severe weather-related warnings

  - Perform hotspot inspections prior to storm event
  - Ensure staff coverage prior to when storm begins
  - Ensure response vehicles are equipped with necessary tools and materials to carry out severe weather response tasks
  - Ensure 800 mHz radios are fully charged and ready for staff deployment
- Severe weather response thresholds include:
  - If three storm-related service requests are received by the City within a 30-minute interval
  - National Weather Service storm-related warnings are occurring or imminent
  - Storm-related weather is threatening the function of public stormwater infrastructure or creating a hazardous condition which is affecting private property, safety, or the environment

5.7.2 Response

This section summarizes the office and field response plans in an event of a severe storm.

Office. One SWES Staff will take positions with the Customer Response Team (CRT) and act as dispatcher while assisting the CRT admin with call intake as necessary. The dispatcher will:

- Coordinate and prioritize service request calls and internal operations.
- Communicate using an 800-megahertz (MHz) radio.
- Section the city into quadrants, but may dispatch staff as needed within those sections.
- Keep the program manager informed of event developments.

Field. Field-related responses include:

- Utility staff will immediately begin checking hot spots and respond to public infrastructure-related service calls as necessary.
- Streets staff will survey ROW public infrastructure, clearing arterial roadways of any ponding or storm-related issues. Staff will also assist with CRT as needed (e.g., deliver pumps, sandbags, etc.).
- CRT staff will respond to customer-related calls. If additional staff or materials (e.g., pumps) are required, Streets Department staff may assist or replace CRT staff at the behest of the dispatcher or incident commander.

Escalation. The storm response will escalate if:

- City Hall suffers a power outage
- If it appears that public safety is threatened or significant property damage is likely
- If call takers are unable to attend all calls as they come in
- Storm-related calls are outstripping field staff availability and assistance beyond that of SWES, Roads Department, and CRT combined, or all available staff
- The forecast predicts the storm to last longer than 12 hours after SWES has begun its storm response
- Complicating factors such as wind, earthquakes, landslides, snow, etc. occur or are predicted to occur within 12 hours of SWES storm response

Prioritization. The City will prioritize service calls by priority level:

- Life and safety threats within the ROW or on City property:
  - Threats to publicly owned infrastructure

- Private property flooding from a publicly owned source (e.g., water off roadway)
- Clearing of water across arterial roadways
- Life and safety threats outside the ROW or City property
- Potential non-life threatening public property/infrastructure/environmental damage
- Potential non-life threatening private property flooding/environmental damage from a City-owned source (e.g., roadway drainage to house or private street)
- Potential non-life threatening private property flooding/environmental damage from a non-City-owned source (e.g., house to house or private street)

5.8 Spill Response

It is the City's obligation under the NPDES Phase II permit to provide spill prevention, spill response planning and training, and spill cleanup. The City therefore has a City-wide Spill Response Plan as well as a municipal stormwater pollution prevention plan (SWPPP) for both the Hamlin Maintenance Yard and the North Maintenance Facility. These plans describe the methods and procedures that City personnel will implement to reduce or eliminate the contamination of stormwater runoff or discharges of pollutants from City operations at the facilities and in the field.

Spills can be identified by various means. A City employee may encounter a spill or identify an illicit discharge while in the field. A citizen may encounter a spill and contact the City's Customer Response Team. All City employees must follow the City's Spill Response Plan (Appendix P), located on the City's website at http://www.cityofshoreline.com/government/departments/public-works/surface-water-utility/water-quality/spill-response-program.

5.9 Vegetation Control

The Utility uses a variety of tools to manage vegetation within stormwater assets. Given the variety of assets within the city, a host of service levels are employed.

- **Stormwater Facilities**. Control requires at least annual vegetation maintenance, using goats at larger sites and contractors for high LOS vegetation control.
- **Ditch**. Vegetation is controlled as needed for ditch function or as needed in preparation of maintenance. Ditch vegetation may provide water quality benefits and may not be controlled solely for aesthetic purposes.
- **Trees**. Trees within the ROW are not managed by the Utility. Within stormwater facilities, trees are maintained as needed to mitigate risks to life, public safety, and public infrastructure.

5.10 Vegetation Management

There are several types of invasive plants within the city, described below.

- **Invasive Plants/Noxious Weeds**. There are variety of non-native plants growing within the city ROW and public property. Of those non-native plant species, there are many that are invasive, but few that are classified as noxious. The City references the King County Noxious Weed Control Board and the Washington State noxious weed control law (17.10 Revised Code of Washington [RCW]). The state classifies noxious weeds into three categories: A, B, and C.
- **Class A Weeds**. Class A weeds are mostly newcomers to Washington, and are generally rare. The goal is to completely eradicate them before they gain a foothold. Landowners are required to completely eradicate Class A weeds.

- **Class B Weeds**. Class B weeds are those that are widespread in some parts of the state, but rare or absent in other parts of the state. The goal with Class B weeds is to prevent them from spreading into new areas, and to contain or reduce their population in already infested areas.
- **Class C Weeds**. Class C weeds are typically common and widespread. Rather than requiring control of these plants, most county weed boards simply offer advice to landowners about the most effective control methods. A county weed board may require landowners to control a Class C weed if it poses a threat to agriculture or natural resources.

Invasive plants are generally not acceptable within the City ROW and public property. Invasive plants should be controlled in conjunction with natural resource enhancement efforts, particularly within natural and sensitive areas.

Noxious weeds are generally not acceptable within the City ROW and public property, and should be controlled in conformance with State of Washington requirements for noxious weeds. In the event of a noxious weed being identified or brought to the attention of the City, staff should review current designation and control requirements.

The primary noxious weeds within the ROW and public property are shown in Table 5-4. These noxious weeds are primarily controlled to the point of not interfering with operations. None of the plants listed are regulated and are not required to be controlled or removed.

Table 5-4. Noxious Weeds in ROW and on Private Property

Common Name	Binomial Nomenclature	Control Method
English Ivy	Hedera helix	Physical removal and herbicide application
Japanese knotweed	Fallopia japonica	Herbicide application via injection and spraying
Reed canary grass	Phalaris arundinacea	Physical removal, smothering, and herbicide application
Scotch broom	Cytisus scoparius	Physical removal

Section 6

References

City of Shoreline (City). 2016. *Engineering Development Manual*.

Herrera and Washington Stormwater Center. 2013. *Guidance Document – Western Washington Low Impact Development (LID) Operation and Maintenance (O&M).* Prepared for Washington State Department of Ecology.

Tri-County Working Group. 2000. *Regional Road Maintenance Endangered Species Act Program Guidelines.* Part 2: Best Management Practices.

Washington State Department of Ecology (Ecology). 2004. *Best Management Practices for Mosquito Control.*

Ecology. 2014. *Stormwater Management Manual for Western Washington*.

Ecology. 2015. *Aquatic Mosquito Control General Permit*.

Woolpert. 2013. *Cityworks Supplemental Training Manual*. Prepared for the City of Shoreline Surface Water Utility as part of the Cityworks Implementation and Integration Project.

Appendix A: Cityworks Service Requests Guide (2015 User Guide - Service Request Basics.docx)

Appendix A

City Works Service Request Guide

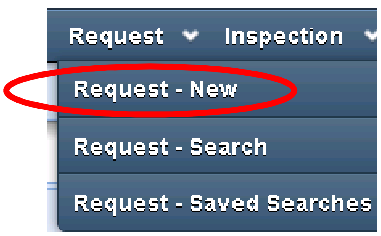
Service requests are used to track complaints/requests for services that come in from citizens, contractors, or other employees. Requests consist of a problem code, incident location, caller information, response information, and related work activities. Service request could originate from a customer calling in with a complaint, a submittal from a public web portal, or many other ways.

Section 1 Service Requests

1.1 Creating a New Service Request

1. First, ensure the map panel is open.

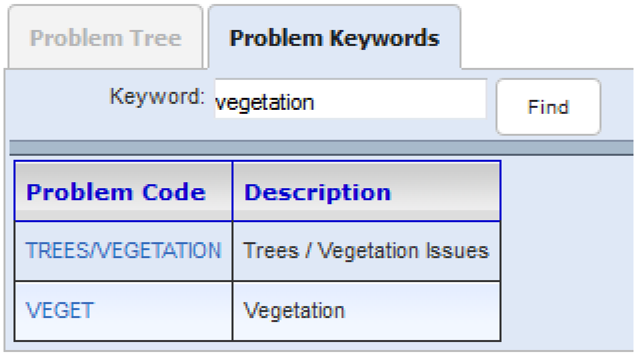
2. Navigate to the New Service Request screen by selecting the arrow next to the Request tab, and then click on **Request - New**.



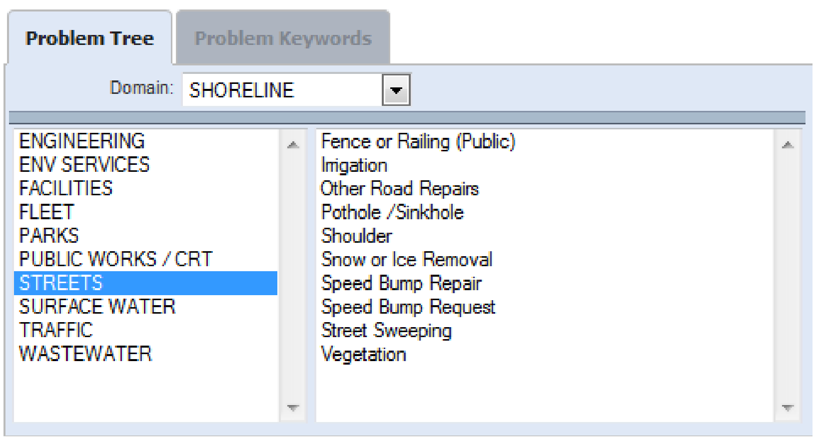
3. The first step in creating a service request is identifying the problem type. There are two ways to identify the problem type - **Problem Keyword** and **Problem Tree**. To select one of these methods, click on the pertinent tab at the top of the New Service Request Screen.

4. The first method is through the **Problem Keyword**. Type in a word and press enter or click on the Find button to search for any problem types that match this keyword.

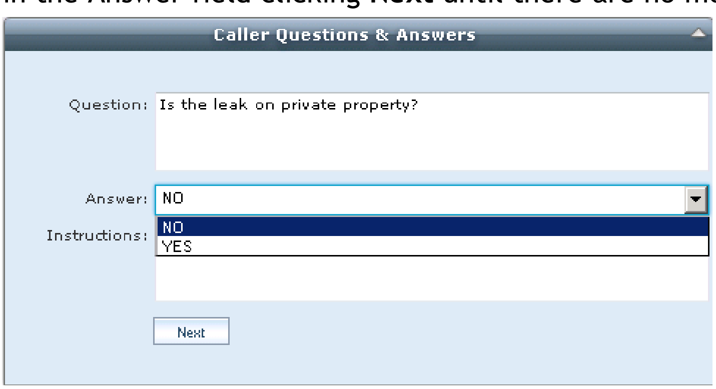
5. Any problem type that matches the keyword entered will appear in the panel. To create a service request with one of the problem types, click on the problem code.



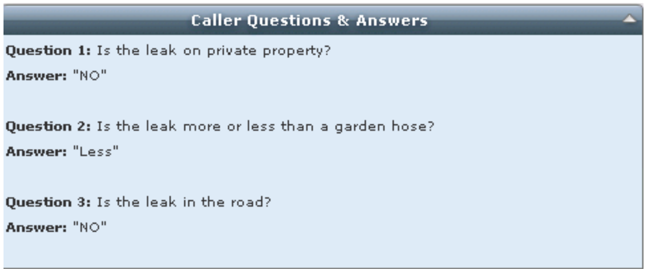
6. The second method for request type searches is through the **Problem Tree**. The left pane of the tree shows problem types grouped roughly by department, and the right pane shows problems.



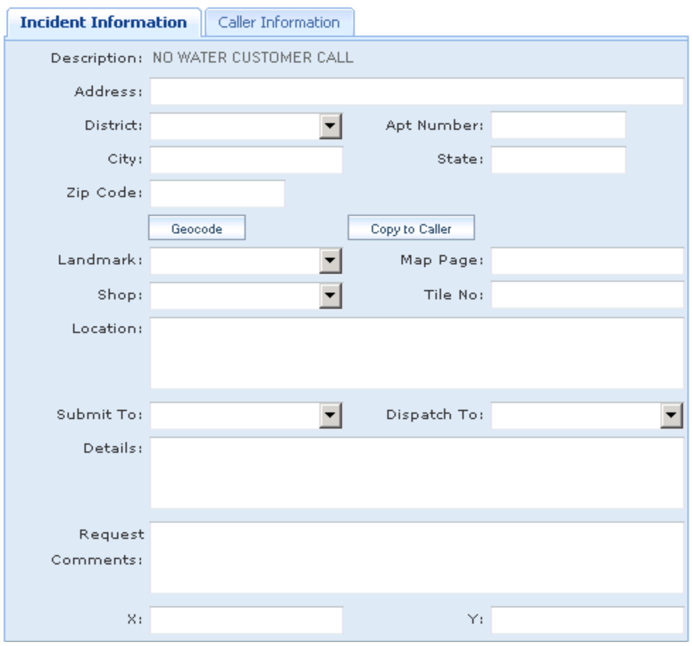
7. After the problem type has been identified, more information needs to be collected for the request. The next step in creating the request is answering predefined questions to gather more information on the request. In the **Create New Service Request** screen, scroll down to the **Caller Questions & Answers** panel and answer the questions in the Answer field clicking **Next** until there are no more answers.



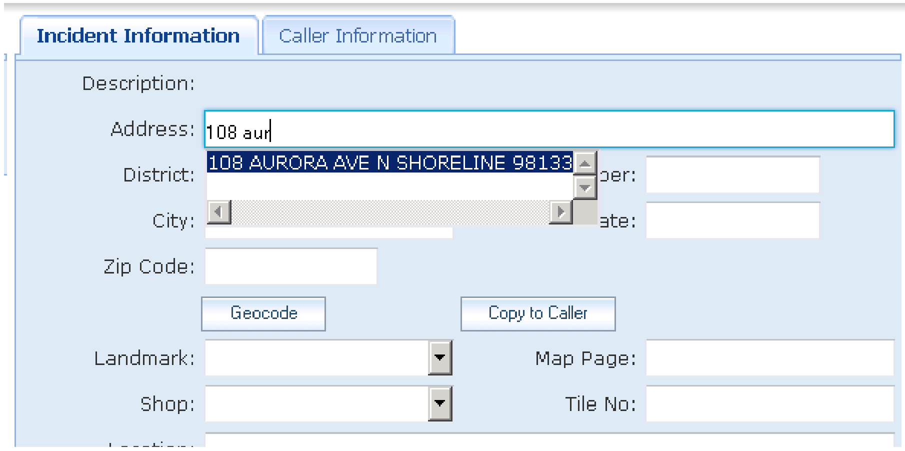
8. This helps provide valuable information for internal staff. Not all service requests will have questions and answers – this is an optional item.



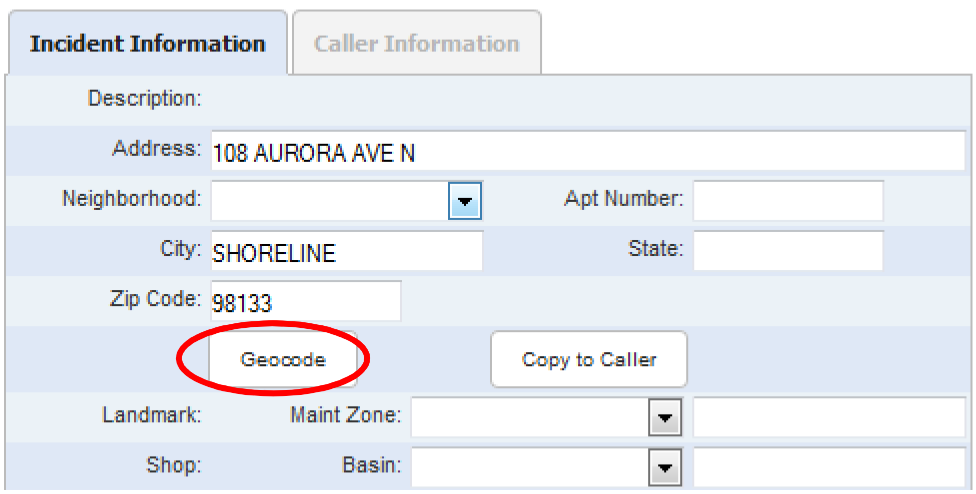
9. Once the questions and answers are completed, complete the fields in the Incident Information Tab.



10. When entering the address, type the street number, and then the first three letters of the street name (without directional notation). Once the first three letters are entered a list of possible street names will appear. Pick the street name that best matches. If none match, manually enter the address.



11. Once the address is entered, press the Geocode button to locate the address on the map.

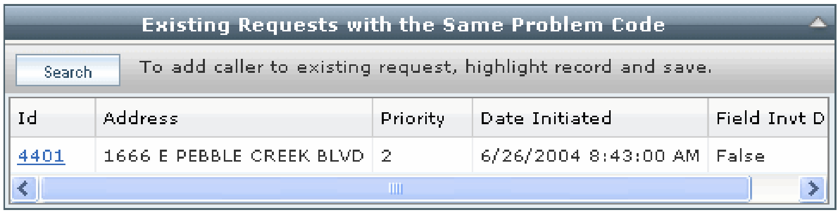


12. Once the location of the services request has been found, enter the caller's information in the **Caller Information** tab.

    If the caller address and incident address are the same, click the **Copy to Caller** button on the **Incident Information** tab to copy this information.

13. Once all the information is entered, check the **Existing Requests with the Same Problem Code** panel on the **Caller Information** tab. This provides the ability to add the new caller to an existing service request if the caller is calling in about a problem that already has a service request created for it. If the new caller can be added to an existing request, highlight the records and click **Save**.

NOTE: this search is limited to the area shown on the map, so make sure you have the map open and showing the area around the address of the problem.



14. To create the request click on the **Save** button.

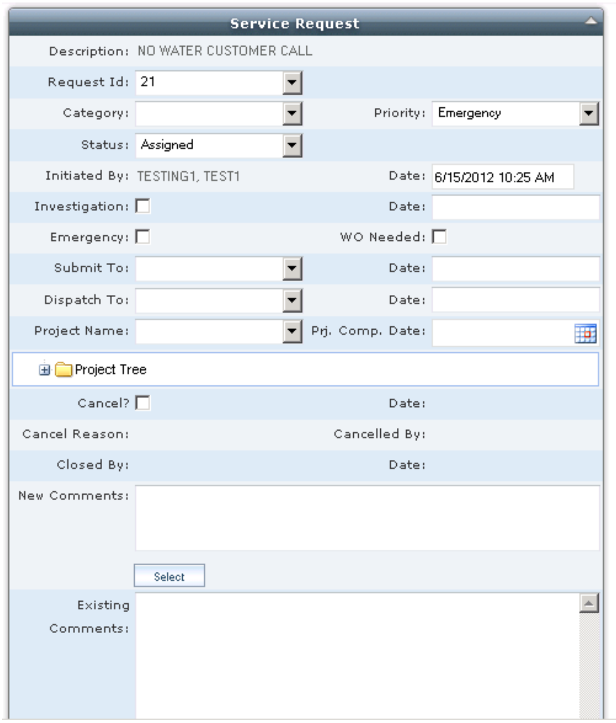
15. Once the request is saved, the Request ID is populated. This ID will never change and will only be used one time within the system.

1.2 Updating a Service Request

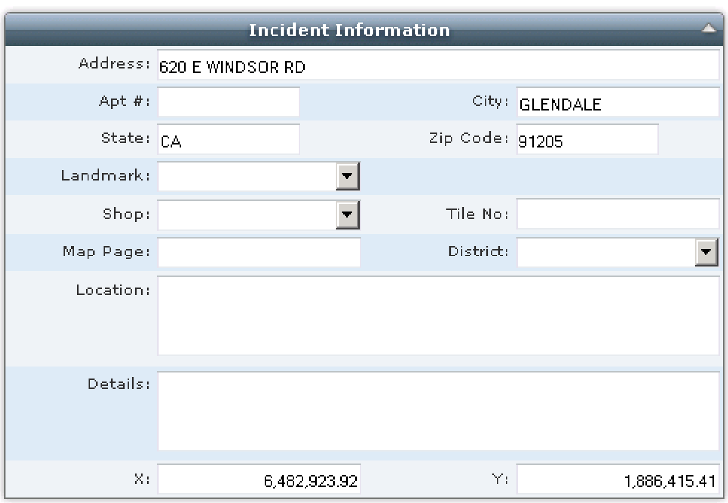
NOTE: Service Requests should be handled within 24 working hours and status changed either to Assigned, Completed, or On Hold.

1. Open a service request record.

2. Update all necessary information in the **Service Request** panel.



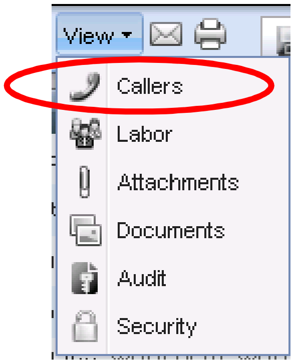
3. Update any information that needs to be updated in the Incident Information panel.



4. Once all updates are made, click the **Save** button.

1.3 Add Additional Callers

1. To add additional callers click **View** dropdown menu and then select the **Callers** button.



2. The toolbar will change once the user selects the Callers option above. The option to select **New Caller** becomes available.

3. When the user selects **New Caller**, the caller information panel becomes available as described under Caller Information, located on in the Create New Request section.

4. After the new caller information has been populated, click on the **Save** button to successfully add the caller to the request.

5. If a caller was mistakenly added, the **Delete** button can be used to the delete the caller by highlighting the caller and clicking on the delete button.

1.4 Adding Attachments to the Service Request

1. The availability of adding attachments is listed under the **View** dropdown. Click on **Attachments** in the View dropdown to open the attachments page.

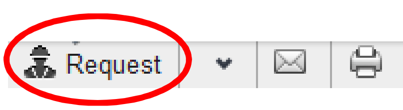
2. Click on the **Browse** button.

3. Search for the document(s) the need to be added to the request.

4. Add comments to identify what the attachment is.

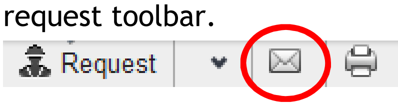
5. Click the **Upload** button.

6. To return back to the request screen, click on the **Request** button in the request menu.



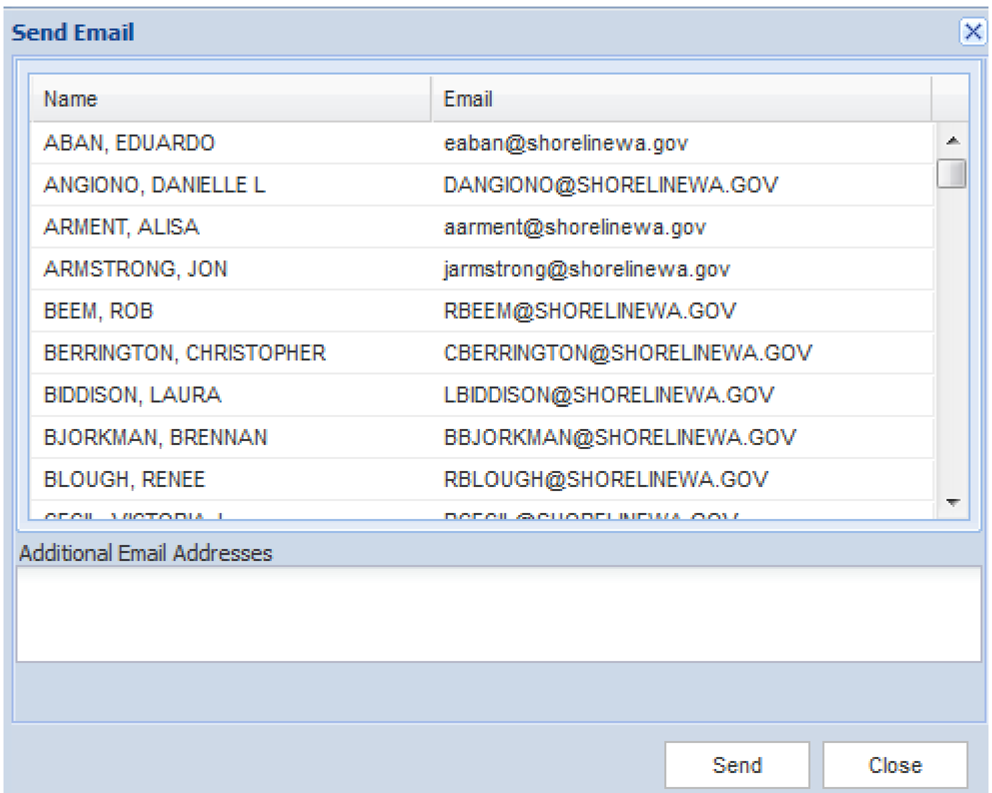
1.5 Manually Email a Service Request

1. To manually email a service request, click on the envelope button in the service request toolbar.



2. Select one or more of the employees from the list to email and click on the **Send** button.

3. Alternatively, if an outside email is required, type the email in **the Additional Email Addresses** field and click **Send**.

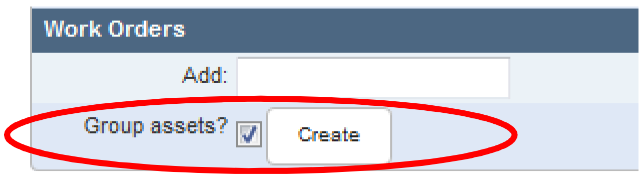


1.6 Create a Work Order from the Service Request

1. If a work order needs to be created to complete the request, the work order should be created from the request screen so that the request and work order are linked together.

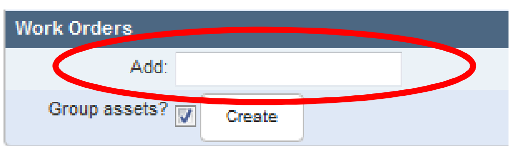
2. Before creating the work order, select an asset from the map that the work order will be created against.

3. With the asset selected through the map or GIS Search, click the **Create Work Order** button from the service request's **Related Work Activities** panel.

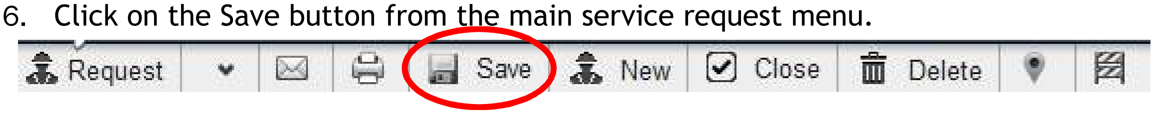


4. Follow the steps from the *Work Order and Inspection Guide* to finish creating the work order.

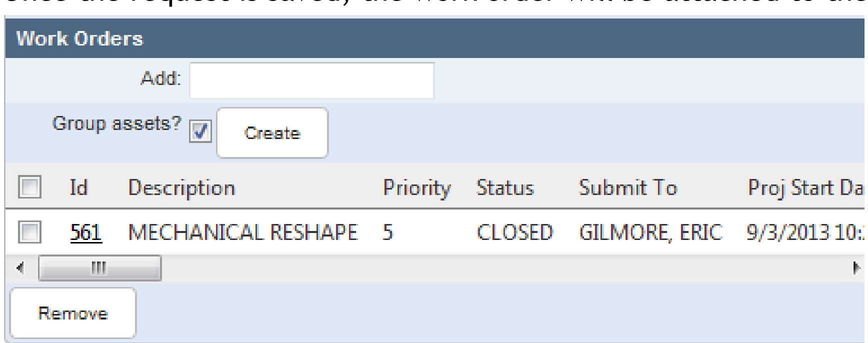
5. If a work order has already been created, but was not properly attached to the service request, it can be attached. In the request's Related Work Activities panel, enter the work order id in the **Add** field.



6. Click on the Save button from the main service request menu.



7. Once the request is saved, the work order will be attached to the request.



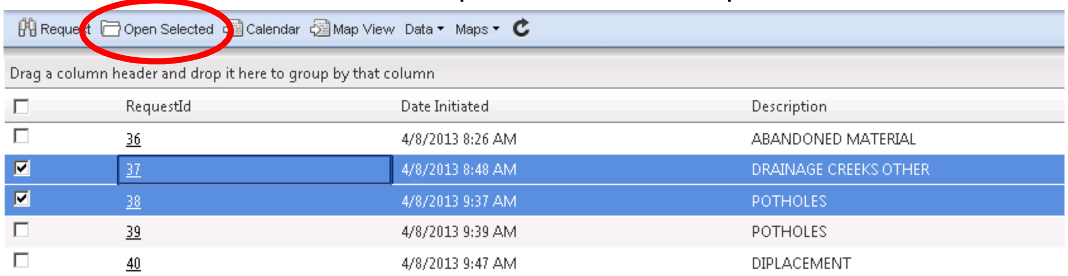
NOTE: When a work order is attached to a service request, the request will be closed when the work order is closed.

1.7 Updating Multiple Records

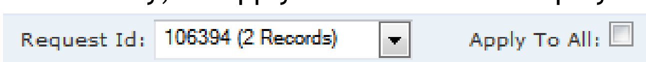
Some scenarios require that multiple requests be updated with the same information. It is more convenient to perform this action with a batch update.

1. Perform a search and select multiple records that need to be updated by placing a check box next to the Request ID. If you can't figure out how to search, instructions are below.

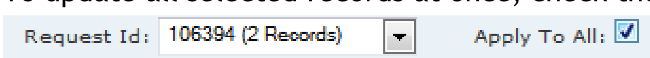
2. Use the Open Selected button to open the selected requests into the same form.



3. In the request screen, the Request ID field should identify how many records are open. Additionally, an Apply To All checkbox displays.



4. To update all selected records at once, check the **Apply To All** checkbox.



5. Update the fields that need to be updated, and click the **Save** button.

NOTE: Requests cannot be closed in a batch mode.

1.8 Closing a Service Request

Requests that do not require a work order will need to be closed once there is a resolution. Closing the service request completes the requests and no more changes can be made. Follow these steps to close a service request.

1. In the request, ensure that all required fields are completed. Fields that are required are highlighted pink with red text.

2. Add any final comments, and click the Close button to close the service request.

Section 2 Searching Service Requests

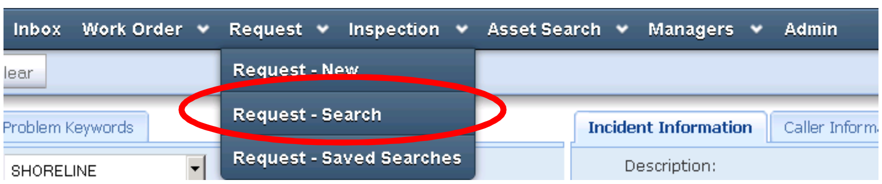
Within a service request, information is gathered and recorded within the main database. Therefore, the information that is captured within the request may be searched for a later time.

2.1 Quick Search Tool

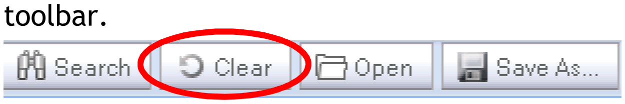
If you know the Service Request ID you are searching for, in the top right of the screen there is a search tool. Type the following as an example SR:21 (e.g. 's', 'r', or 'sr' for service requests) and hit the enter button. This will locate the service request quickly without having to open the service request search screen.

2.2 Service Request Search

1. To navigate to the request search screen, click the dropdown arrow next to the **Service Request** tab and click on **Search Requests**.

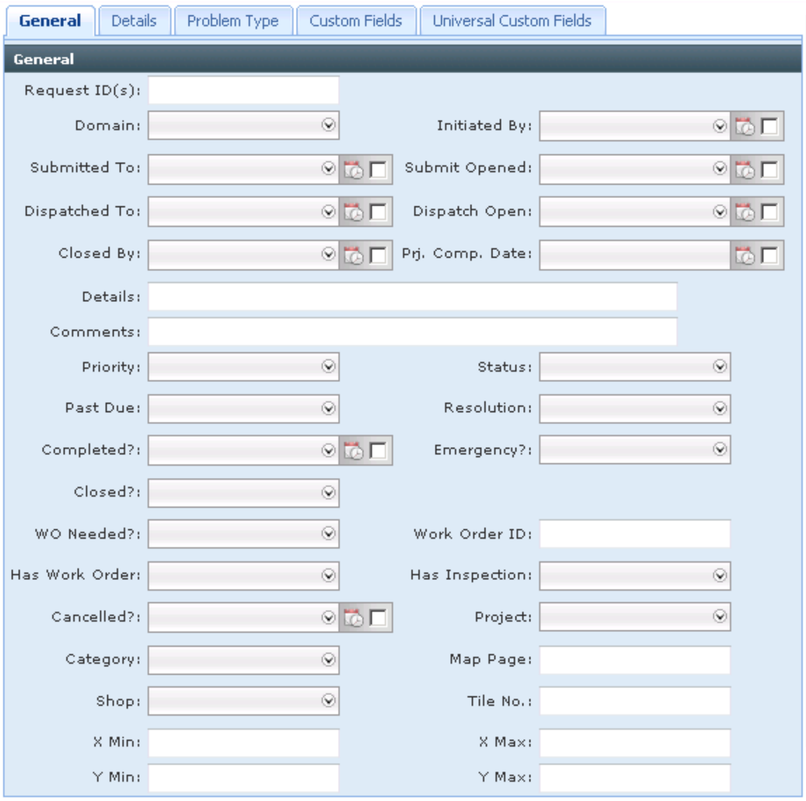


2. Before beginning any search, clear the screen by clicking on the **Clear** button on the toolbar.

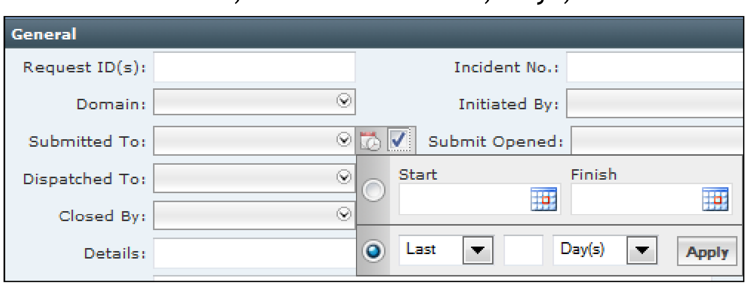


3. The General Tab includes items that are directly related to the service request. If the **Request ID** is known, type the number into the **Request ID** field. Enter at least one search parameter and click the **Search** button to initiate a search and list the results.

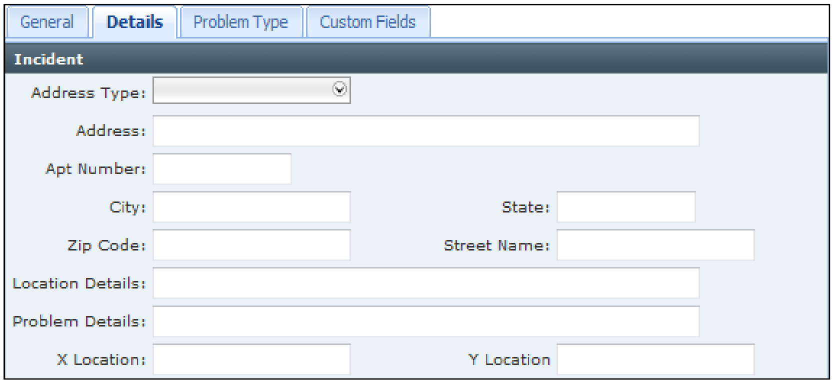
4. Use dropdowns to select pick list items like Submit To, Category, and Status.



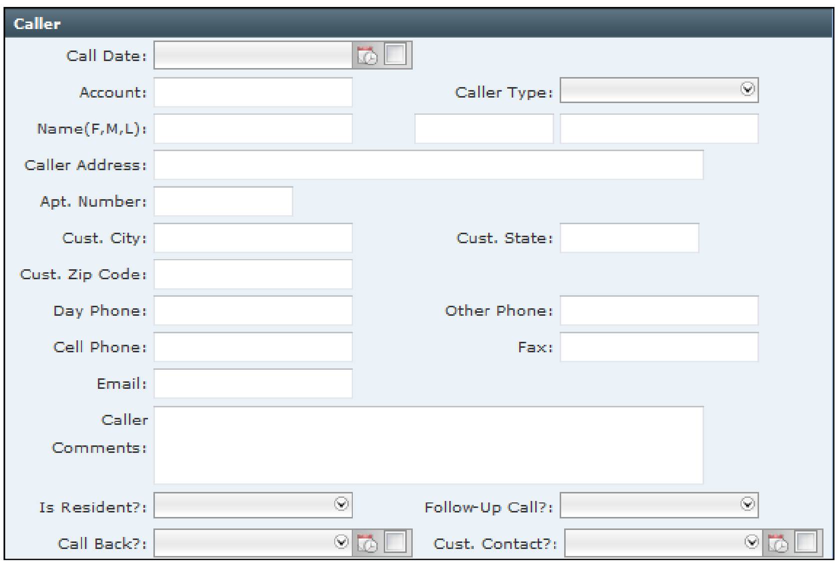
5. On the General tab, enter From/To dates by checking the checkbox as shown below. Once the box has been checked the options are presented to either select a start and finish date range using the calendar or by selecting the option for Last and the user can fill in the number, then select Hours, Days, Weeks or Months.



6. The Details tab consists of the Incident information, Caller and the Other System Information grids.
   a. Incident information:

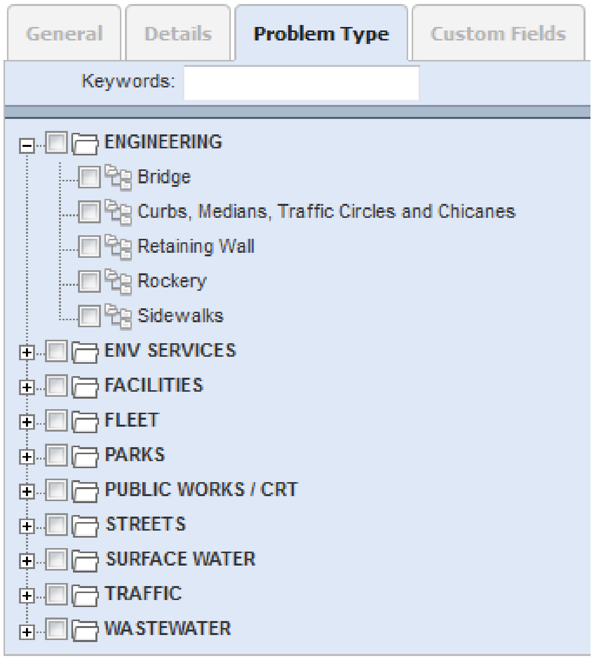


   b. Caller information:

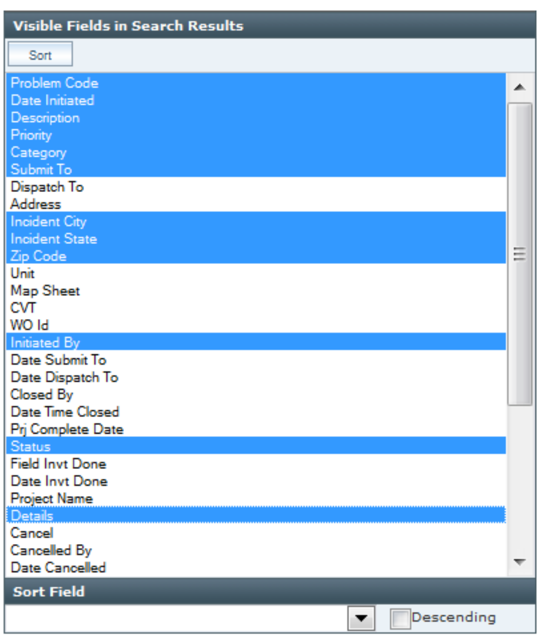


NOTE: Fields in these panels can be searched on by entering text values into them. Wild card searches can be performed by using the % symbol. For example, in one of the address fields, the name of the street could be entered between wild cards (%Main%) and all requests on that street would be returned.

7. A user can select the Problem Type tab whereby the checkbox shown next to the folder, sub-folder and/or service request type. If a high-level folder or sub-folder is chosen then the items listed under that folder will all be selected as well. See the example below.



8. In order to update the results list that is presented after the user enters the search criteria and clicks on the search button, the user must highlight the fields they wish to show in the search. Click on each field and use the control button to select more fields to show in the results list.



9. Once all the parameters are set for the search, click the **Search** button to perform the search.

2.3 Search Results

1. Once the search is run, the results of the search are displayed in the search results screen. Data can be sorted by clicking field headers. To open a record, click on the Request ID link in the results list.

	RequestId	Date Initiated	Description	Priority
☐	8	3/18/2013 11:18 AM	BEES	3
☐	9	3/18/2013 12:52 PM	POTHOLES	3
☐	10	3/18/2013 1:26 PM	DEAD ANIMAL	3
☐	11	3/18/2013 1:27 PM	PARK GRAFFITI	3

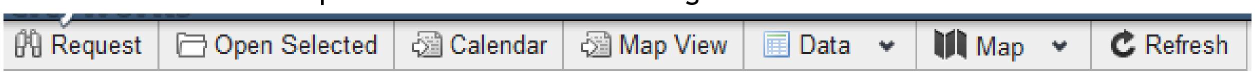
2. Grouping can be performed in the search results screen by dragging a field header to the gray area above the field headers.

Drag a column header and drop it here to group by that column

☐	RequestId	Date Initiated
☐	8	3/18/2013 11:18 AM
☐	9	3/18/2013 12:52 PM

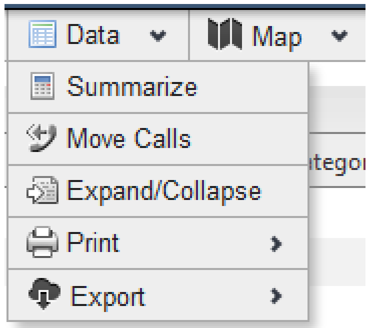
3. To ungroup, drag the grouped header back down to the row of field headings.

4. The result list screen is presented with the following search tools:

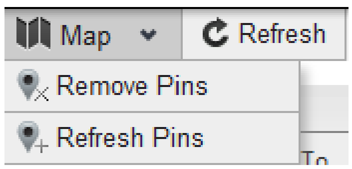


- **Request** – This button will bring the user back to the search criteria screen to either make modifications or to clear the screen and select a new search criteria.
- **Open Selected** – Within the results list screen, a user can select service requests by highlighting the requests they would like to review (use the control button to select more than one record at a time). Clicking the **Open Selected** button will open all selected records. This can be used to update more than one record at a time.
- **Calendar** – Displays the search results list within a Calendar view. This information is more clearly defined in the section called Calendar.
- **Map View** – Views the results in a map view.

- **Data** – Dropdown menu that provides users with numerous methods to view data (i.e. printing or exporting).



- **Map** – Dropdown list that allows users to remove or refresh pins shown in the search results.



NOTE: The map must be open in order for the user to utilize this function.

- **Refresh Button** – Refreshes the search results.

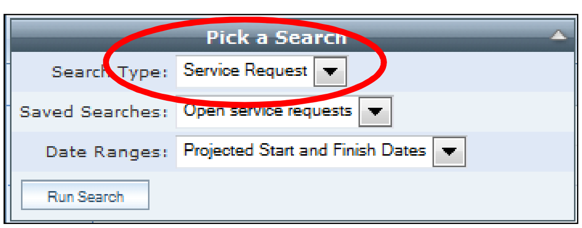
2.4 Search Results - Calendar

1. The Calendar button takes the results list grid format and populates a calendar to view the search criteria.

2. Request records can be "rescheduled" by dragging and dropping records to a new day.

3. If the search criteria originally used needs to be modified, or the user would like to see another search in the calendar view, they can click on **Change Search** from the toolbar.

4. The **Pick a Search** pop up box is displayed. These menus configure what is displayed on the calendar:

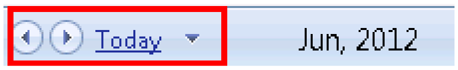


- **Search Type -** Select from Service Requests, Workorders or Inspections.
- **Saved Searches** – Saved searches for the selected search type.
- **Date Ranges** – Configure whether projected start and finish dates or actual start and finish dates.

5. After the information from the Pick a Search box is updated, click on the **Run Search** button and the new criteria is added to the calendar.

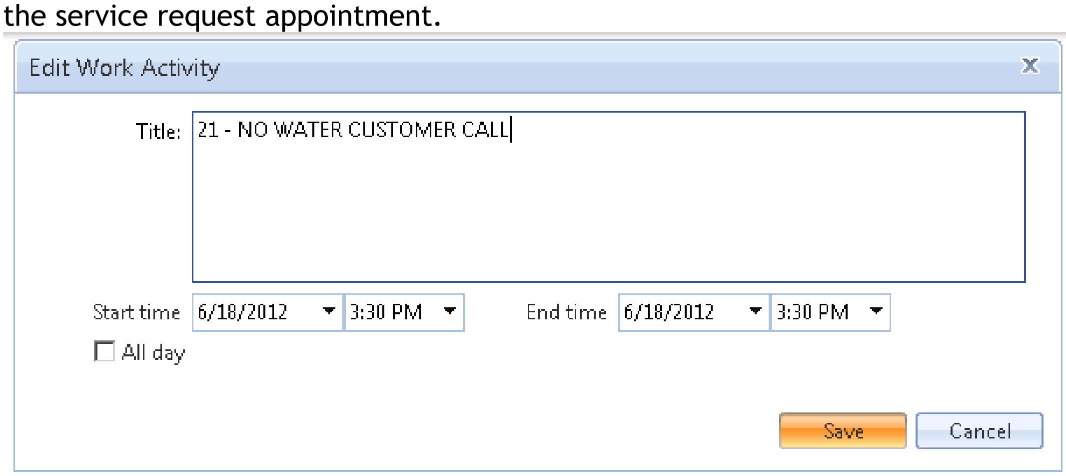
6. Located on the right-hand side of the calendar is the option to see the calendar display in Day, Week, Month or in a Timeline. Just click on the type of display preferred and the calendar will modify its display.

7. Located on the left-hand side of the calendar is the option to move months with the arrow keys



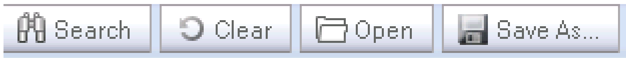
8. The today link will move the calendar to the day range the current day falls within. The dropdown calendar button next to the today link is used to select a date to move the calendar to the date range that dates falls within.

9. Service requests can be opened from the calendar by double clicking on the request and the Edit Work Activity screen is displayed. Date ranges can be updated to move the service request appointment.

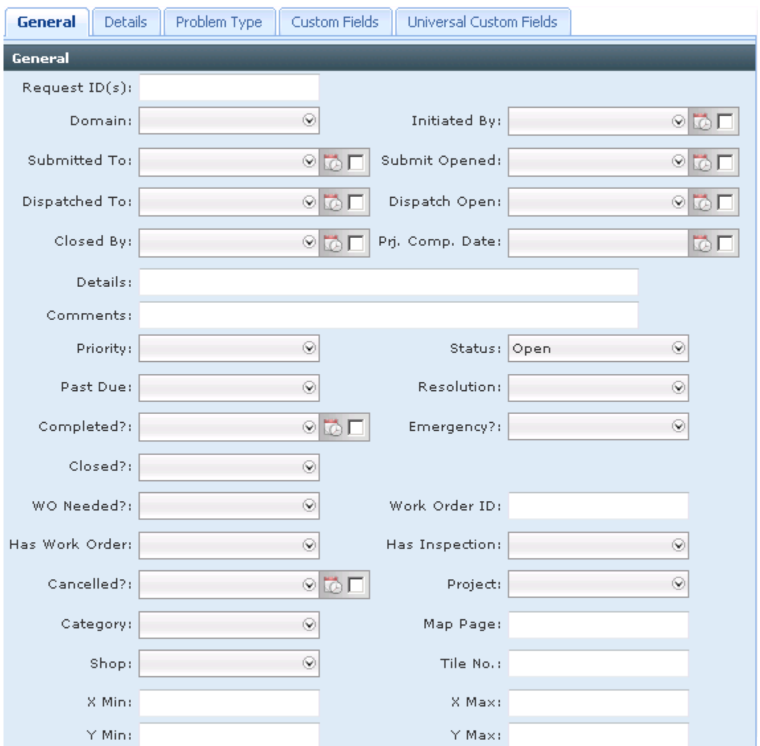


2.5 Saving Searches

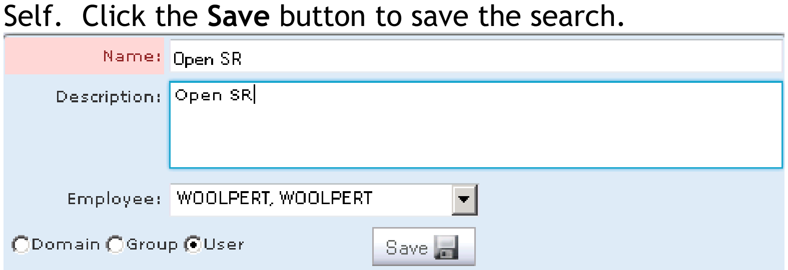
1. When a search is used often, search criteria from the Request Search screen can be saved to be run at a later time or added to a user's Inbox. The search toolbar consists of the Search, Clear, Open and Save As buttons as shown below.



2. In the following example, search parameters have been setup to search for open service requests. To save the search, click the **Save As** button.



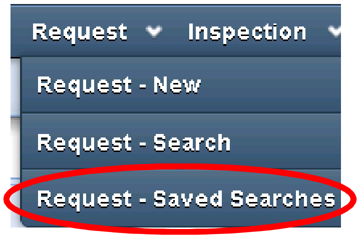
3. In the Save As screen, provide the search a Name and Description. Select the radio button for the search to be available to all in the Domain, all in the same Group, or Self. Click the **Save** button to save the search.



NOTE: Only Administrators should save searches to the Domain.

2.6 Opening Saved Searches

1. Using the Request menu, click on Request- Saved Searches.



2. A list of saved searches will appear.

Select Search

View In Grid | Delete Selected

☐	Name	Description	Date Created	Created By	Shared By	Edit	Type	Map	Service
☐	WWC Service Requests Open		4/1/2013 8:49 AM	NANCE, RALPH E	Group	Edit	Request	Map	Service
☐	WD ALL OPEN SERVICE ORDERS		4/1/2013 8:00 AM	EVANS, NOAH M	Group	Edit	Request	Map	Service

3. Select the search to open from the list and click on the **View in Grid** button. Searches can be updated before performing the search by selecting the edit button on the far right. The user can also delete the selected saved search if it is no longer needed.

NOTE: If the Shared By column displays "Domain" or "Group", DO NOT delete the search. Consult the person listed under "Created By" before deleting anything.

4. The search results list is now shown.

Drag a column header and drop it here to group by that column

☐	RequestId	Date Initiated	Description
☐	24	3/25/2013 1:18 PM	SERVICE LEAKS
☐	25	3/25/2013 1:19 PM	SERVICE LEAKS
☐	26	3/25/2013 2:07 PM	WATER METER LEAKS
☐	50	4/17/2013 2:41 PM	WATER MAIN LEAKS
☐	67	5/15/2013 2:39 PM	WATER MAIN LEAKS
☐	73	5/21/2013 8:26 AM	TURN ON/OFFS (Springbrook)
☐	74	5/21/2013 8:30 AM	HYDRANT KNOCKDOWN

Appendix B: 2014 SWMMWW Tables

Highlighted items in SWMMWW Table of Contents
are assets included in O&M Manual

V-4.6 Maintenance Standards for Drainage Facilities

The facility-specific maintenance standards contained in this section are intended to be conditions for determining if maintenance actions are required as identified through inspection. They are not intended to be measures of the facility's required condition at all times between inspections. In other words, exceedence of these conditions at any time between inspections and/or maintenance does not automatically constitute a violation of these standards. However, based upon inspection observations, the inspection and maintenance schedules shall be adjusted to minimize the length of time that a facility is in a condition that requires a maintenance action.

Table V-4.5.2(1) Maintenance Standards - Detention Ponds

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
General	Trash & Debris	Any trash and debris which exceed 1 cubic feet per 1,000 square feet. In general, there should be no visual evidence of dumping. If less than threshold all trash and debris will be removed as part of next scheduled maintenance.	Trash and debris cleared from site
	Poisonous Vegetation and noxious weeds	Any poisonous or nuisance vegetation which may constitute a hazard to maintenance personnel or the public. Any evidence of noxious weeds as defined by State or local regulations. (Apply requirements of adopted IPM policies for the use of herbicides).	No danger of poisonous vegetation where maintenance personnel or the public might normally be. (Coordinate with local health department) Complete eradication of noxious weeds may not be possible. Compliance with State or local eradication policies required
	Contaminants	Any evidence of oil,	No contaminants or pol-

Table V-4.5.2(1) Maintenance Standards - Detention Ponds (continued)

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
	and Pollution	gasoline, contaminants or other pollutants (Coordinate removal/cleanup with local water quality response agency).	lutants present.
	Rodent Holes	Any evidence of rodent holes if facility is acting as a dam or berm, or any evidence of water piping through dam or berm via rodent holes.	Rodents destroyed and dam or berm repaired. (Coordinate with local health department; coordinate with Ecology Dam Safety Office if pond exceeds 10 acre-feet.)
	Beaver Dams	Dam results in change or function of the facility.	Facility is returned to design function. (Coordinate trapping of beavers and removal of dams with appropriate permitting agencies)
	Insects	When insects such as wasps and hornets interfere with maintenance activities.	Insects destroyed or removed from site. Apply insecticides in compliance with adopted IPM policies
	Tree Growth and Hazard Trees	Tree growth does not allow maintenance access or interferes with maintenance activity (i.e., slope mowing, silt removal, vactoring, or equipment movements). If trees are not interfering with access or maintenance, do not remove	Trees do not hinder maintenance activities. Harvested trees should be recycled into mulch or other beneficial uses (e.g., alders for firewood). Remove hazard Trees

Table V-4.5.2(1) Maintenance Standards - Detention Ponds (continued)

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
		If dead, diseased, or dying trees are identified (Use a certified Arborist to determine health of tree or removal requirements)	
Side Slopes of Pond	Erosion	Eroded damage over 2 inches deep where cause of damage is still present or where there is potential for continued erosion. Any erosion observed on a compacted berm embankment.	Slopes should be stabilized using appropriate erosion control measure (s); e.g.,rock reinforcement, planting of grass, compaction. If erosion is occurring on compacted berms a licensed civil engineer should be consulted to resolve source of erosion.
Storage Area	Sediment	Accumulated sediment that exceeds 10% of the designed pond depth unless otherwise specified or affects inletting or outletting condition of the facility.	Sediment cleaned out to designed pond shape and depth; pond reseeded if necessary to control erosion.
	Liner (if Applicable)	Liner is visible and has more than three 1/4-inch holes in it.	Liner repaired or replaced. Liner is fully covered.
Ponds Berms (Dikes)	Settlements	Any part of berm which has settled 4 inches lower than the design elevation If settlement is apparent, measure berm to determine amount of settlement	Dike is built back to the design elevation.

Table V-4.5.2(1) Maintenance Standards - Detention Ponds (continued)

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
		Settling can be an indication of more severe problems with the berm or outlet works. A licensed civil engineer should be consulted to determine the source of the settlement.	
	Piping	Discernable water flow through pond berm. Ongoing erosion with potential for erosion to continue. (Recommend a Goethechnical engineer be called in to inspect and evaluate condition and recommend repair of condition.	Piping eliminated. Erosion potential resolved.
Emergency Overflow/ Spillway and Berms over 4 feet in height	Tree Growth	Tree growth on emergency spillways creates blockage problems and may cause failure of the berm due to uncontrolled overtopping. Tree growth on berms over 4 feet in height may lead to piping through the berm which could lead to failure of the berm.	Trees should be removed. If root system is small (base less than 4 inches) the root system may be left in place. Otherwise the roots should be removed and the berm restored. A licensed civil engineer should be consulted for proper berm/spillway restoration.
	Piping	Discernable water flow through pond berm. Ongoing erosion with	Piping eliminated. Erosion potential resolved.

Table V-4.5.2(1) Maintenance Standards - Detention Ponds (continued)

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
		potential for erosion to continue. (Recommend a Goethechnical engineer be called in to inspect and evaluate condition and recommend repair of condition.	
Emergency Overflow/Spillway	Emergency Overflow/Spillway	Only one layer of rock exists above native soil in area five square feet or larger, or any exposure of native soil at the top of out flow path of spillway. (Rip-rap on inside slopes need not be replaced.)	Rocks and pad depth are restored to design standards.
	Erosion	See "Side Slopes of Pond"	

Table V-4.5.2(2) Maintenance Standards - Infiltration

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
General	Trash & Debris	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1).
	Poisonous/Noxious Vegetation	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1).
	Contaminants and Pollution	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1).
	Rodent Holes	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1)
Storage Area	Sediment	Water ponding in infiltration pond after rainfall ceases and appropriate	Sediment is removed

Table V-4.5.2(2) Maintenance Standards - Infiltration (continued)

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
		time allowed for infiltration. Treatment basins should infiltrate Water Quality Design Storm Volume within 48 hours, and empty within 24 hours after cessation of most rain events. (A percolation test pit or test of facility indicates facility is only working at 90% of its designed capabilities. Test every 2 to 5 years. If two inches or more sediment is present, remove).	and/or facility is cleaned so that infiltration system works according to design.
Filter Bags (if applicable)	Filled with Sediment and Debris	Sediment and debris fill bag more than 1/2 full.	Filter bag is replaced or system is redesigned.
Rock Filters	Sediment and Debris	By visual inspection, little or no water flows through filter during heavy rain storms.	Gravel in rock filter is replaced.
Side Slopes of Pond	Erosion	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1).
Emergency Overflow Spillway and Berms over 4 feet in height.	Tree Growth	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1).
	Piping	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1).
Emergency Overflow Spillway	Rock Missing	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1).
	Erosion	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1).
Pre-settling Ponds and Vaults	Facility or sump filled with Sediment and/or debris	6" or designed sediment trap depth of sediment.	Sediment is removed.

Table V-4.5.2(3) Maintenance Standards - Closed Detention Systems (Tanks/Vaults)

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
Storage Area	Plugged Air Vents	One-half of the cross section of a vent is blocked at any point or the vent is damaged.	Vents open and functioning.
	Debris and Sediment	Accumulated sediment depth exceeds 10% of the diameter of the storage area for 1/2 length of storage vault or any point depth exceeds 15% of diameter. (Example: 72-inch storage tank would require cleaning when sediment reaches depth of 7 inches for more than 1/2 length of tank.)	All sediment and debris removed from storage area.
	Joints Between Tank/Pipe Section	Any openings or voids allowing material to be transported into facility. (Will require engineering analysis to determine structural stability).	All joint between tank/pipe sections are sealed.
	Tank Pipe Bent Out of Shape	Any part of tank/pipe is bent out of shape more than 10% of its design shape. (Review required by engineer to determine structural stability).	Tank/pipe repaired or replaced to design.
	Vault Structure Includes Cracks in Wall, Bottom, Damage to Frame and/or Top Slab	Cracks wider than 1/2-inch and any evidence of soil particles entering the structure through the cracks, or maintenance/inspection personnel determines that the vault is not structurally sound. Cracks wider than 1/2-inch at the joint of any inlet/outlet pipe or any evidence of soil particles entering the vault through the walls.	Vault replaced or repaired to design specifications and is structurally sound. No cracks more than 1/4-inch wide at the joint of the inlet/outlet pipe.
Manhole	Cover Not in Place	Cover is missing or only partially in place. Any open manhole requires maintenance.	Manhole is closed.

Table V-4.5.2(3) Maintenance Standards - Closed Detention Systems (Tanks/Vaults) (continued)

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
	Locking Mechanism Not Working	Mechanism cannot be opened by one maintenance person with proper tools. Bolts into frame have less than 1/2 inch of thread (may not apply to self-locking lids).	Mechanism opens with proper tools.
	Cover Difficult to Remove	One maintenance person cannot remove lid after applying normal lifting pressure. Intent is to keep cover from sealing off access to maintenance.	Cover can be removed and reinstalled by one maintenance person.
	Ladder Rungs Unsafe	Ladder is unsafe due to missing rungs, misalignment, not securely attached to structure wall, rust, or cracks.	Ladder meets design standards. Allows maintenance person safe access.
Catch Basins	See "Catch Basins" (No. 5)	See "Catch Basins" (No. 5).	See "Catch Basins" (No. 5).

Table V-4.5.2(4) Maintenance Standards - Control Structure/Flow Restrictor

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Trash and Debris (Includes Sediment)	Material exceeds 25% of sump depth or 1 foot below orifice plate.	Control structure orifice is not blocked. All trash and debris removed.
	Structural Damage	Structure is not securely attached to manhole wall. Structure is not in upright position (allow up to 10% from plumb). Connections to outlet pipe	Structure securely attached to wall and outlet pipe. Structure in correct position. Connections to outlet pipe are water tight; structure repaired or replaced and works as

Table V-4.5.2(4) Maintenance Standards - Control Structure/Flow Restrictor (continued)

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
		are not watertight and show signs of rust.	designed.
		Any holes - other than designed holes - in the structure.	Structure has no holes other than designed holes.
Cleanout Gate	Damaged or Missing	Cleanout gate is not watertight or is missing.	Gate is watertight and works as designed.
		Gate cannot be moved up and down by one maintenance person.	Gate moves up and down easily and is watertight.
		Chain/rod leading to gate is missing or damaged.	Chain is in place and works as designed.
		Gate is rusted over 50% of its surface area.	Gate is repaired or replaced to meet design standards.
Orifice Plate	Damaged or Missing	Control device is not working properly due to missing, out of place, or bent orifice plate.	Plate is in place and works as designed.
	Obstructions	Any trash, debris, sediment, or vegetation blocking the plate.	Plate is free of all obstructions and works as designed.
Overflow Pipe	Obstructions	Any trash or debris blocking (or having the potential of blocking) the overflow pipe.	Pipe is free of all obstructions and works as designed.
Manhole	See "Closed Detention Systems" (No. 3).	See "Closed Detention Systems" (No. 3).	See "Closed Detention Systems" (No. 3).
Catch Basin	See "Catch Basins" (No. 5).	See "Catch Basins" (No. 5).	See "Catch Basins" (No. 5).

Table V-4.5.2(5) Maintenance Standards - Catch Basins

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is performed
General	Trash & Debris	Trash or debris which is located immediately in front of the catch basin opening or is blocking inletting capacity of the basin by more than 10%. Trash or debris (in the basin) that exceeds 60 percent of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case less than a minimum of six inches clearance from the debris surface to the invert of the lowest pipe. Trash or debris in any inlet or outlet pipe blocking more than 1/3 of its height. Dead animals or vegetation that could generate odors that could cause complaints or dangerous gases (e.g., methane).	No Trash or debris located immediately in front of catch basin or on grate opening. No trash or debris in the catch basin. Inlet and outlet pipes free of trash or debris. No dead animals or vegetation present within the catch basin.
	Sediment	Sediment (in the basin) that exceeds 60 percent of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case less than a minimum of 6 inches clearance from the sediment surface to the invert of the lowest pipe.	No sediment in the catch basin
	Structure Damage to Frame and/or Top Slab	Top slab has holes larger than 2 square inches or cracks wider than 1/4 inch. (Intent is to make sure no material is running into basin).	Top slab is free of holes and cracks. Frame is sit-

Table V-4.5.2(5) Maintenance Standards - Catch Basins (continued)

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is performed
		Frame not sitting flush on top slab, i.e., separation of more than 3/4 inch of the frame from the top slab. Frame not securely attached	ting flush on the riser rings or top slab and firmly attached.
	Fractures or Cracks in Basin Walls/ Bottom	Maintenance person judges that structure is unsound. Grout fillet has separated or cracked wider than 1/2 inch and longer than 1 foot at the joint of any inlet/outlet pipe or any evidence of soil particles entering catch basin through cracks.	Basin replaced or repaired to design standards. Pipe is regrouted and secure at basin wall.
	Settlement/ Misalignment	If failure of basin has created a safety, function, or design problem.	Basin replaced or repaired to design standards.
	Vegetation	Vegetation growing across and blocking more than 10% of the basin opening. Vegetation growing in inlet/outlet pipe joints that is more than six inches tall and less than six inches apart.	No vegetation blocking opening to basin. No vegetation or root growth present.
	Contamination and Pollution	See "Detention Ponds" (No. 1).	No pollution present.
Catch Basin Cover	Cover Not in Place	Cover is missing or only partially in place. Any open catch basin requires maintenance.	Catch basin cover is closed
	Locking Mechanism Not	Mechanism cannot be opened by one maintenance person with proper tools. Bolts into	Mechanism opens with

Table V-4.5.2(5) Maintenance Standards - Catch Basins (continued)

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is performed
	Working	frame have less than 1/2 inch of thread.	proper tools.
	Cover Difficult to Remove	One maintenance person cannot remove lid after applying normal lifting pressure. (Intent is keep cover from sealing off access to maintenance.)	Cover can be removed by one maintenance person.
Ladder	Ladder Rungs Unsafe	Ladder is unsafe due to missing rungs, not securely attached to basin wall, misalignment, rust, cracks, or sharp edges.	Ladder meets design standards and allows maintenance person safe access.
Metal Grates (If Applicable)	Grate opening Unsafe	Grate with opening wider than 7/8 inch.	Grate opening meets design standards.
	Trash and Debris	Trash and debris that is blocking more than 20% of grate surface inletting capacity.	Grate free of trash and debris.
	Damaged or Missing.	Grate missing or broken member(s) of the grate.	Grate is in place and meets design standards.

Table V-4.5.2(6) Maintenance Standards - Debris Barriers (e.g., Trash Racks)

Maintenance Components	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Trash and Debris	Trash or debris that is plugging more than 20% of the openings in the barrier.	Barrier cleared to design flow capacity.
Metal	Damaged/ Missing	Bars are bent out of shape more than 3 inches.	Bars in place with no bends more than 3/4

Table V-4.5.2(6) Maintenance Standards - Debris Barriers (e.g., Trash Racks) (continued)

Maintenance Com-ponents	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
			inch.
	Bars.	Bars are missing or entire barrier missing.	Bars in place according to design.
		Bars are loose and rust is causing 50% deterioration to any part of barrier.	Barrier replaced or repaired to design standards.
	Inlet/Outlet Pipe	Debris barrier missing or not attached to pipe	Barrier firmly attached to pipe

Table V-4.5.2(7) Maintenance Standards - Energy Dissipaters

Maintenance Components	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
External:			
Rock Pad	Missing or Moved Rock	Only one layer of rock exists above native soil in area five square feet or larger, or any exposure of native soil.	Rock pad replaced to design standards.
	Erosion	Soil erosion in or adjacent to rock pad.	Rock pad replaced to design standards.
Dispersion Trench	Pipe Plugged with Sediment	Accumulated sediment that exceeds 20% of the design depth.	Pipe cleaned/flushed so that it matches design.
	Not Discharging Water Properly	Visual evidence of water discharging at concentrated points along trench (normal condition is a "sheet flow" of water along trench). Intent is to prevent erosion damage.	Trench redesigned or rebuilt to standards.
	Perforations Plugged.	Over 1/2 of perforations in pipe are plugged with debris and sediment.	Perforated pipe cleaned or replaced.

Table V-4.5.2(7) Maintenance Standards - Energy Dissipaters (continued)

Maintenance Components	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
	Water Flows Out Top of "Distributor" Catch Basin.	Maintenance person observes or receives credible report of water flowing out during any storm less than the design storm or its causing or appears likely to cause damage.	Facility rebuilt or redesigned to standards.
	Receiving Area Over-Saturated	Water in receiving area is causing or has potential of causing landslide problems.	No danger of landslides.
Internal:			
Manhole/Chamber	Worn or Damaged Post, Baffles, Side of Chamber	Structure dissipating flow deteriorates to 1/2 of original size or any concentrated worn spot exceeding one square foot which would make structure unsound.	Structure replaced to design standards.
	Other Defects	See "Catch Basins" (No. 5).	See "Catch Basins" (No. 5).

Table V-4.5.2(8) Maintenance Standards - Typical Biofiltration Swale

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Recommended Maintenance to Correct Problem
General	Sediment Accumulation on Grass	Sediment depth exceeds 2 inches.	Remove sediment deposits on grass treatment area of the bio-swale. When finished, swale should be level from side to side and drain freely toward outlet. There should be no areas of standing water once inflow has ceased.
	Standing Water	When water stands in the swale between storms and does not drain freely.	Any of the following may apply: remove sediment or trash blockages, improve grade from head to foot of swale, remove clogged check dams, add underdrains or convert to a wet

Table V-4.5.2(8) Maintenance Standards - Typical Biofiltration Swale (continued)

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Recommended Maintenance to Correct Problem
			biofiltration swale.

Table V-4.5.2(8) Maintenance Standards - Typical Biofiltration Swale (continued)

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Recommended Maintenance to Correct Problem
	Flow spreader	Flow spreader uneven or clogged so that flows are not uniformly distributed through entire swale width.	Level the spreader and clean so that flows are spread evenly over entire swale width.
	Constant Baseflow	When small quantities of water continually flow through the swale, even when it has been dry for weeks, and an eroded, muddy channel has formed in the swale bottom.	Add a low-flow pea-gravel drain the length of the swale or by-pass the baseflow around the swale.
	Poor Vegetation Coverage	When grass is sparse or bare or eroded patches occur in more than 10% of the swale bottom.	Determine why grass growth is poor and correct that condition. Re-plant with plugs of grass from the upper slope: plant in the swale bottom at 8-inch intervals. Or re-seed into loosened, fertile soil.
	Vegetation	When the grass becomes excessively tall (greater than 10-inches); when nuisance weeds and other vegetation starts to take over.	Mow vegetation or remove nuisance vegetation so that flow not impeded. Grass should be mowed to a height of 3 to 4 inches. Remove grass clippings.
	Excessive Shading	Grass growth is poor because sunlight does not reach swale.	If possible, trim back over-hanging limbs and remove brushy vegetation on adjacent slopes.

Table V-4.5.2(8) Maintenance Standards - Typical Biofiltration Swale (continued)

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Recommended Maintenance to Correct Problem
	Inlet/Outlet	Inlet/outlet areas clogged with sediment and/or debris.	Remove material so that there is no clogging or blockage in the inlet and outlet area.
	Trash and Debris Accumulation	Trash and debris accumulated in the bio-swale.	Remove trash and debris from bioswale.
	Erosion/Scouring	Eroded or scoured swale bottom due to flow channelization, or higher flows.	For ruts or bare areas less than 12 inches wide, repair the damaged area by filling with crushed gravel. If bare areas are large, generally greater than 12 inches wide, the swale should be re-graded and re-seeded. For smaller bare areas, overseed when bare spots are evident, or take plugs of grass from the upper slope and plant in the swale bottom at 8-inch intervals.

Table V-4.5.2(9) Maintenance Standards - Wet Biofiltration Swale

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Recommended Maintenance to Correct Problem
General	Sediment Accumulation	Sediment depth exceeds 2-inches in 10% of the swale treatment area.	Remove sediment deposits in treatment area.
	Water Depth	Water not retained to a depth of about 4 inches during the wet season.	Build up or repair outlet berm so that water is retained in the wet swale.
	Wetland Vegetation	Vegetation becomes sparse and does not provide adequate filtration, OR vegetation is crowded out	Determine cause of lack of vigor of vegetation and correct. Replant as needed. For excessive cattail growth, cut cattail shoots back and compost off-site.

Table V-4.5.2(9) Maintenance Standards - Wet Biofiltration Swale (continued)

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Recommended Maintenance to Correct Problem
		by very dense clumps of cattail, which do not allow water to flow through the clumps.	Note: normally wetland vegetation does not need to be harvested unless die-back is causing oxygen depletion in downstream waters.
	Inlet/Outlet	Inlet/outlet area clogged with sediment and/or debris.	Remove clogging or blockage in the inlet and outlet areas.
	Trash and Debris Accumulation	See "Detention Ponds" (No. 1).	Remove trash and debris from wet swale.
	Erosion/Scouring	Swale has eroded or scoured due to flow channelization, or higher flows.	Check design flows to assure swale is large enough to handle flows. By-pass excess flows or enlarge swale. Replant eroded areas with fibrous-rooted plants such as Juncus effusus (soft rush) in wet areas or snowberry (Symphoricarpos albus) in dryer areas.

Table V-4.5.2(10) Maintenance Standards - Filter Strips

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Recommended Maintenance to Correct Problem
General	Sediment Accumulation on Grass	Sediment depth exceeds 2 inches.	Remove sediment deposits, re-level so slope is even and flows pass evenly through strip.
	Vegetation	When the grass becomes excessively tall (greater than 10-inches); when nuisance weeds and other veget-	Mow grass, control nuisance vegetation, such that flow not impeded. Grass should be mowed to a height between 3-4 inches.

Table V-4.5.2(10) Maintenance Standards - Filter Strips (continued)

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Recommended Maintenance to Correct Problem
		ation starts to take over.	
	Trash and Debris Accumulation	Trash and debris accumulated on the filter strip.	Remove trash and Debris from filter.
	Erosion/Scouring	Eroded or scoured areas due to flow channelization, or higher flows.	For ruts or bare areas less than 12 inches wide, repair the damaged area by filling with crushed gravel. The grass will creep in over the rock in time. If bare areas are large, generally greater than 12 inches wide, the filter strip should be re-graded and re-seeded. For smaller bare areas, overseed when bare spots are evident.
	Flow spreader	Flow spreader uneven or clogged so that flows are not uniformly distributed through entire filter width.	Level the spreader and clean so that flows are spread evenly over entire filter width.

Table V-4.5.2(11) Maintenance Standards - Wetponds

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Water level	First cell is empty, doesn't hold water.	Line the first cell to maintain at least 4 feet of water. Although the second cell may drain, the first cell must remain full to control turbulence of the incoming flow and reduce sediment resuspension.
	Trash and Debris	Accumulation that exceeds 1 CF per	Trash and debris removed from pond.

Table V-4.5.2(11) Maintenance Standards - Wetponds (continued)

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
		1000-SF of pond area.	
	Inlet/Outlet Pipe	Inlet/Outlet pipe clogged with sediment and/or debris material.	No clogging or blockage in the inlet and outlet piping.
	Sediment Accumulation in Pond Bottom	Sediment accumulations in pond bottom that exceeds the depth of sediment zone plus 6-inches, usually in the first cell.	Sediment removed from pond bottom.
	Oil Sheen on Water	Prevalent and visible oil sheen.	Oil removed from water using oil-absorbent pads or vactor truck. Source of oil located and corrected. If chronic low levels of oil persist, plant wetland plants such as Juncus effusus (soft rush) which can uptake small concentrations of oil.
	Erosion	Erosion of the pond's side slopes and/or scouring of the pond bottom, that exceeds 6-inches, or where continued erosion is prevalent.	Slopes stabilized using proper erosion control measures and repair methods.
	Settlement of Pond Dike/Berm	Any part of these components that has settled 4-inches or lower than the design elevation, or inspector determines dike/berm is unsound.	Dike/berm is repaired to specifications.
	Internal Berm	Berm dividing cells should be level.	Berm surface is leveled so that water flows evenly over entire length of

Table V-4.5.2(11) Maintenance Standards - Wetponds (continued)

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
			berm.
	Overflow Spillway	Rock is missing and soil is exposed at top of spillway or outside slope.	Rocks replaced to specifications.

Table V-4.5.2(12) Maintenance Standards - Wetvaults

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Trash/Debris Accumulation	Trash and debris accumulated in vault, pipe or inlet/outlet (includes floatables and non-floatables).	Remove trash and debris from vault.
	Sediment Accumulation in Vault	Sediment accumulation in vault bottom exceeds the depth of the sediment zone plus 6-inches.	Remove sediment from vault.
	Damaged Pipes	Inlet/outlet piping damaged or broken and in need of repair.	Pipe repaired and/or replaced.
	Access Cover Damaged/Not Working	Cover cannot be opened or removed, especially by one person.	Pipe repaired or replaced to proper working specifications.
	Ventilation	Ventilation area blocked or plugged.	Blocking material removed or cleared from ventilation area. A specified % of the vault surface area must provide ventilation to the vault interior (see design specifications).
	Vault Structure Damage - Includes Cracks in Walls Bottom, Damage to	Maintenance/inspection personnel determine that the vault is not structurally sound. Cracks wider than 1/2-	Vault replaced or repairs made so that vault meets design specifications and is structurally sound. Vault repaired so that no cracks

Table V-4.5.2(12) Maintenance Standards - Wetvaults (continued)

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
	Frame and/or Top Slab	inch at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks.	exist wider than 1/4-inch at the joint of the inlet/outlet pipe.
	Baffles	Baffles corroding, cracking, warping and/or showing signs of failure as determined by maintenance/inspection staff.	Baffles repaired or replaced to specifications.
	Access Ladder Damage	Ladder is corroded or deteriorated, not functioning properly, not attached to structure wall, missing rungs, has cracks and/or misaligned. Confined space warning sign missing.	Ladder replaced or repaired to specifications, and is safe to use as determined by inspection personnel. Replace sign warning of confined space entry requirements. Ladder and entry notification complies with OSHA standards.

Table V-4.5.2(13) Maintenance Standards - Sand Filters (Above Ground/Open)

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
Above Ground (open sand filter)	Sediment Accumulation on top layer	Sediment depth exceeds 1/2-inch.	No sediment deposit on grass layer of sand filter that would impede permeability of the filter section.
	Trash and Debris Accumulations	Trash and debris accumulated on sand filter bed.	Trash and debris removed from sand filter bed.
	Sediment/ Debris in Clean-Outs	When the clean-outs become full or partially plugged with sediment and/or debris.	Sediment removed from clean-outs.
	Sand Filter Media	Drawdown of water through the sand filter media takes longer than 24-hours, and/or flow	Top several inches of sand are scraped. May require replacement of entire sand filter depth depending on extent of plugging

Table V-4.5.2(13) Maintenance Standards - Sand Filters (Above Ground/Open) (continued)

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
		through the overflow pipes occurs frequently.	(a sieve analysis is helpful to determine if the lower sand has too high a proportion of fine material).
	Prolonged Flows	Sand is saturated for prolonged periods of time (several weeks) and does not dry out between storms due to continuous base flow or prolonged flows from detention facilities.	Low, continuous flows are limited to a small portion of the facility by using a low wooden divider or slightly depressed sand surface.
	Short Circuiting	When flows become concentrated over one section of the sand filter rather than dispersed.	Flow and percolation of water through sand filter is uniform and dispersed across the entire filter area.
	Erosion Damage to Slopes	Erosion over 2-inches deep where cause of damage is prevalent or potential for continued erosion is evident.	Slopes stabilized using proper erosion control measures.
	Rock Pad Missing or Out of Place	Soil beneath the rock is visible.	Rock pad replaced or rebuilt to design specifications.
	Flow Spreader	Flow spreader uneven or clogged so that flows are not uniformly distributed across sand filter.	Spreader leveled and cleaned so that flows are spread evenly over sand filter.
	Damaged Pipes	Any part of the piping that is crushed or deformed more than 20% or any other failure to the piping.	Pipe repaired or replaced.

Table V-4.5.2(14) Maintenance Standards - Sand Filters (Below Ground/Enclosed)

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
Below Ground Vault.	Sediment Accumulation on Sand Media Section	Sediment depth exceeds 1/2-inch.	No sediment deposits on sand filter section that which would impede permeability of the filter section.
	Sediment Accumulation in Pre-Settling Portion of Vault	Sediment accumulation in vault bottom exceeds the depth of the sediment zone plus 6-inches.	No sediment deposits in first chamber of vault.
	Trash/Debris Accumulation	Trash and debris accumulated in vault, or pipe inlet/outlet, floatables and non-floatables.	Trash and debris removed from vault and inlet/outlet piping.
	Sediment in Drain Pipes/Cleanouts	When drain pipes, cleanouts become full with sediment and/or debris.	Sediment and debris removed.
	Short Circuiting	When seepage/flow occurs along the vault walls and corners. Sand eroding near inflow area.	Sand filter media section re-laid and compacted along perimeter of vault to form a semi-seal. Erosion protection added to dissipate force of incoming flow and curtail erosion.
	Damaged Pipes	Inlet or outlet piping damaged or broken and in need of repair.	Pipe repaired and/or replaced.
	Access Cover Damaged/Not Working	Cover cannot be opened, corrosion/deformation of cover. Maintenance person cannot remove cover using normal lifting pressure.	Cover repaired to proper working specifications or replaced.
	Ventilation	Ventilation area blocked or plugged	Blocking material removed or cleared from ventilation

Table V-4.5.2(14) Maintenance Standards - Sand Filters (Below Ground/Enclosed) (continued)

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
			area. A specified % of the vault surface area must provide ventilation to the vault interior (see design specifications).
	Vault Structure Damaged; Includes Cracks in Walls, Bottom, Damage to Frame and/or Top Slab.	Cracks wider than 1/2-inch or evidence of soil particles entering the structure through the cracks, or maintenance/inspection personnel determine that the vault is not structurally sound. Cracks wider than 1/2-inch at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks.	Vault replaced or repairs made so that vault meets design specifications and is structurally sound. Vault repaired so that no cracks exist wider than 1/4-inch at the joint of the inlet/outlet pipe.
	Baffles/Internal walls	Baffles or walls corroding, cracking, warping and/or showing signs of failure as determined by maintenance/inspection person.	Baffles repaired or replaced to specifications.
	Access Ladder Damaged	Ladder is corroded or deteriorated, not functioning properly, not securely attached to structure wall, missing rungs, cracks, and misaligned.	Ladder replaced or repaired to specifications, and is safe to use as determined by inspection personnel.

Table V-4.5.2(15) Maintenance Standards - Manufactured Media Filters

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
Below Ground Vault	Sediment Accu-	Sediment depth exceeds 0.25-inches.	No sediment depos-

Table V-4.5.2(15) Maintenance Standards - Manufactured Media Filters (continued)

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
	mulation on Media.		its which would impede permeability of the compost media.
	Sediment Accumulation in Vault	Sediment depth exceeds 6-inches in first chamber.	No sediment deposits in vault bottom of first chamber.
	Trash/Debris Accumulation	Trash and debris accumulated on compost filter bed.	Trash and debris removed from the compost filter bed.
	Sediment in Drain Pipes/Clean-Outs	When drain pipes, clean-outs, become full with sediment and/or debris.	Sediment and debris removed.
	Damaged Pipes	Any part of the pipes that are crushed or damaged due to corrosion and/or settlement.	Pipe repaired and/or replaced.
	Access Cover Damaged/Not Working	Cover cannot be opened; one person cannot open the cover using normal lifting pressure, corrosion/deformation of cover.	Cover repaired to proper working specifications or replaced.
	Vault Structure Includes Cracks in Wall, Bottom, Damage to Frame and/or Top Slab	Cracks wider than 1/2-inch or evidence of soil particles entering the structure through the cracks, or maintenance/inspection personnel determine that the vault is not structurally sound. Cracks wider than 1/2-inch at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks.	Vault replaced or repairs made so that vault meets design specifications and is structurally sound. Vault repaired so that no cracks exist wider than 1/4-inch at the joint of the inlet/outlet pipe.
	Baffles	Baffles corroding, cracking warping, and/or showing signs of failure as determined by maintenance/inspection person.	Baffles repaired or replaced to specifications.

Table V-4.5.2(15) Maintenance Standards - Manufactured Media Filters (continued)

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
	Access Ladder Damaged	Ladder is corroded or deteriorated, not functioning properly, not securely attached to structure wall, missing rungs, cracks, and mis-aligned.	Ladder replaced or repaired and meets specifications, and is safe to use as determ-ined by inspection personnel.
Below Ground Cart-ridge Type	Media	Drawdown of water through the media takes longer than 1 hour, and/or overflow occurs frequently.	Media cartridges replaced.
	Short Circuiting	Flows do not properly enter filter cartridges.	Filter cartridges replaced.

Table V-4.5.2(16) Maintenance Standards - Baffle Oil/Water Separators (API Type)

Maintenance Component	Defect	Condition When Main-tenance is Needed	Results Expected When Maintenance is Performed
General	Monitoring	Inspection of discharge water for obvious signs of poor water quality.	Effluent discharge from vault should be clear with out thick visible sheen.
	Sediment Accu-mulation	Sediment depth in bottom of vault exceeds 6-inches in depth.	No sediment deposits on vault bottom that would impede flow through the vault and reduce separation effi-ciency.
	Trash and Debris Accumulation	Trash and debris accu-mulation in vault, or pipe inlet/outlet, floatables and non-floatables.	Trash and debris removed from vault, and inlet/outlet piping.
	Oil Accumulation	Oil accumulations that exceed 1-inch, at the surface of the water.	Extract oil from vault by vactoring. Disposal in accordance with state and local rules and reg-ulations.

Table V-4.5.2(16) Maintenance Standards - Baffle Oil/Water Separators (API Type) (continued)

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
	Damaged Pipes	Inlet or outlet piping damaged or broken and in need of repair.	Pipe repaired or replaced.
	Access Cover Damaged/Not Working	Cover cannot be opened, corrosion/deformation of cover.	Cover repaired to proper working specifications or replaced.
	Vault Structure Damage - Includes Cracks in Walls Bottom, Damage to Frame and/or Top Slab	See "Catch Basins" (No. 5) Cracks wider than 1/2-inch at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks.	Vault replaced or repairs made so that vault meets design specifications and is structurally sound. Vault repaired so that no cracks exist wider than 1/4-inch at the joint of the inlet/outlet pipe.
	Baffles	Baffles corroding, cracking, warping and/or showing signs of failure as determined by maintenance/inspection person.	Baffles repaired or replaced to specifications.
	Access Ladder Damaged	Ladder is corroded or deteriorated, not functioning properly, not securely attached to structure wall, missing rungs, cracks, and misaligned.	Ladder replaced or repaired and meets specifications, and is safe to use as determined by inspection personnel.

Table V-4.5.2(17) Maintenance Standards - Coalescing Plate Oil/Water Separators

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Monitoring	Inspection of discharge water for obvious signs of poor water	Effluent discharge from vault should be clear with

Table V-4.5.2(17) Maintenance Standards - Coalescing Plate Oil/Water Separators (continued)

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
		quality.	no thick visible sheen.

Table V-4.5.2(17) Maintenance Standards - Coalescing Plate Oil/Water Separators (continued)

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
	Sediment Accumulation	Sediment depth in bottom of vault exceeds 6-inches in depth and/or visible signs of sediment on plates.	No sediment deposits on vault bottom and plate media, which would impede flow through the vault and reduce separation efficiency.
	Trash and Debris Accumulation	Trash and debris accumulated in vault, or pipe inlet/outlet, floatables and non-floatables.	Trash and debris removed from vault, and inlet/outlet piping.
	Oil Accumulation	Oil accumulation that exceeds 1-inch at the water surface.	Oil is extracted from vault using vactoring methods. Coalescing plates are cleaned by thoroughly rinsing and flushing. Should be no visible oil depth on water.
	Damaged Coalescing Plates	Plate media broken, deformed, cracked and/or showing signs of failure.	A portion of the media pack or the entire plate pack is replaced depending on severity of failure.
	Damaged Pipes	Inlet or outlet piping damaged or broken and in need of repair.	Pipe repaired and or replaced.
	Baffles	Baffles corroding, cracking, warping and/or showing signs of failure as determined by maintenance/inspection person.	Baffles repaired or replaced to specifications.
	Vault Structure Damage - Includes Cracks in Walls, Bottom, Damage to Frame and/or Top Slab	Cracks wider than 1/2-inch or evidence of soil particles entering the structure through the cracks, or maintenance/inspection personnel determine that the vault is not structurally sound.	Vault replaced or repairs made so that vault meets design specifications and is structurally sound. Vault repaired so that no cracks exist wider than 1/4-inch at the joint of the

Table V-4.5.2(17) Maintenance Standards - Coalescing Plate Oil/Water Separators (continued)

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
		Cracks wider than 1/2-inch at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks.	inlet/outlet pipe.
	Access Ladder Damaged	Ladder is corroded or deteriorated, not functioning properly, not securely attached to structure wall, missing rungs, cracks, and misaligned.	Ladder replaced or repaired and meets specifications, and is safe to use as determined by inspection personnel.

Table V-4.5.2(18) Maintenance Standards - Catch Basin Inserts

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Sediment Accumulation	When sediment forms a cap over the insert media of the insert and/or unit.	No sediment cap on the insert media and its unit.
	Trash and Debris Accumulation	Trash and debris accumulates on insert unit creating a blockage/restriction.	Trash and debris removed from insert unit. Runoff freely flows into catch basin.
	Media Insert Not Removing Oil	Effluent water from media insert has a visible sheen.	Effluent water from media insert is free of oils and has no visible sheen.
	Media Insert Water Saturated	Catch basin insert is saturated with water and no longer has the capacity to absorb.	Remove and replace media insert
	Media Insert-Oil Saturated	Media oil saturated due to petroleum spill that drains into catch basin.	Remove and replace media insert.
	Media Insert Use Beyond Product Life	Media has been used beyond the typical average life of media insert product.	Remove and replace media at regular intervals, depending on insert product.

Table V-4.5.2(19) Maintenance Standards - Media Filter Drain (MFD)

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Sediment accumulation on grass filter strip	Sediment depth exceeds 2 inches or creates uneven grading that interferes with sheet flow.	Remove sediment deposits on grass treatment area of the embankment. When finished, embankment should be level from side to side and drain freely toward the toe of the embankment slope. There should be no areas of standing water once inflow has ceased.
	No-vegetation zone/-flow spreader	Flow spreader is uneven or clogged so that flows are not uniformly distributed over entire embankment width.	Level the spreader and clean to spread flows evenly over entire embankment width.
	Poor vegetation coverage	Grass is sparse or bare, or eroded patches are observed in more than 10% of the grass strip surface area.	Determine why grass growth is poor and correct the offending condition. Reseed into loosened, fertile soil or compost; or, replant with plugs of grass from the upper slope.
	Vegetation	Grass becomes excessively tall (greater than 10 inches); nuisance weeds and other vegetation start to take over.	Mow vegetation or remove nuisance vegetation to not impede flow. Mow grass to a height of 6 inches.
	Media filter drain mix replacement	Water is seen on the surface of the media filter drain mix long after the storms have ceased. Typically, the 6-month, 24-hour precipitation event should drain within 48 hours. More common storms should drain within 24 hours. Maintenance also needed on a 10-year cycle and during a preservation project.	Excavate and replace all of the media filter drain mix contained within the media filter drain.
	Excessive shading	Grass growth is poor because sunlight does not reach	If possible, trim back overhanging limbs and remove

Table V-4.5.2(19) Maintenance Standards - Media Filter Drain (MFD) (continued)

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
		embankment.	brushy vegetation on adjacent slopes.
	Trash and debris	Trash and debris have accumulated on embankment.	Remove trash and debris from embankment.
	Flooding of Media filter drain	When media filter drain is inundated by flood water	Evaluate media filter drain material for acceptable infiltration rate and replace if media filter drain does not meet long-term infiltration rate standards.

Table V-4.5.2(20) Maintenance Standards - Compost Amended Vegetated Filter Strip (CAVFS)

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Sediment accumulation on grass	Sediment depth exceeds 2 inches.	Remove sediment deposits. Relevel so slope is even and flows pass evenly through strip.
	Vegetation	Grass becomes excessively tall (greater than 10 inches); nuisance weeds and other vegetation start to take over.	Mow grass and control nuisance vegetation so that flow is not impeded. Grass should be mowed to a height of 6 inches.
	Trash and debris	Trash and debris have accumulated on the vegetated filter strip.	Remove trash and debris from filter.

Table V-4.5.2(20) Maintenance Standards - Compost Amended Vegetated Filter Strip (CAVFS) (continued)

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
	Erosion/scouring	Areas have eroded or scoured due to flow channelization or high flows.	For ruts or bare areas less than 12 inches wide, repair the damaged area by filling with a 50/50 mixture of crushed gravel and compost. The grass will creep in over the rock in time. If bare areas are large, generally greater than 12 inches wide, the vegetated filter strip should be regraded and reseeded. For smaller bare areas, overseed when bare spots are evident.
	Flow spreader	Flow spreader is uneven or clogged so that flows are not uniformly distributed over entire filter width.	Level the spreader and clean so that flows are spread evenly over entire filter width

Table V-4.5.2(21) Maintenance Standards - Bioretention Facilities

Maintenance Component	Recommended Frequency a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
Facility Footprint				
Earthen side slopes and berms	B, S		Erosion (gullies/ rills) greater than 2 inches deep around inlets, outlet, and alongside slopes	• Eliminate cause of erosion and stabilize damaged area (regrade, rock, vegetation, erosion control matting) • For deep channels or cuts (over 3 inches in ponding

Table V-4.5.2(21) Maintenance Standards - Bioretention Facilities (continued)

Maintenance Component	Recommended Frequency [a]		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
				depth), temporary erosion control measures should be put in place until permanent repairs can be made. • Properly designed, constructed and established facilities with appropriate flow velocities should not have erosion problems except perhaps in extreme events. If erosion problems persist, the following should be reassessed: (1) flow volumes from contributing areas and bioretention facility sizing; (2) flow velocities and gradients within the facility; and (3) flow dissipation and erosion protection strategies at the facility inlet.
	A		Erosion of sides causes slope to become a hazard	Take actions to eliminate the hazard and stabilize slopes
	A, S		Settlement greater than 3	Restore to design height

Table V-4.5.2(21) Maintenance Standards - Bioretention Facilities (continued)

Maintenance Component	Recommended Frequency [a]		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
			inches (relative to undisturbed sections of berm)	
	A, S		Downstream face of berm wet, seeps or leaks evident	Plug any holes and compact berm (may require consultation with engineer, particularly for larger berms)
	A		Any evidence of rodent holes or water piping in berm	• Eradicate rodents (see "Pest control") • Fill holes and compact (may require consultation with engineer, particularly for larger berms)
Concrete sidewalls	A		Cracks or failure of concrete sidewalls	• Repair/ seal cracks • Replace if repair is insufficient
Rockery sidewalls	A		Rockery side walls are insecure	Stabilize rockery sidewalls (may require consultation with engineer, particularly for walls 4 feet or greater in height)
Facility area		All maintenance visits (at least biannually)	Trash and debris present	Clean out trash and debris
Facility bottom area	A, S		Accumulated sediment to extent that infiltration rate is	• Remove excess sediment • Replace any vegetation damaged or

Table V-4.5.2(21) Maintenance Standards - Bioretention Facilities (continued)

Maintenance Component	Recommended Frequency a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
			reduced (see "Ponded water") or surface storage capacity significantly impacted	destroyed by sediment accumulation and removal • Mulch newly planted vegetation • Identify and control the sediment source (if feasible) • If accumulated sediment is recurrent, consider adding presettlement or installing berms to create a forebay at the inlet
		During/after fall leaf drop	Accumulated leaves in facility	Remove leaves if there is a risk to clogging outlet structure or water flow is impeded
Low permeability check dams and weirs	A, S		Sediment, vegetation, or debris accumulated at or blocking (or having the potential to block) check dam, flow control weir or orifice	Clear the blockage
	A, S		Erosion and/or undercutting present	Repair and take preventative measures to prevent future erosion and/or undercutting

Table V-4.5.2(21) Maintenance Standards - Bioretention Facilities (continued)

Maintenance Component	Recommended Frequency a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
	A		Grade board or top of weir damaged or not level	Restore to level position
Ponded water	B, S		Excessive ponding water: Water overflows during storms smaller than the design event or ponded water remains in the basin 48 hours or longer after the end of a storm.	Determine cause and resolve in the following order: 1. Confirm leaf or debris buildup in the bottom of the facility is not impeding infiltration. If necessary, remove leaf litter/debris. 2. Ensure that underdrain (if present) is not clogged. If necessary, clear underdrain. 3. Check for other water inputs (e.g., groundwater, illicit connections). 4. Verify that the facility is sized appropriately for the contributing area. Confirm that the contributing area has not increased. If steps #1-4 do not solve the problem,

Table V-4.5.2(21) Maintenance Standards - Bioretention Facilities (continued)

Maintenance Component	Recommended Frequency [a]		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
				the bioretention soil is likely clogged by sediment accumulation at the surface or has become overly compacted. Dig a small hole to observe soil profile and identify compaction depth or clogging front to help determine the soil depth to be removed or otherwise rehabilitated (e.g., tilled). Consultation with an engineer is recommended.
Bioretention soil media	As needed		Bioretention soil media protection is needed when performing maintenance requiring entrance into the facility footprint	• Minimize all loading in the facility footprint (foot traffic and other loads) to the degree feasible in order to prevent compaction of bioretention soils. • Never drive equipment or apply heavy loads in facility footprint. • Because the risk of compaction is higher during saturated soil

Table V-4.5.2(21) Maintenance Standards - Bioretention Facilities (continued)

Maintenance Component	Recommended Frequency a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
				conditions, any type of loading in the cell (including foot traffic) should be minimized during wet conditions. â€¢ Consider measures to distribute loading if heavy foot traffic is required or equipment must be placed in facility. As an example, boards may be placed across soil to distribute loads and minimize compaction. â€¢ If compaction occurs, soil must be loosened or otherwise rehabilitated to original design state.
Inlets/Outlets/Pipes				
Splash block inlet	A		Water is not being directed properly to the facility and away from the inlet structure	Reconfigure/ repair blocks to direct water to facility and away from structure
Curb cut inlet/outlet	M during the wet season and before severe storm	Weekly during fall leaf drop	Accumulated leaves at curb cuts	Clear leaves (particularly important for key inlets and low points along long, linear facilities)

Table V-4.5.2(21) Maintenance Standards - Bioretention Facilities (continued)

Maintenance Component	Recommended Frequency a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
	is forecasted			
Pipe inlet/outlet	A		Pipe is damaged	Repair/ replace
	W		Pipe is clogged	Remove roots or debris
	A, S		Sediment, debris, trash, or mulch reducing capacity of inlet/outlet	• Clear the blockage • Identify the source of the blockage and take actions to prevent future blockages
		Weekly during fall leaf drop	Accumulated leaves at inlets/outlets	Clear leaves (particularly important for key inlets and low points along long, linear facilities)
		A	Maintain access for inspections	• Clear vegetation (transplant vegetation when possible) within 1 foot of inlets and outlets, maintain access pathways • Consultation with a landscape architect is recommended for removal, transplant, or substitution of plants
Erosion control at inlet	A		Concentrated flows are causing erosion	Maintain a cover of rock or cobbles or other erosion protection measure (e.g., matting) to protect the ground where concentrated water enters the facility (e.g., a pipe, curb

Table V-4.5.2(21) Maintenance Standards - Bioretention Facilities (continued)

Maintenance Component	Recommended Frequency a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
				cut or swale)
Trash rack	S		Trash or other debris present on trash rack	Remove/dispose
	A		Bar screen damaged or missing	Repair/replace
Overflow	A, S		Capacity reduced by sediment or debris	Remove sediment or debris/dispose
Underdrain pipe	Clean pipe as needed	Clean orifice at least biannually (may need more frequent cleaning during wet season)	• Plant roots, sediment or debris reducing capacity of underdrain • Prolonged surface ponding (see "Ponded water"	• Jet clean or rotary cut debris/roots from underdrain(s) • If underdrains are equipped with a flow restrictor (e.g., orifice) to attenuate flows, the orifice must be cleaned regularly.
Vegetation				
Facility bottom area and upland slope vegetation	Fall and Spring		Vegetation survival rate falls below 75% within first two years of establishment (unless project O&M manual or record drawing stipulates more	• Determine cause of poor vegetation growth and correct condition • Replant as necessary to obtain 75% survival rate or greater. Refer to original planting plan, or approved jur-

Table V-4.5.2(21) Maintenance Standards - Bioretention Facilities (continued)

Maintenance Component	Recommended Frequency [a]		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
			or less than 75% survival rate).	isdictional species list for appropriate plant replacements (See Appendix 3 - Bioretention Plant List, in the LID Technical Guidance Manual for Puget Sound). • Confirm that plant selection is appropriate for site growing conditions • Consultation with a landscape architect is recommended for removal, transplant, or substitution of plants
Vegetation (general)	As needed		Presence of diseased plants and plant material	• Remove any diseased plants or plant parts and dispose of in an approved location (e.g., commercial landfill) to avoid risk of spreading the disease to other plants • Disinfect gardening tools after pruning to prevent the spread of disease • See Pacific North-

Table V-4.5.2(21) Maintenance Standards - Bioretention Facilities (continued)

Maintenance Component	Recommended Frequency [a] Inspection	Recommended Frequency [a] Routine Maintenance	Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
				west Plant Disease Management Handbook for information on disease recognition and for additional resources • Replant as necessary according to recommendations provided for "facility bottom area and upland slope vegetation".
Trees and shrubs		All pruning seasons (timing varies by species)	Pruning as needed	• Prune trees and shrubs in a manner appropriate for each species. Pruning should be performed by landscape professionals familiar with proper pruning techniques • All pruning of mature trees should be performed by or under the direct guidance of an ISA certified arborist
	A		Large trees and shrubs interfere with operation of the facility or access for maintenance	• Prune trees and shrubs using most current ANSI A300 standards and ISA BMPs. • Remove trees and

Table V-4.5.2(21) Maintenance Standards - Bioretention Facilities (continued)

Maintenance Component	Recommended Frequency [a]		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
				shrubs, if necessary.

Table V-4.5.2(21) Maintenance Standards - Bioretention Facilities (continued)

Maintenance Component	Recommended Frequency [a]		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
	Fall and Spring		Standing dead vegetation is present	• Remove standing dead vegetation • Replace dead vegetation within 30 days of reported dead and dying plants (as practical depending on weather/planting season) • If vegetation replacement is not feasible within 30 days, and absence of vegetation may result in erosion problems, temporary erosion control measures should be put in place immediately. • Determine cause of dead vegetation and address issue, if possible • If specific plants have a high mortality rate, assess the cause and replace with appropriate species. Consultation with a landscape architect is recommended.
	Fall and		Planting	• When working

Table V-4.5.2(21) Maintenance Standards - Bioretention Facilities (continued)

Maintenance Component	Recommended Frequency [a]		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
	Spring		beneath mature trees	around and below mature trees, follow the most current ANSI A300 standards and ISA BMPs to the extent practicable (e.g., take care to minimize any damage to tree roots and avoid compaction of soil). • Planting of small shrubs or groundcovers beneath mature trees may be desirable in some cases; such plantings should use mainly plants that come as bulbs, bare root or in 4-inch pots; plants should be in no larger than 1-gallon containers.
	Fall and Spring		Presence of or need for stakes and guys (tree growth, maturation, and support needs)	• Verify location of facility liners and underdrain (if any) prior to stake installation in order to prevent liner puncture or pipe damage • Monitor tree support systems: Repair and adjust as needed to

Table V-4.5.2(21) Maintenance Standards - Bioretention Facilities (continued)

Maintenance Component	Recommended Frequency [a]		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
				provide support and prevent damage to tree. • Remove tree supports (stakes, guys, etc.) after one growing season or maximum of 1 year. • Backfill stake holes after removal.
Trees and shrubs adjacent to vehicle travel areas (or areas where visibility needs to be maintained)	A		Vegetation causes some visibility (line of sight) or driver safety issues	• Maintain appropriate height for sight clearance • When continued, regular pruning (more than one time/ growing season) is required to maintain visual sight lines for safety or clearance along a walk or drive, consider relocating the plant to a more appropriate location. • Remove or transplant if continual safety hazard • Consultation with a landscape architect is recommended for removal, transplant, or substitution of

Table V-4.5.2(21) Maintenance Standards - Bioretention Facilities (continued)

Maintenance Component	Recommended Frequency a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
				plants
Flowering plants		A	Dead or spent flowers present	Remove spent flowers (deadhead)
Perennials		Fall	Spent plants	Cut back dying or dead and fallen foliage and stems
Emergent vegetation		Spring	Vegetation compromises conveyance	Hand rake sedges and rushes with a small rake or fingers to remove dead foliage before new growth emerges in spring or earlier only if the foliage is blocking water flow (sedges and rushes do not respond well to pruning)
Ornamental grasses (perennial)		Winter and Spring	Dead material from previous year's growing cycle or dead collapsed foliage	• Leave dry foliage for winter interest • Hand rake with a small rake or fingers to remove dead foliage back to within several inches from the soil before new growth emerges in spring or earlier if the foliage collapses and is blocking water flow
Ornamental grasses (evergreen)		Fall and Spring	Dead growth present in spring	• Hand rake with a small rake or fingers to remove dead growth before new growth emerges in spring

Table V-4.5.2(21) Maintenance Standards - Bioretention Facilities (continued)

Maintenance Component	Recommended Frequency a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
				• Clean, rake, and comb grasses when they become too tall • Cut back to ground or thin every 2-3 years as needed
Noxious weeds		M (March - October, preceding seed dispersal)	Listed noxious vegetation is present (refer to current county noxious weed list)	• By law, class A & B noxious weeds must be removed, bagged and disposed as garbage immediately • Reasonable attempts must be made to remove and dispose of class C noxious weeds • It is strongly encouraged that herbicides and pesticides not be used in order to protect water quality; use of herbicides and pesticides may be prohibited in some jurisdictions • Apply mulch after weed removal (see "Mulch")
Weeds		M (March - October, preceding seed dispersal)	Weeds are present	• Remove weeds with their roots manually with pincer-type weeding tools, flame

Table V-4.5.2(21) Maintenance Standards - Bioretention Facilities (continued)

Maintenance Component	Recommended Frequency [a]		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
				weeders, or hot water weeders as appropriate • Follow IPM protocols for weed management (see "Additional Maintenance Resources" section for more information on IPM protocols)
Excessive vegetation		Once in early to mid- May and once in early- to mid- September	Low-lying vegetation growing beyond facility edge onto sidewalks, paths, or street edge poses pedestrian safety hazard or may clog adjacent permeable pavement surfaces due to associated leaf litter, mulch, and soil	• Edge or trim groundcovers and shrubs at facility edge • Avoid mechanical blade-type edger and do not use edger or trimmer within 2 feet of tree trunks • While some clippings can be left in the facility to replenish organic material in the soil, excessive leaf litter can cause surface soil clogging
	As needed		Excessive vegetation density inhibits stormwater flow beyond design ponding or	• Determine whether pruning or other routine maintenance is adequate to maintain proper plant density and aesthetics

Table V-4.5.2(21) Maintenance Standards - Bioretention Facilities (continued)

Maintenance Component	Recommended Frequency a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
			becomes a hazard for pedestrian and vehicular circulation and safety	• Determine if planting type should be replaced to avoid ongoing maintenance issues (an aggressive grower under perfect growing conditions should be transplanted to a location where it will not impact flow) • Remove plants that are weak, broken or not true to form; replace in-kind • Thin grass or plants impacting facility function without leaving visual holes or bare soil areas • Consultation with a landscape architect is recommended for removal, transplant, or substitution of plants
	As needed		Vegetation blocking curb cuts, causing excessive sediment buildup and flow bypass	Remove vegetation and sediment buildup

Table V-4.5.2(21) Maintenance Standards - Bioretention Facilities (continued)

Maintenance Component	Recommended Frequency [a]		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
Mulch				
Mulch		Following weeding	Bare spots (without mulch cover) are present or mulch depth less than 2 inches	• Supplement mulch with hand tools to a depth of 2 to 3 inches • Replenish mulch per O&M manual. Often coarse compost is used in the bottom of the facility and arborist wood chips are used on side slopes and rim (above typical water levels) • Keep all mulch away from woody stems
Watering				
Irrigation system (if any)		Based on manufacturer's instructions	Irrigation system present	Follow manufacturer's instructions for O&M
	A		Sprinklers or drip irrigation not directed/located to properly water plants	Redirect sprinklers or move drip irrigation to desired areas
Summer watering (first year)		Once every 1-2 weeks or as needed during prolonged dry periods	Trees, shrubs and groundcovers in first year of establishment period	• 10 to 15 gallons per tree • 3 to 5 gallons per shrub • 2 gallons water per square foot for groundcover areas

Table V-4.5.2(21) Maintenance Standards - Bioretention Facilities (continued)

Maintenance Component	Recommended Frequency [a]		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		

				• Water deeply, but infrequently, so that the top 6 to 12 inches of the root zone is moist
				• Use soaker hoses or spot water with a shower type wand when irrigation system is not present
				  ◦ Pulse water to enhance soil absorption, when feasible
				  ◦ Pre-moisten soil to break surface tension of dry or hydrophobic soils/mulch, followed by several more passes. With this method , each pass increases soil absorption and allows more water to infiltrate prior to runoff
				• Add a tree bag or slow-release watering device (e.g.,

Table V-4.5.2(21) Maintenance Standards - Bioretention Facilities (continued)

Maintenance Component	Recommended Frequency a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
				bucket with a perforated bottom) for watering newly installed trees when irrigation system is not present

Summer watering (second and third years)		Once every 2-4 weeks or as needed during prolonged dry periods	Trees, shrubs and groundcovers in second or third year of establishment period	• 10 to 15 gallons per tree
				• 3 to 5 gallons per shrub
				• 2 gallons water per square foot for groundcover areas
				• Water deeply, but infrequently, so that the top 6 to 12 inches of the root zone is moist
				• Use soaker hoses or spot water with a shower type wand when irrigation system is not present
				  ◦ Pulse water to enhance soil absorption, when feasible
				  ◦ Pre-moisten soil to break surface tension of dry or hydrophobic soils/mulch, fol-

Table V-4.5.2(21) Maintenance Standards - Bioretention Facilities (continued)

Maintenance Component	Recommended Frequency [a]		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
				lowed by several more passes. With this method , each pass increases soil absorption and allows more water to infiltrate prior to runoff
Summer watering (after establishment)		As needed	Established vegetation (after 3 years)	• Plants are typically selected to be drought tolerant and not require regular watering after establishment; however, trees may take up to 5 years of watering to become fully established • Identify trigger mechanisms for drought-stress (e.g., leaf wilt, leaf senescence, etc.) of different species and water immediately after initial signs of stress appear • Water during drought conditions or more often if necessary to main-

Table V-4.5.2(21) Maintenance Standards - Bioretention Facilities (continued)

Maintenance Component	Recommended Frequency [a]		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
				tain plant cover
Pest Control				
Mosquitoes	B, S		Standing water remains for more than 3 days after the end of a storm	• Identify the cause of the standing water and take appropriate actions to address the problem (see "Ponded water") • To facilitate maintenance, manually remove standing water and direct to the storm drainage system (if runoff is from non pollution-generating surfaces) or sanitary sewer system (if runoff is from pollution-generating surfaces) after getting approval from sanitary sewer authority. • Use of pesticides or *Bacillus thuringiensis israelensis* (Bti) may be considered only as a temporary measure while addressing the standing water cause. If overflow to

Table V-4.5.2(21) Maintenance Standards - Bioretention Facilities (continued)

Maintenance Component	Recommended Frequency [a]		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
				a surface water will occur within 2 weeks after pesticide use, apply for coverage under the Aquatic Mosquito Control NPDES General Permit.
Nuisance animals	As needed		Nuisance animals causing erosion, damaging plants, or depositing large volumes of feces	• Reduce site conditions that attract nuisance species where possible (e.g., plant shrubs and tall grasses to reduce open areas for geese, etc.) • Place predator decoys • Follow IPM protocols for specific nuisance animal issues (see "Additional Maintenance Resources" section for more information on IPM protocols) • Remove pet waste regularly • For public and right-of-way sites consider adding garbage cans with dog bags for picking

Table V-4.5.2(21) Maintenance Standards - Bioretention Facilities (continued)

Maintenance Component	Recommended Frequency [a]		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
				up pet waste.
Insect pests	Every site visit associated with vegetation management		Signs of pests, such as wilting leaves, chewed leaves and bark, spotting or other indicators	• Reduce hiding places for pests by removing diseased and dead plants • For infestations, follow IPM protocols (see "Additional Maintenance Resources" section for more information on IPM protocols)

Note that the inspection and routine maintenance frequencies listed above are recommended by Ecology. They do not supersede or replace the municipal stormwater permit requirements for inspection frequency required of municipal stormwater permittees for "stormwater treatment and flow control BMPs/facilities".

[a] Frequency: A = Annually; B = Biannually (twice per year); M = Monthly; W = At least one visit should occur during the wet season (for debris/clog related maintenance, this inspection/maintenance visit should occur in the early fall, after deciduous trees have lost their leaves); S = Perform inspections after major storm events (24-hour storm event with a 10-year or greater recurrence interval).

IPM - Integrated Pest Management

ISA - International Society of Arboriculture

Table V-4.5.2(22) Maintenance Standards - Permeable Pavement

Component	Recommended Frequency [a]		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
Surface/Wearing Course				
Permeable	A, S		Runoff from	• Clean deposited soil or

Table V-4.5.2(22) Maintenance Standards - Permeable Pavement (continued)

Component	Recommended Frequency [a]		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
Pavements, all			adjacent pervious areas deposits soil, mulch or sediment on paving	other materials from permeable pavement or other adjacent surfacing • Check if surface elevation of planted area is too high, or slopes towards pavement, and can be regraded (prior to regrading, protect permeable pavement by covering with temporary plastic and secure covering in place) • Mulch and/or plant all exposed soils that may erode to pavement surface
Porous asphalt or pervious concrete		A or B	None (routine maintenance)	Clean surface debris from pavement surface using one or a combination of the following methods: • Remove sediment, debris, trash, vegetation, and other debris deposited onto pavement (rakes and leaf blowers can be used for removing leaves) • Vacuum/sweep permeable paving installation using: ◦ Walk-behind vacuum (sidewalks) ◦ High efficiency regenerative air or vacuum sweeper (roadways, parking lots)

Table V-4.5.2(22) Maintenance Standards - Permeable Pavement (continued)

Component	Recommended Frequency [a] Inspection	Recommended Frequency [a] Routine Maintenance	Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
				◦ ShopVac or brush brooms (small areas) • Hand held pressure washer or power washer with rotating brushes Follow equipment manufacturer guidelines for when equipment is most effective for cleaning permeable pavement. Dry weather is more effective for some equipment.
	A[b]		Surface is clogged: Ponding on surface or water flows off the permeable pavement surface during a rain event (does not infiltrate)	• Review the overall performance of the facility (note that small clogged areas may not reduce overall performance of facility) • Test the surface infiltration rate using ASTM C1701 as a corrective maintenance indicator. Perform one test per installation, up to 2,500 square feet. Perform an additional test for each additional 2,500 square feet up to 15,000 square feet total. Above 15,000 square feet, add one test for every 10,000 square feet. • If the results indicate an infiltration rate of 10 inches per hour or less, then perform corrective main-

Table V-4.5.2(22) Maintenance Standards - Permeable Pavement (continued)

Component	Recommended Frequency [a]		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
				tenance to restore permeability. To clean clogged pavement surfaces, use one or combination of the following methods: ◦ Combined pressure wash and vacuum system calibrated to not dislodge wearing course aggregate. ◦ Hand held pressure washer or power washer with rotating brushes ◦ Pure vacuum sweepers Note: If the annual/biannual routine maintenance standard to clean the pavement surface is conducted using equipment from the list above, corrective maintenance may not be needed.
	A		Sediment present at the surface of the pavement	• Assess the overall performance of the pavement system during a rain event. If water runs off the pavement and/or there is ponding then see above. • Determine source of sediment loading and evaluate whether or not the source

Table V-4.5.2(22) Maintenance Standards - Permeable Pavement (continued)

Component	Recommended Frequency [a]		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
				can be reduced/eliminated. If the source cannot be addressed, consider increasing frequency of routine cleaning (e.g., twice per year instead of once per year).
	Summer		Moss growth inhibits infiltration or poses slip safety hazard	• Sidewalks: Use a stiff broom to remove moss in the summer when it is dry • Parking lots and roadways: Pressure wash, vacuum sweep, or use a combination of the two for cleaning moss from pavement surface. May require stiff broom or power brush in areas of heavy moss.
	A		Major cracks or trip hazards and concrete spalling and raveling	• Fill potholes or small cracks with patching mixes • Large cracks and settlement may require cutting and replacing the pavement section. Replace in-kind where feasible. Replacing porous asphalt with conventional asphalt is acceptable if it is a small percentage of the total facility area and does not impact the overall facility function. • Take appropriate pre-

Table V-4.5.2(22) Maintenance Standards - Permeable Pavement (continued)

Component	Recommended Frequency [a]		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
				cautions during pavement repair and replacement efforts to prevent clogging of adjacent porous materials
Interlocking concrete paver blocks and aggregate pavers		A or B	None (routine maintenance)	Clean pavement surface using one or a combination of the following methods: • Remove sediment, debris, trash, vegetation, and other debris deposited onto pavement (rakes and leaf blowers can be used for removing leaves) • Vacuum/sweep permeable paving installation using: ◦ Walk-behind vacuum (sidewalks) ◦ High efficiency regenerative air or vacuum sweeper (roadways, parking lots) ◦ ShopVac or brush brooms (small areas) Note: Vacuum settings may have to be adjusted to prevent excess uptake of aggregate from paver openings or joints. Vacuum surface openings in dry weather to remove dry, encrusted sediment.
	A[b]		Surface is	• Review the overall per-

Table V-4.5.2(22) Maintenance Standards - Permeable Pavement (continued)

Component	Recommended Frequency a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
			clogged: Ponding on surface or water flows off the permeable pavement surface during a rain event (does not infiltrate)	formance of the facility (note that small clogged areas may not reduce overall performance of facility) • Test the surface infiltration rate using ASTM C1701 as a corrective maintenance indicator. Perform one test per installation, up to 2,500 square feet. Perform an additional test for each additional 2,500 square feet up to 15,000 square feet total. Above 15,000 square feet, add one test for every 10,000 square feet. • If the results indicate an infiltration rate of 10 inches per hour or less, then perform corrective maintenance to restore permeability. • Clogging is usually an issue in the upper 2 to 3 centimeters of aggregate. Remove the upper layer of encrusted sediment, and fines, and/or vegetation from openings and joints between the pavers by mechanical means and/or suction equipment (e.g., pure vacuum sweeper).

Table V-4.5.2(22) Maintenance Standards - Permeable Pavement (continued)

Component	Recommended Frequency a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
b				
A		Sediment present at the surface of the pavement	• Assess the overall performance of the pavement system during a rain event. If water runs off the pavement and/or there is ponding, then see above. • Determine source of sediment loading and evaluate whether or not the source can be	

Table V-4.5.2(22) Maintenance Standards - Permeable Pavement (continued)

Component	Recommended Frequency [a]		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
			reduced/eliminated. If the source cannot be addressed, consider increasing frequency of routine cleaning (e.g., twice per year instead of once per year).	
Summer		Moss growth inhibits infiltration or poses slip safety hazard	• Sidewalks: Use a stiff broom to remove moss in the summer when it is dry	

Table V-4.5.2(22) Maintenance Standards - Permeable Pavement (continued)

Component	Recommended Frequency a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
			• Parking lots and roadways: Vacuum sweep or stiff broom/power brush for cleaning moss from pavement surface	
A		Paver block missing or damaged	Remove individual damaged paver blocks by hand and replace or repair per manufacturer's recommendations	
A		Loss of aggregate material between paver blocks	Refill per manufacturer's recommendations for interlocking paver sections	
A		Settlement of	May require	

Table V-4.5.2(22) Maintenance Standards - Permeable Pavement (continued)

Component	Recommended Frequency [a]		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
		surface	resetting	
Open-celled paving grid with gravel		A or B	None (routine maintenance)	• Remove sediment, debris, trash, vegetation, and other debris deposited onto pavement (rakes and leaf blowers can be used for removing leaves) • Follow equipment manufacturer guidelines for cleaning surface.
	A [b]		Aggregate is clogged: Ponding on surface or water flows off the permeable pavement surface during a rain event (does not infiltrate)	• Use vacuum truck to remove and replace top course aggregate • Replace aggregate in paving grid per manufacturer's recommendations
	A		Paving grid missing or damaged	• Remove pins, pry up grid segments, and replace gravel • Replace grid segments where three or more adjacent rings are broken or damaged • Follow manufacturer guidelines for repairing surface.
	A		Settlement of surface	May require resetting
	A		Loss of	Replenish aggregate material by

Table V-4.5.2(22) Maintenance Standards - Permeable Pavement (continued)

Component	Recommended Frequency [a]		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
			aggregate material in paving grid	spreading gravel with a rake (gravel level should be maintained at the same level as the plastic rings or no more than 1/4 inch above the top of rings). See manufacturer's recommendations.
		A	Weeds present	• Manually remove weeds • Presence of weeds may indicate that too many fines are present (refer to Actions Needed under "Aggregate is clogged" to address this issue)
Open-celled paving grid with grass		A or B	None (routine maintenance)	• Remove sediment, debris, trash, vegetation, and other debris deposited onto pavement (rakes and leaf blowers can be used for removing leaves) • Follow equipment manufacturer guidelines for cleaning surface.
	A[b]		Aggregate is clogged: Ponding on surface or water flows off the permeable pavement surface during a rain event (does not infiltrate)	Rehabilitate per manufacturer's recommendations.

Table V-4.5.2(22) Maintenance Standards - Permeable Pavement (continued)

Component	Recommended Frequency a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
	A		Paving grid missing or damaged	• Remove pins, pry up grid segments, and replace grass • Replace grid segments where three or more adjacent rings are broken or damaged • Follow manufacturer guidelines for repairing surface.
	A		Settlement of surface	May require resetting
	A		Poor grass coverage in paving grid	• Restore growing medium, reseed or plant, aerate, and/or amend vegetated area as needed • Traffic loading may be inhibiting grass growth; reconsider traffic loading if feasible
		As needed	None (routine maintenance)	Use a mulch mower to mow grass
		A	None (routine maintenance)	• Sprinkle a thin layer of compost on top of grass surface (1/2" top dressing) and sweep it in • Do not use fertilizer
		A	Weeds present	• Manually remove weeds • Mow, torch, or inoculate and replace with preferred vegetation
Inlets/Outlets/Pipes				
Inlet/outlet	A		Pipe is dam-	Repair/replace

Table V-4.5.2(22) Maintenance Standards - Permeable Pavement (continued)

Component	Recommended Frequency [a]		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
pipe			aged	
	A		Pipe is clogged	Remove roots or debris
Underdrain pipe	Clean pipe as needed	Clean orifice at least biannually (may need more frequent cleaning during wet season)	Plant roots, sediment or debris reducing capacity of underdrain (may cause prolonged drawdown period)	• Jet clean or rotary cut debris/roots from underdrain(s) • If underdrains are equipped with a flow restrictor (e.g., orifice) to attenuate flows, the orifice must be cleaned regularly
Raised subsurface overflow pipe	Clean pipe as needed	Clean orifice at least biannually (may need more frequent cleaning during wet season)	Plant roots, sediment or debris reducing capacity of underdrain	• Jet clean or rotary cut debris/roots from underdrain(s) • If underdrains are equipped with a flow restrictor (e.g., orifice) to attenuate flows, the orifice must be cleaned regularly
Outlet structure	A, S		Sediment, vegetation, or debris reducing capacity of outlet structure	• Clear the blockage • Identify the source of the blockage and take actions to prevent future blockages
Overflow	B		Native soil is exposed or other signs of erosion damage are present at discharge point	Repair erosion and stabilize surface

Table V-4.5.2(22) Maintenance Standards - Permeable Pavement (continued)

Component	Recommended Frequency [a]		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
Aggregate Storage Reservoir				
Observation port	A, S		Water remains in the storage aggregate longer than anticipated by design after the end of a storm	If immediate cause of extended ponding is not identified, schedule investigation of subsurface materials or other potential causes of system failure.
Vegetation				
Adjacent large shrubs or trees		As needed	Vegetation related fallout clogs or will potentially clog voids	• Sweep leaf litter and sediment to prevent surface clogging and ponding • Prevent large root systems from damaging subsurface structural components
		Once in May and Once in September	Vegetation growing beyond facility edge onto sidewalks, paths, and street edge	Edging and trimming of planted areas to control groundcovers and shrubs from overreaching the sidewalks, paths and street edge improves appearance and reduces clogging of permeable pavements by leaf litter, mulch and soil.
Leaves, needles, and organic debris		In fall (October to December) after leaf drop (1-3 times, depending on canopy cover)	Accumulation of organic debris and leaf litter	Use leaf blower or vacuum to blow or remove leaves, evergreen needles, and debris (i.e., flowers, blossoms) off of and away from permeable pavement
Note that the inspection and routine maintenance frequencies listed above are recom-				

Table V-4.5.2(22) Maintenance Standards - Permeable Pavement (continued)

Component	Recommended Frequency [a]		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
mended by Ecology. They do not supersede or replace the municipal stormwater permit requirements for inspection frequency required of municipal stormwater permittees for "stormwater treatment and flow control BMPs/facilities". a Frequency: A= Annually; B= Biannually (twice per year); S = Perform inspections after major storm events (24-hour storm event with a 10-year or greater recurrence interval). b Inspection should occur during storm event.				

Appendix C: Catch Basin Inspection Procedure

Appendix C

Catch Basin Inspection Procedure

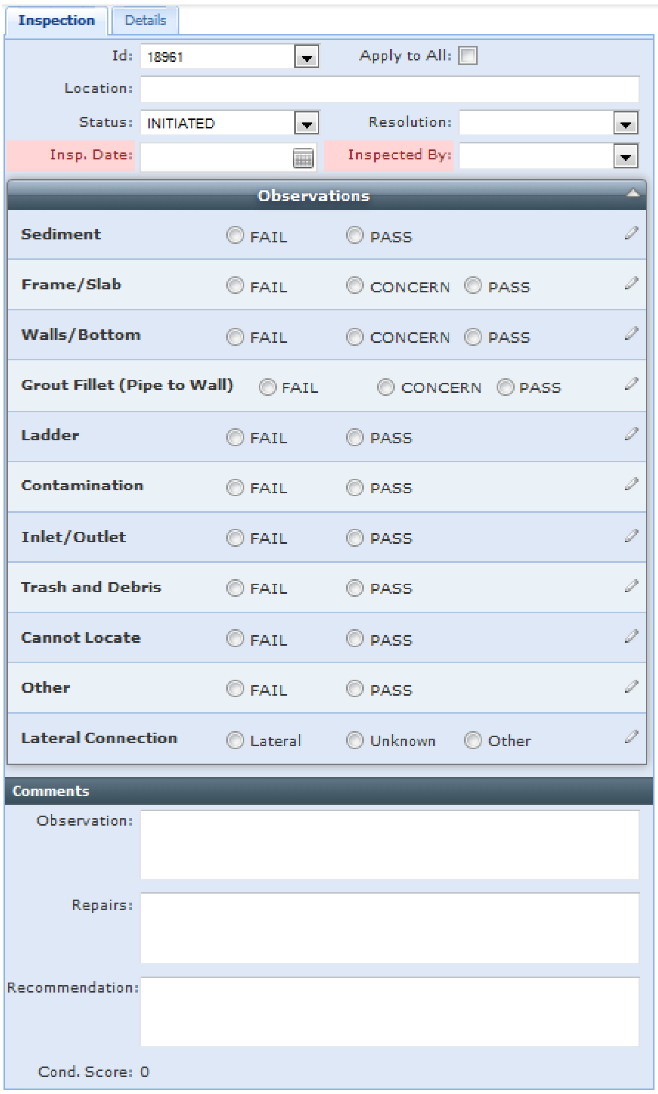
Catch basin inspections require two staff members. Staff member one is responsible for driving the vehicle, routing, and completing the Cityworks Inspection Forms. Staff member two is responsible for the visual inspection of the catch basin which includes probing the catch basin for sediment depth.

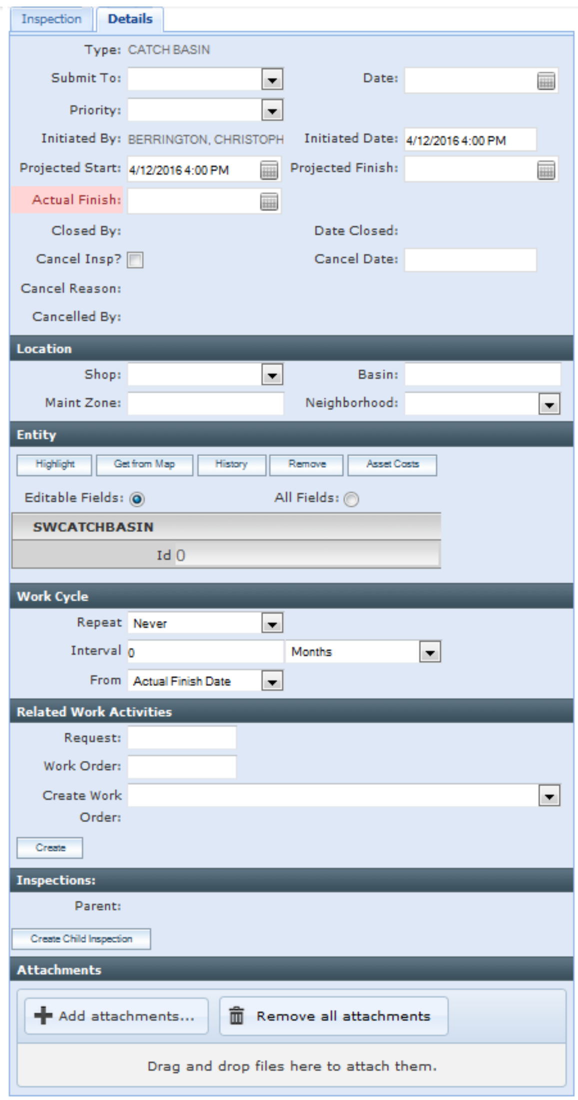
Upon arriving at a catch basin:

- Staff Member one activates the light bar and positions the vehicle next to the catch basin. Staff member one remains in the vehicle and prepares to record inspection observations.
- Staff member two exits the vehicle and removes the catch basin lid and reports observations to staff member one.
- Staff member one records the inspection observations.
- In the event of a structural failure staff member one exits the vehicle and documents the failure with photographs.
- In the event of a sediment failure staff member one spawns a vactor sediment work order from the inspection form.
- Staff member two either re-enters the vehicle or walks to the next catch basin depending on the location of the next catch basin.

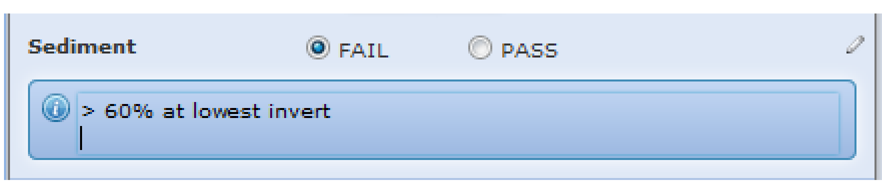
If a catch basin fails one or a combination of the structural observations, photos are taken and attached to the inspection template. One picture demonstrates an overview of the catch basin's location. Additional pictures are taken to document the failure/failures.

The following figures demonstrate the inspection form and the custom inspection observations. The custom inspection observations have been configured to reflect best management practices (BMPs) from the 2012 Stormwater Management Manual for Western Washington.

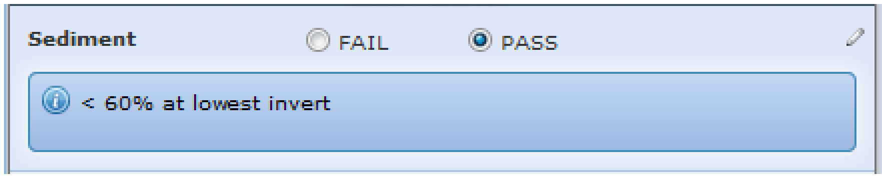




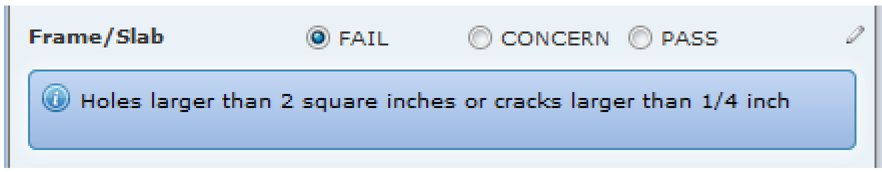
The sediment observation is pass/fail. If sediment is greater than 60 percent of the sump at the lowest invert, select fail. A sediment failure requires the creation of a vactor sediment work order.



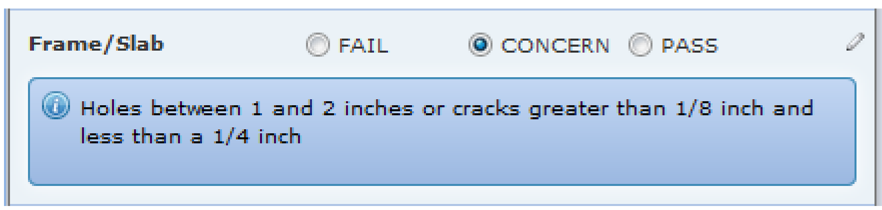
If the sediment is less than 60 percent of the sump at the lowest invert, select pass.



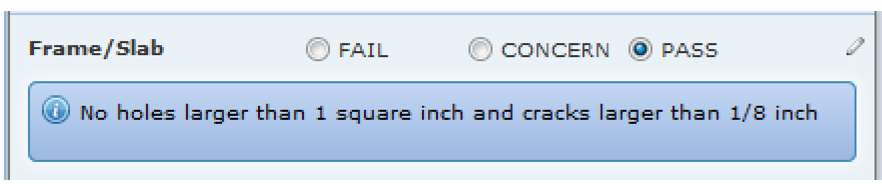
If the top slab or frame slab connection has holes larger than 2 square inches or cracks wider than ¼ inch, select fail.



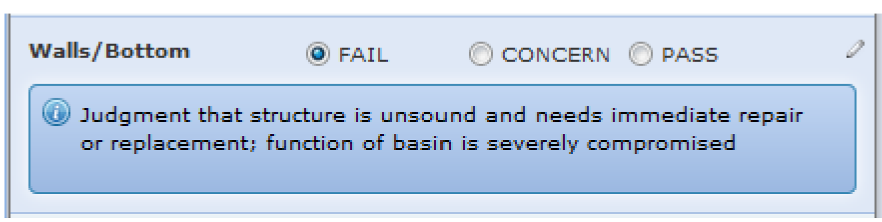
If the top slab or frame slab connection has holes between 1 and 2 square inches or cracks greater than 1/8 inch and less than ¼ inch, select concern.



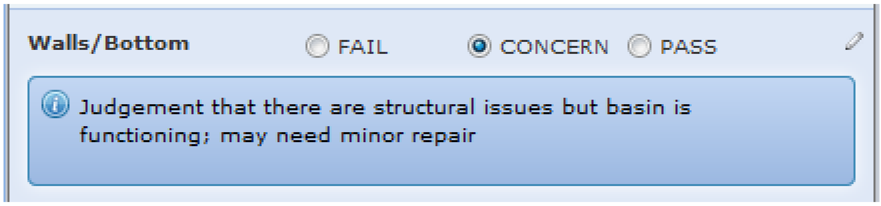
If the top slab or frame slab connection has holes less than 1 square inch or cracks less than 1/8 inch, select pass.



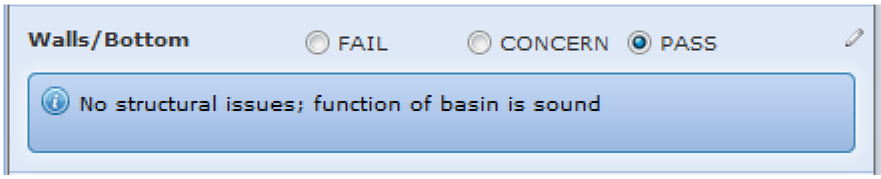
If the structure is judged to be unsound, select fail.



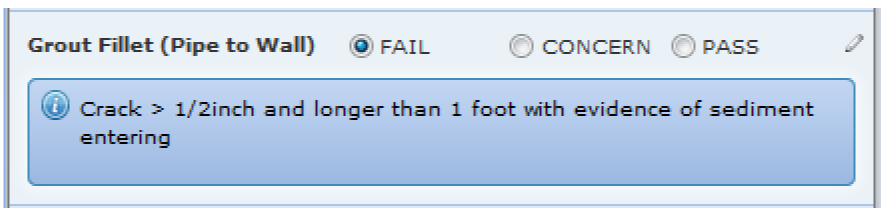
If the structure has structural issues but does not require immediate repair, select concern.



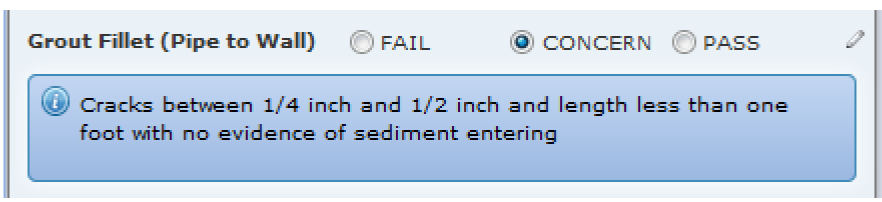
If the structure has no structural issues, select pass.



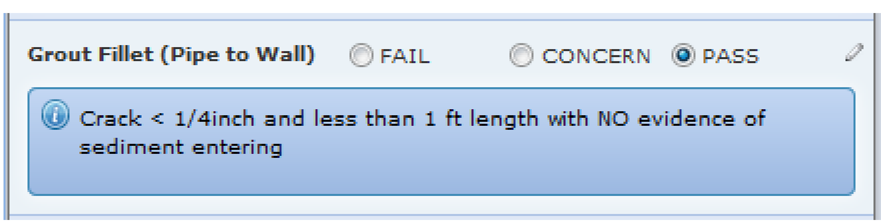
If the grout fillet has separated or cracked wider than ½ inch and longer than one foot at the joint of any inlet/outlet pipe or any evidence of soil particles entering the catch basin through the cracks, select fail.



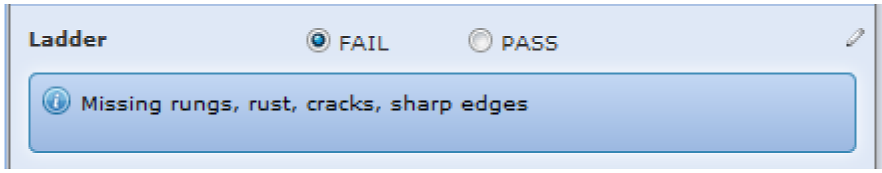
If the grout fillet has separated or cracks between 1/4 inch and ½ inch and the length is less than one foot at the joint of any inlet/outlet pipe and there is no evidence of soil particles entering the catch basin through the cracks, select concern.



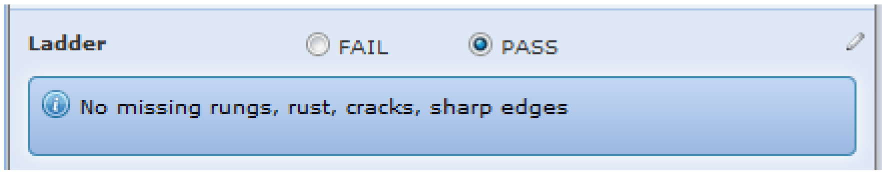
If the grout fillet has not separated or cracks less than 1/4 inch and a length less than one foot at the joint of any inlet/outlet pipe and there is no evidence of soil particles entering the catch basin through the cracks, pass.



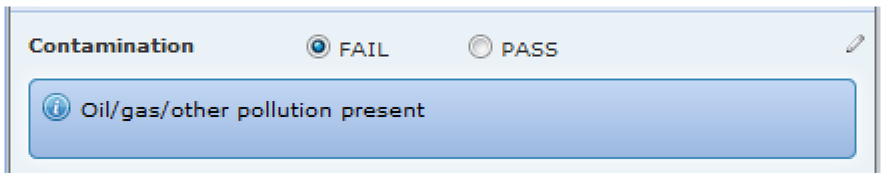
Ladders in type 2 catch basins are inspected to determine if they are safe. Conditions that warrant failure include: missing rungs, not attached securely, rust, or sharp edges.



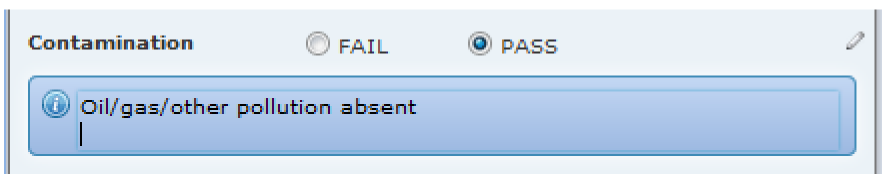
Conditions that warrant pass include: all rungs intact, attached securely, no rust, no cracks, and no sharp edges.



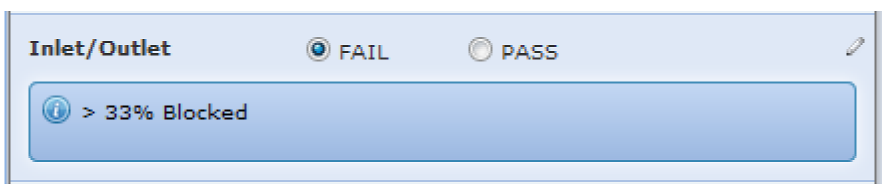
If contamination is detected either by site or smell, select fail.



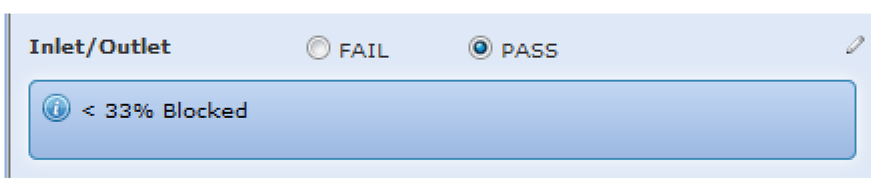
If contamination is not detected, select pass.



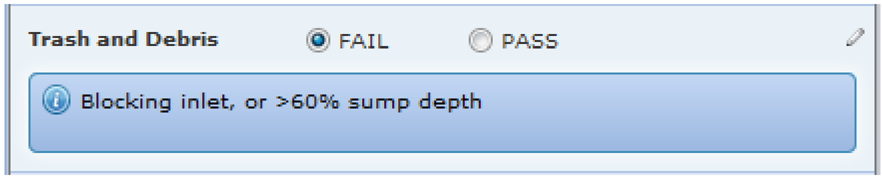
If the sediment is blocking 33 percent of the inlet or outlet, select fail.



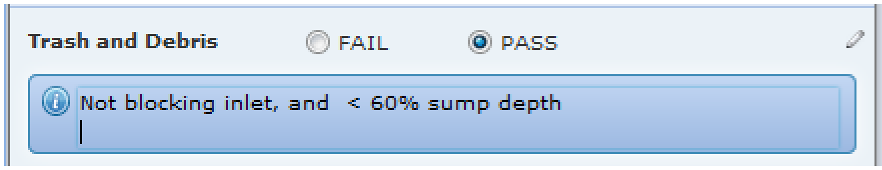
If the sediment is not blocking 33 percent of the inlet or outlet, select pass.



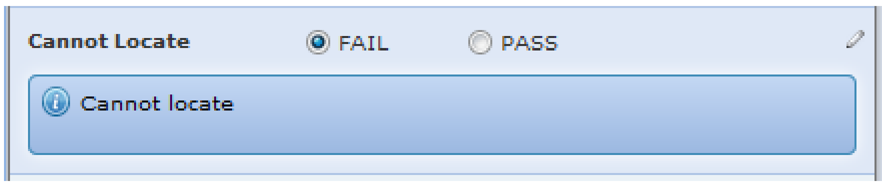
If trash or debris exceeds 60 percent of the sump depth or is blocking the inlet, select fail.



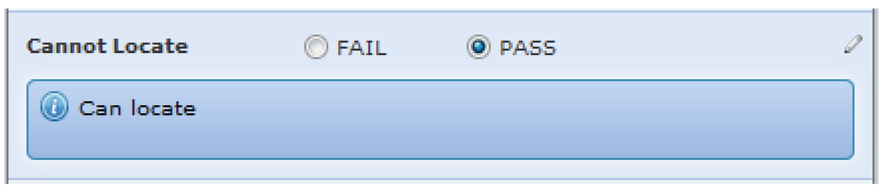
If trash or debris is less than 60 percent of the sump depth and is not blocking the inlet, select pass.



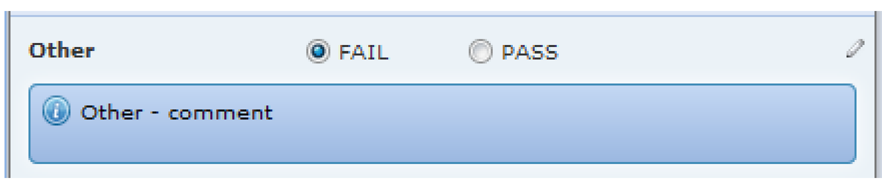
If the catch basin cannot be located, select fail.



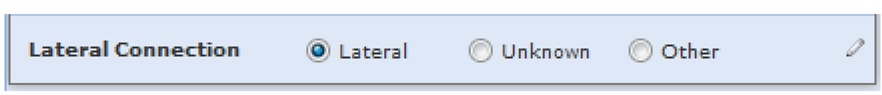
If the catch basin can be located, select pass.



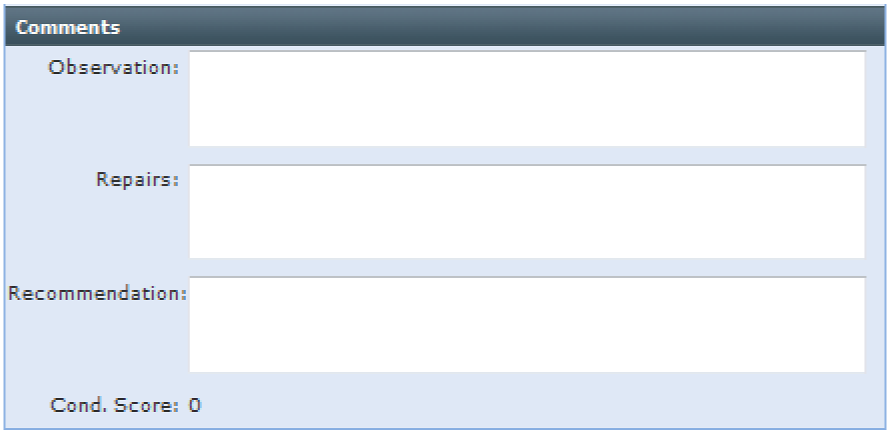
Other can be used for any condition that is deemed unacceptable and is not covered by the other observation categories.



Lateral connection is used to identify unmapped lateral connections.



The Comments section is used to provide additional information. For example, if a lateral connection is selected the following information should be gathered: pipe size, pipe material, and pipe orientation.



Procedure for creating repair/replace work orders

After each month of catch basin inspections, inspection forms will be queried in order to determine which catch basins require repair or replacement. In order to create the maintenance work orders, eight Cityworks searches must be completed.

Cityworks Searches for Creating Maintenance Workorders
• Frame/Slab, Walls/Bottom, and Grout Fillet
• Frame/Slab, Walls/Bottom (Pass or Concern on Grout Fillet)
• Frame/Slab, Grout Fillet (Pass or Concern on Walls/Bottom)
• Walls/Bottom and Grout Fillet (Pass or Concern on Frame/Slab)
• Frame/Slab (Pass or Concern on Walls/Bottom and Grout Fillet)
• Walls Bottom (Pass or Concern on Frame/Slab and Grout Fillet)
• Grout Fillet (Pass or Concern on Frame/Slab and Walls Bottom)
• Total Work Orders/Assets

After completing each search, highlight the assets within Cityworks and create the appropriate work order. The six-month window for completing the work will begin once the work orders are created.

Appendix D: Ditch Maintenance Inspection Procedure

Appendix D

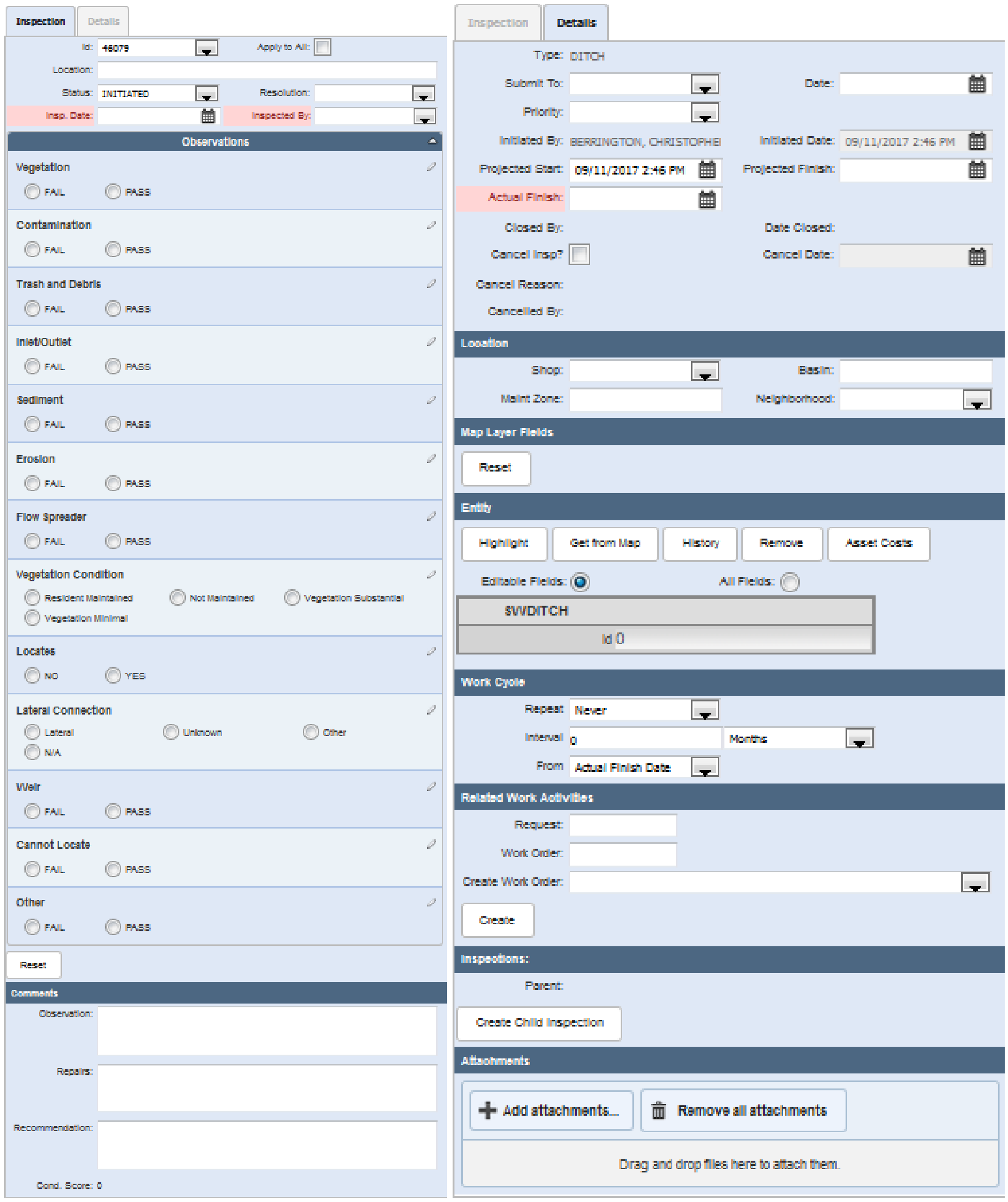
Ditch Maintenance Inspection Procedure

Ditch Inspections require one staff member. The staff member is responsible for driving the vehicle, routing, visual inspection, probing the ditch (as necessary), and completing the Cityworks Inspection Forms.

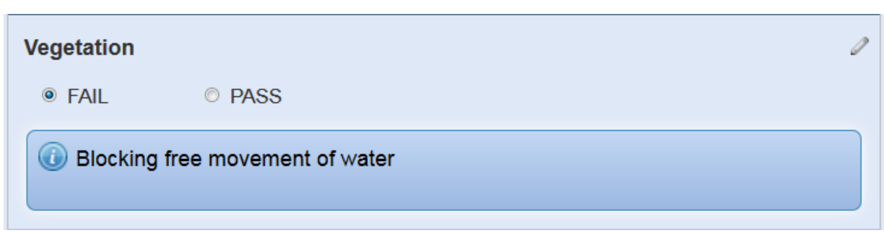
Upon arriving at a ditch:

- The staff member will activate the truck's light bar and position the vehicle next to the ditch.
- The staff member exits the vehicle and records inspection observations.
- In the event of a failure, the staff member will create a repair work order.

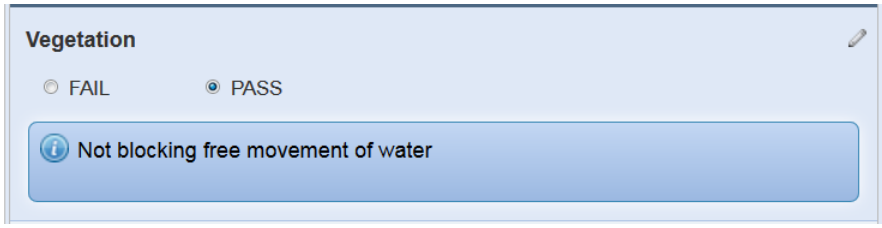
The following figures demonstrate the inspection form and the custom inspection observations. The custom inspection observations have been configured to reflect best management practices (BMPs) from the 2012 Stormwater Management Manual for Western Washington.



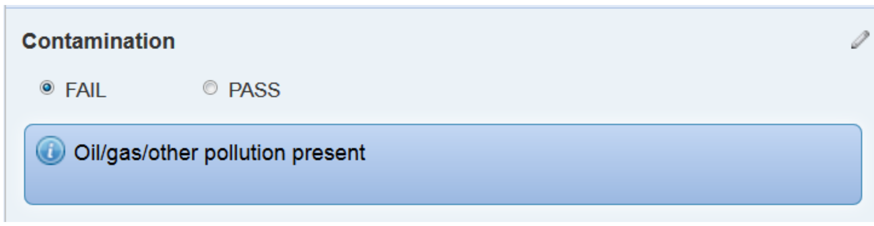
If vegetation is blocking the free movement of water, select fail.



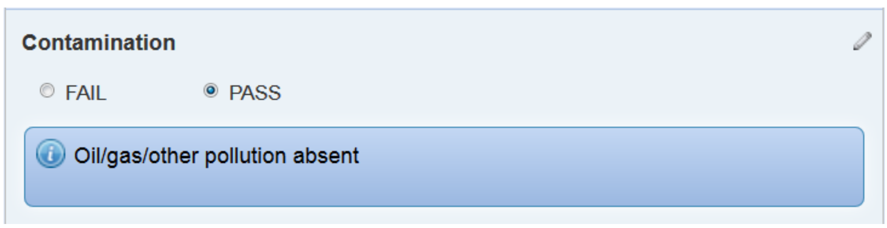
If vegetation is not blocking the free movement of water, select pass.



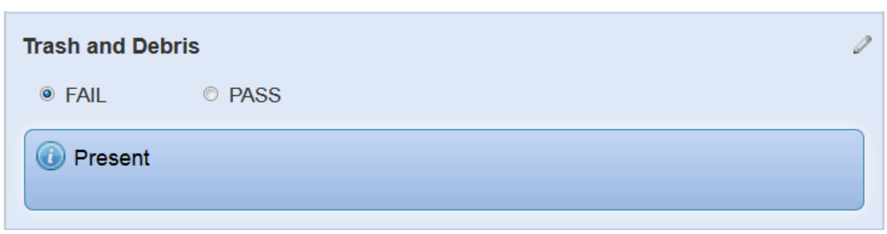
If oil, gas, or other pollution is detected, select fail.



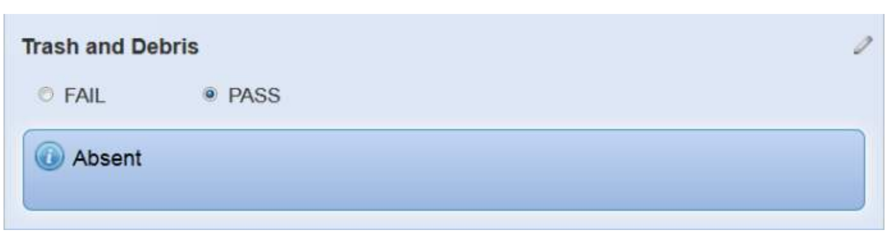
If oil, gas, or other pollution is not detected, select pass.



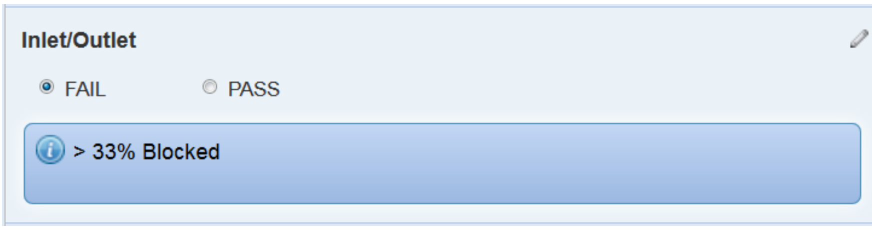
If trash of debris is present, select fail.



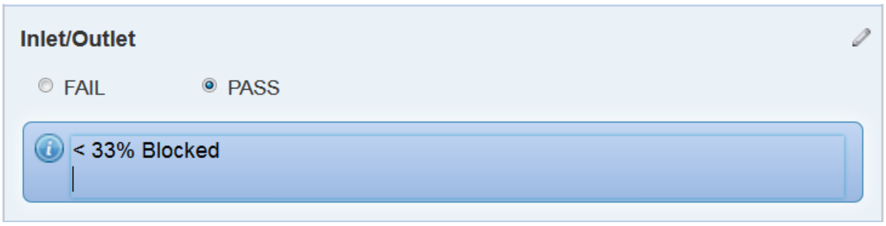
If trash of debris is absent, select pass.



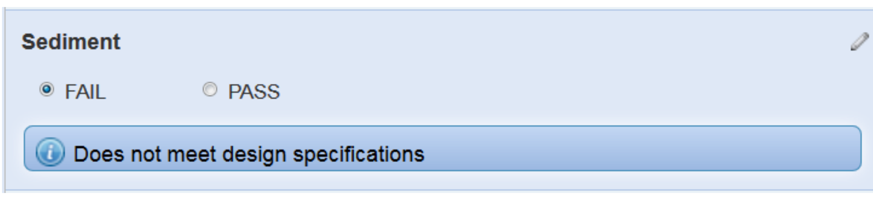
If the inlet or outlet pipe is 33% blocked, select fail.



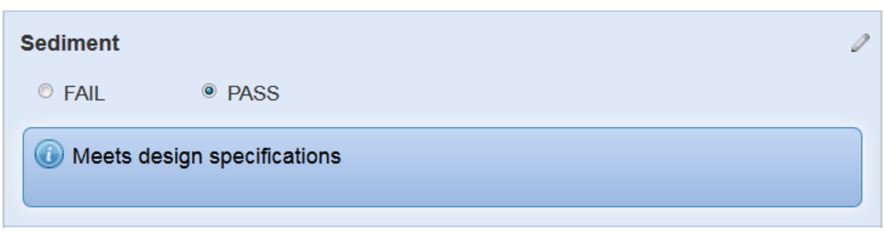
If the inlet or outlet pipe is not 33% blocked, select pass.



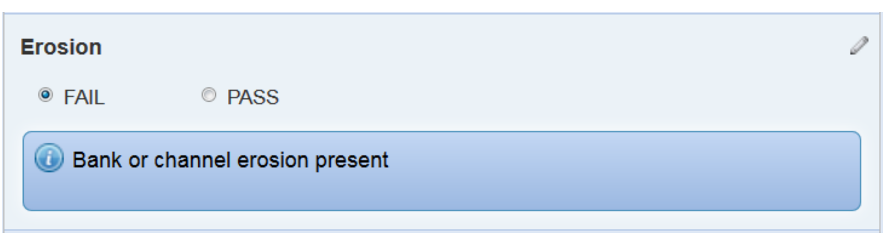
If sediment has accumulated and the ditch no longer conforms to design standards, select fail.



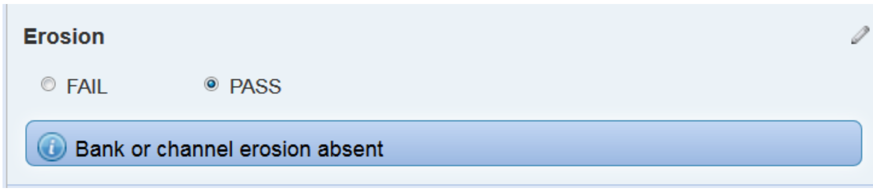
If sediment has not accumulated and the ditch conforms to design standards, select pass.



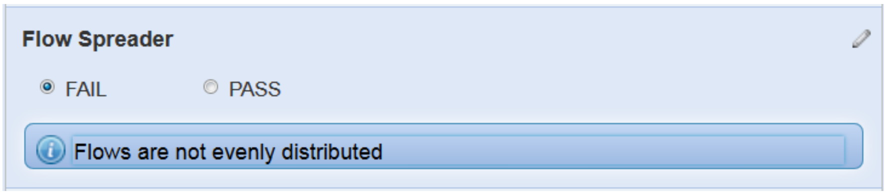
If bank or channel erosion is present, select fail.



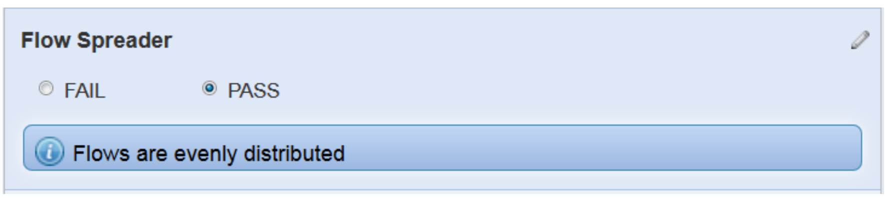
If bank or channel erosion is not present, select pass.



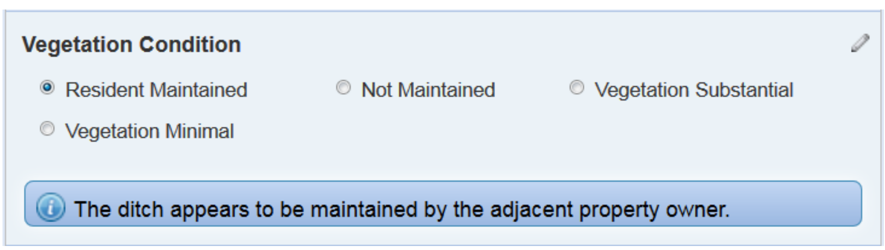
If sheet flow cannot enter the ditch along the length of the ditch, select fail.



If sheet flow can enter the ditch along the length of the ditch, select fail.

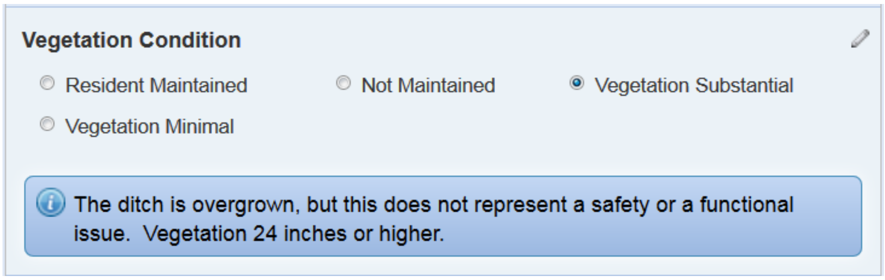


If it appears that the ditch vegetation is maintained by a local resident, select resident maintained.

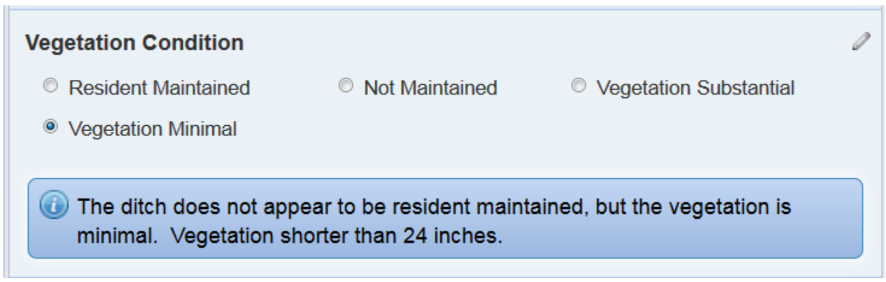


If it appears that the ditch vegetation is not maintained and it does not have any vegetation requiring maintenance, select not maintained.

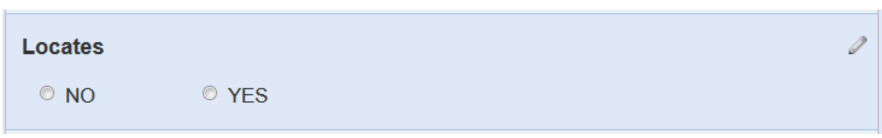
If the ditch vegetation is ≥ 24 inches but does not represent a safety or functional issue, select vegetation substantial.



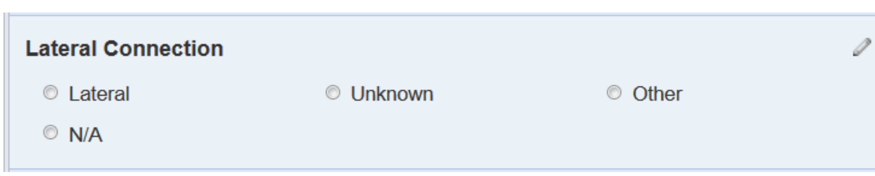
If the ditch does not appear to be resident maintained and the vegetation is < 24 inches, select vegetation minimal.



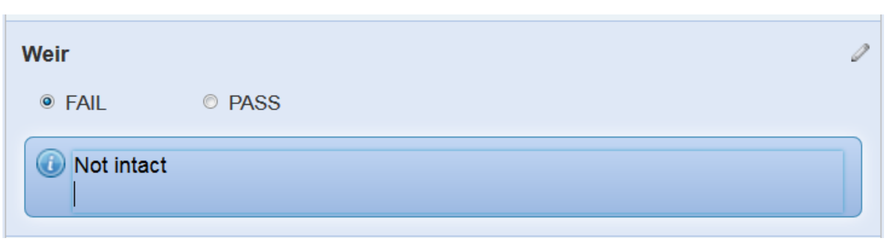
If locates are not required select no. If locates are required select yes.



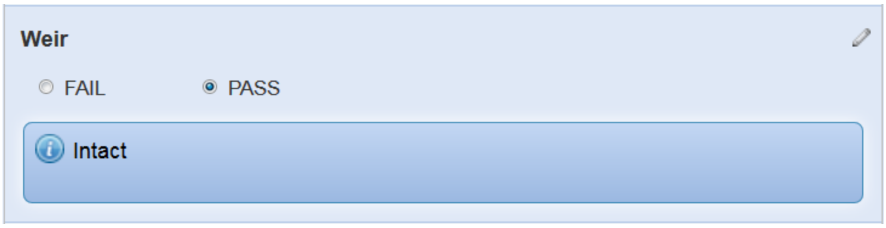
If a lateral connection is detected and it appears to come from a private residence, select lateral. If a lateral connection is detected, but the origin is unclear, select unknown. Other should be used for other situations that do not fall under lateral or unknown.



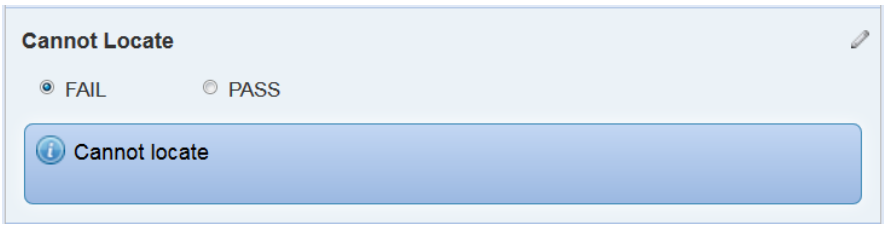
If the ditch has a weir that is no longer intact, select fail.



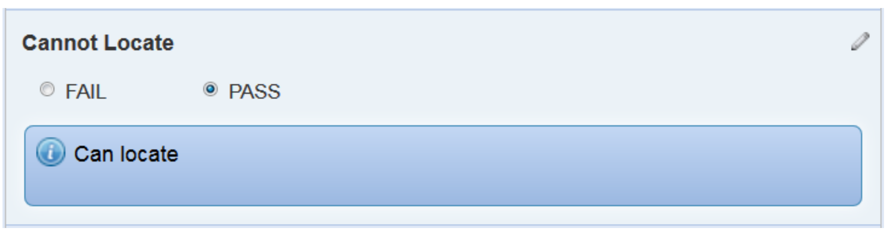
If the ditch has a weir that is intact, select pass.



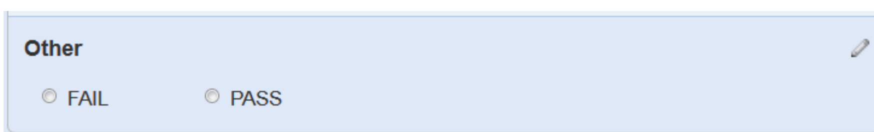
If the ditch cannot be located, select fail.



If the ditch can be located, select pass.



If the ditch has a failure that is not covered with the other custom inspection observations, select fail and record the failure in the comments section of the inspection template.



Appendix E: Aqua-Filter: AquaSwirl Chamber and Filter Media Maintenance Guidance

AQUA-FILTER™

Aqua-Filter™ / Maintenance
Pretreatment Swirl Chamber

The pretreatment hydrodynamic separator (swirl chamber) has been designed to minimize and simplify the inspection and maintenance process. The single swirl chamber system can be inspected and maintained entirely from the surface thereby eliminating the need for confined space entry. There are no areas of the structure that are blocked from visual inspection or periodic cleaning. Inspection of any free-floating oil and floatable debris can be directly observed and maintained through the manhole access provided directly over the swirl chamber.

Swirl Chamber Inspection Procedure

To inspect the pretreatment swirl chamber, a hook is needed to remove the manhole cover. AquaShield™ provides a customized manhole cover with our distinctive logo to make it easy for maintenance crews to locate a system in the field. We also provide a permanent metal information plate affixed inside the access riser which provides our contact information, the model size and serial number.

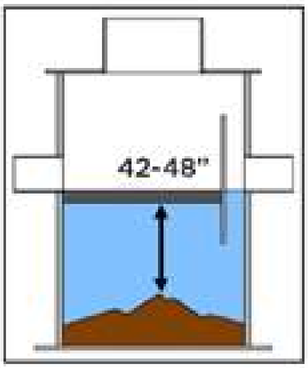
The only tools needed to inspect the swirl chamber are a flashlight and a measuring device such as a stadia rod or pole. Given the easy and direct accessibility provided, floating oil and debris can be observed directly from the surface. Sediment depths can easily be determined by lowering a measuring device to the top of the sediment pile and to the surface of the water.

The maintenance trigger for 3.5 foot to 13 foot diameter swirl chambers occurs when the sediment pile is within 42 to 48 inches of the standing water surface. For the 2.5 foot diameter swirl chamber, maintenance is needed when the top of the sediment pile is measured to be 30 to 32 inches below the standing water surface.

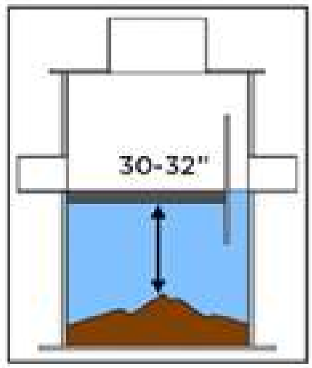
Sediment inspection using a stadia rod in a single pretreatment chamber.

AquaShield™ WATER TREATMENT SOLUTIONS

AQUA-FILTER™



Maintenance trigger for 3.5 to 13 foot diameter swirl chamber occurs when sediment pile is 42-48 inches below water surface.



Maintenance trigger for 2.5 foot diameter swirl chamber occurs when sediment pile is 30-32" inches below water surface.

It should be noted that in order to avoid underestimating the volume of sediment in the chamber, the measuring device must be carefully lowered to the top of the sediment pile. Keep in mind that the finer sediment at the top of the pile may offer less resistance to the measuring device than the larger particles which typically occur deeper within the sediment pile.

The swirl chamber design allows for the sediment to accumulate in a semi-conical fashion as illustrated above. That is, the depth to sediment as measured below the water surface may be less in the center of the swirl chamber; and likewise, may be greater at the edges of the swirl chamber.

Swirl Chamber Cleanout Procedure

Cleaning the pretreatment swirl chamber is simple and quick. Free-floating oil and floatable debris can be observed and removed directly through the 30-inch service access riser provided. A vacuum truck is typically used to remove the accumulated sediment and debris. An advantage of the swirl chamber design is that the entire sediment storage area can be reached with a vacuum hose from the surface (reaching all the sides). Since there are no multiple or limited (hidden or "blind") chambers in the pretreatment hydrodynamic separator, there are no restrictions to impede on-site maintenance tasks.

Disposal of Recovered Materials from Swirl Chamber

Disposal of recovered material is typically handled in the same fashion as catch basin cleanouts. AquaShield™ recommends that all maintenance activities be performed in accordance with appropriate health and safety practices for the tasks and equipment being used. AquaShield™ also recommends that all materials removed from the swirl chamber and any external structures (e.g, bypass features) be handled and disposed in full accordance with any applicable local and state requirements.

AQUA-FILTER™

Aqua-Filter™ / Maintenance

Filter Chamber

The filter media is also easily observed from the surface. Manhole covers are spaced over the entire filtration bed to provide easy access. AquaShield™ provides a customized manhole cover with our logo to make it easy for maintenance crews to locate a system in the field. An entry riser provides direct access into the filtration chamber with a permanent ladder welded into the downstream section of the filtration chamber. This additional access allows for the vacuuming of any standing water and an unobstructed access to the downstream side of the filter bed.

Initially, perlite filter media is light tan or white in color. When the media color turns black or dark brown, it has become saturated due to pollutant loading and requires replacement. Call toll free (888) 344-9044 to order replacement filters.

Replacement of the filtration media typically requires entry into the filtration chamber by one of a two-member maintenance crew. Confined space entry methods should be followed by the maintenance crew when removing and replacing the filters. The spent filter containers are normally retrieved from the filter chamber by a second crewmember at the surface through the multiple 30-inch risers spaced across the top of the filter bed. In addition, the filter containers can be accessed directly from within the filtration chamber via a vertical removable panel (bulkhead door) at the rear of the filter bed and directly across from the ladder.

A permanent ingress/egress ladder provides access to filter chamber. Note metal product identification plate above ladder.

AQUA-FILTER™

Aqua-Filter™ / Maintenance

Filter Media Disposal

Disposal of recovered material is typically handled in the same fashion as catch basin cleanouts. AquaShield™ recommends that all maintenance activities be performed in accordance with appropriate health and safety practices for the tasks and equipment being used. AquaShield™ also recommends that all materials removed from the pretreatment swirl chamber and any external structures (e.g, bypass features) be handled and disposed in full accordance with any applicable local and state requirements.

Spent filter media can often be recycled or sent to a permitted lined landfill. Always check local regulations to ensure proper disposal of spent filter media.

Filter Media Replacement

Instructions and photographs are provided on page 12 showing the procedures to follow to install fresh filter media containers. The bottom of two courses is placed on the fiberglass grates. Cargo netting is used across the top course of the filter containers to secure them in place.

Cargo Netting Installation

Cargo netting is used to secure filter containers in place after containers are installed in the appropriate orientation within the filtration chamber. Cargo netting is placed on top of the top course of filter containers and stretched into place using provided heavy duty cable ties. The netting is cable tied to anchor blocks and attached to the side walls of the filtration chamber. It is important to install the netting in such a way as to both cover the entire surface area of the containers while stretching netting snuggly to minimize container movement under high flow conditions. Netting installation is complete when all surface area of filter containers are covered with netting and netting is secured with cable ties to anchor blocks.

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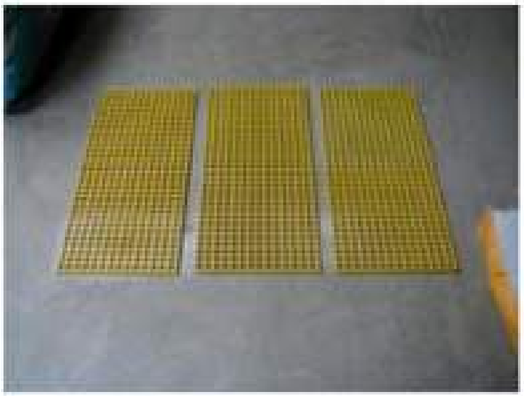
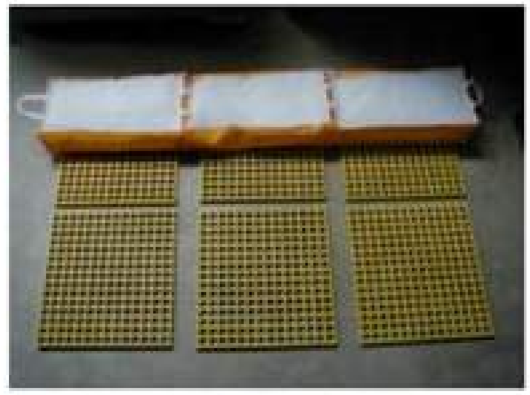
Aqua-Filter™ / Maintenance

Installation instructions for filter containers

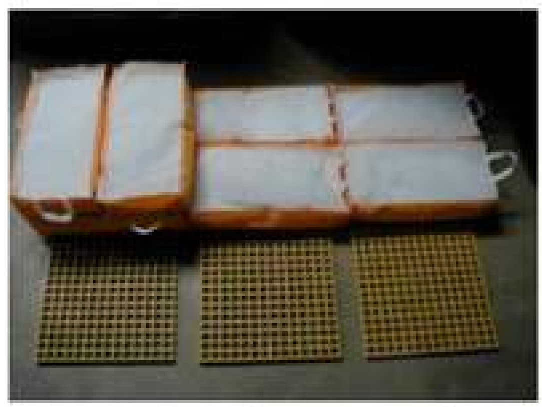


(1) Bottom Grates found in chamber



(2) First row first course

(3) Second row



(4) Second course started

(5) Second course complete

AQUA-FILTER™

Aqua-Filter™
Inspection and Maintenance Manual Work Sheets

SITE & OWNER INFORMATION

Site Name: ______________________

Site Location: ______________________

Date: ______________________ Time: ______________

Inspector Name: ______________________

Inspector Company: ______________________ Phone #: ______________

Owner Name: ______________________

Owner Address: ______________________

Owner Phone #: ______________________ Emergency #: ______________

INSPECTION

Note: Aqua-FilterTM system is a treatment train including pretreatment hydrodynamic separator (swirl chamber) and filtration chamber.

I. Floatable Debris and Oil in Swirl Chamber

1. Remove manhole lid to expose liquid surface of the swirl chamber.
2. Remove floatable debris with basket or net if any present.
3. If oil is present, measure its depth. Clean liquids from system if one half (½) inch or more oil is present.

Note: Water in swirl chamber can appear black and similar to oil due to the dark body of the surrounding structure. Oil may appear darker than water in the system and is usually accompanied by oil stained debris (e.g. Styrofoam, etc.). The depth of oil can be measured with an oil/water interface probe, a stadia rod with water finding paste, a coliwasa, or collect a representative sample with a jar attached to a rod.

II. Sediment Accumulation in Swirl Chamber

1. Lower measuring device (e.g. stadia rod) into swirl chamber through service access provided until top of sediment pile is reached
2. Record distance to top of sediment pile from top of standing water: inches
3. For swirl chambers 3.5 to 13 feet in diameter, schedule cleaning if value in Step #2 is 48 to 42 inches or less.
4. For swirl chamber 2.5 feet in diameter, schedule cleaning if value in Step #2 is 32 to 30 inches or less.

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WATER TREATMENT SOLUTIONS

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Inspection and Maintenance Manual Work Sheets

III. Filtration Chamber

Figure 1.
Removable bulkhead door across from ingress/egress ladder at rear of filtration chamber.

1. Remove manhole lid(s) to expose filter media bed and access ingress/egress ladder. At a minimum, one manhole lid will be present to access ladder. Larger filtration chamber sizes may have one or more manhole lids to access filter media bed.
2. Enter filtration chamber via ladder or through access riser(s) over filter bed. **Note: Water may be present at minimal depths in the filtration chamber prior to clean-out during inspection.**
3. Remove bulkhead door (gate) at downstream end of filtration chamber and across from ladder **(Figure 1)**.
4. Remove filter grate covers/cargo nets and filters through access risers located along filtration chamber length or through ingress/egress ladder manhole.
5. Visually inspect filter media noting color and saturation or contaminants.
6. If (perlite) media is dark brown or black, the media is fully spent and should be replaced **(Figure 2)**.
7. Contact AquaShield™ for replacement filter media containers at (888) 344-9044, or info@aquashieldinc.com.
8. Schedule cleaning as described below.

Figure 2.
Perlite filter media needs replacement.

IV. Diversion Structures (External Bypass Features)

Diversion (external bypass) structures should be inspected as follows:

1. Inspect weir or other bypass feature for structural decay or damage. Weirs are more susceptible to damage than off-set piping and should be checked to confirm that they are not crumbling (concrete or brick) or decaying (steel).
2. Inspect diversion structure and bypass piping for signs of structural damage or blockage from debris or sediment accumulation.
3. When feasible, measure elevations on diversion weir or piping to ensure it is consistent with site plan designs.
4. Inspect downstream (convergence) structure(s) for sign of blockage or structural failure as noted above.

Appendix F: Contech StormFilter Maintenance Guidelines

BI #51

72" StormFilter Manhole (Top Foods)

CONTECH STORMWATER SOLUTIONS

The Stormwater Management StormFilter

Important: Inspection should be performed by a person who is familiar with the StormFilter treatment unit.

StormFilter Maintenance Guidelines

Maintenance requirements and frequency are dependent on the pollutant load characteristics of each site, and may be required in the event of a chemical spill or due to excessive sediment loading.

Maintenance Procedures

Although there are other effective maintenance options, CONTECH recommends the following two step procedure:

1. Inspection: Determine the need for maintenance.
2. Maintenance: Cartridge replacement and sediment removal.

Inspection and Maintenance Activity Timing

At least one scheduled inspection activity should take place per year with maintenance following as warranted.

First, inspection should be done before the winter season. During which, the need for maintenance should be determined and, if disposal during maintenance will be required, samples of the accumulated sediments and media should be obtained.

Second, if warranted, maintenance should be performed during periods of dry weather.

In addition, you should check the condition of the StormFilter unit after major storms for potential damage caused by high flows and for high sediment accumulation. It may be necessary to adjust the inspection/maintenance activity schedule depending on the actual operating conditions encountered by the system.

Generally, inspection activities can be conducted at any time, and maintenance should occur when flows into the system are unlikely.

Maintenance Activity Frequency

Maintenance is performed on an as needed basis, based on inspection. Average maintenance lifecycle is 1-3 years. The primary factor controlling timing of maintenance of the StormFilter is sediment loading. Until appropriate timeline is determined, use the following:

Inspection:

- One time per year
- After major storms

Maintenance:

- As needed
- Per regulatory requirement
- In the event of a chemical spill

Inspection Procedures

It is desirable to inspect during a storm to observe the relative flow through the filter cartridges. If the submerged cartridges are severely plugged, then typically large amounts of sediments will be present and very little flow will be discharged from the drainage pipes. If this is the case, then maintenance is warranted and the cartridges need to be replaced.

Warning: In the case of a spill, the worker should abort inspection activities until the proper guidance is obtained. Notify the local hazard control agency and CONTECH immediately.

To conduct an inspection:

1. If applicable, set up safety equipment to protect and notify surrounding vehicle and pedestrian traffic.
2. Visually inspect the external condition of the unit and take notes concerning defects/problems.
3. Open the access portals to the vault and allow the system vent.
4. Without entering the vault, visually inspect the inside of the unit, and note accumulations of liquids and solids.
5. Be sure to record the level of sediment build-up on the floor of the vault, in the forebay, and on top of the cartridges. If flow is occurring, note the flow of water per drainage pipe. Record all observations. Digital pictures are valuable for historical documentation.
6. Close and fasten the access portals.
7. Remove safety equipment.
8. If appropriate, make notes about the local drainage area relative to ongoing construction, erosion problems, or high loading of other materials to the system.
9. Discuss conditions that suggest maintenance and make decision as to weather or not maintenance is needed.

Maintenance Decision Tree

The need for maintenance is typically based on results of the inspection. Use the following as a general guide. (Other factors, such as regulatory requirements, may need to be considered)

1. Sediment loading on the vault floor. If >4" of accumulated sediment, then go to maintenance.
2. Sediment loading on top of the cartridge. If >1/4" of accumulation, then go to maintenance.
3. Submerged cartridges. If >4" of static water in the cartridge bay for more that 24 hrs after end of rain event, then go to maintenance.
4. Plugged media. If pore space between media granules is absent, then go to maintenance.
5. Bypass condition. If inspection is conducted during an average rain fall event and StormFilter remains in bypass condition (water over the internal outlet baffle wall or submerged cartridges), then go to maintenance.
6. Hazardous material release. If hazardous material release (automotive fluids or other) is reported, then go to maintenance.
7. Pronounced scum line. If pronounced scum line (say ≥ 1/4" thick) is present above top cap, then go to maintenance.
8. Calendar Lifecycle. If system has not been maintained for 3 years, then go to maintenance.

Assumptions:

No rainfall for 24 hours or more.

No upstream detention (at least not draining into StormFilter).

Structure is online. Outlet pipe is clear of obstruction. Construction bypass is plugged.

Maintenance

Depending on the configuration of the particular system, workers will be required to enter the vault to perform the maintenance.

Important: If vault entry is required, OSHA rules for confined space entry must be followed.

Filter cartridge replacement should occur during dry weather. It may be necessary to plug the filter inlet pipe if base flow is occurring.

Replacement cartridges can be delivered to the site or customers facility. Contact CONTECH for more information.

Warning: In the case of a spill, the worker should abort maintenance activities until the proper guidance is obtained. Notify the local hazard control agency and CONTECH immediately.

To conduct cartridge replacement and sediment removal:

1. If applicable, set up safety equipment to protect workers and pedestrians from site hazards.
2. Visually inspect the external condition of the unit and take notes concerning defects/problems.
3. Open the doors (access portals) to the vault and allow the system to vent.
4. Without entering the vault, give the inside of the unit, including components, a general condition inspection.
5. Make notes about the external and internal condition of the vault. Give particular attention to recording the level of sediment build-up on the floor of the vault, in the forebay, and on top of the internal components.
6. Using appropriate equipment offload the replacement cartridges (up to 150 lbs. each) and set aside.
7. Remove used cartridges from the vault using one of the following methods:

Method 1:

A. This activity will require that workers enter the vault to remove the cartridges from the under drain manifold and place them under the vault opening for lifting (removal). Unscrew (counterclockwise rotations) each filter cartridge from the underdrain connector. Roll the loose cartridge, on edge, to a convenient spot beneath the vault access.

   Using appropriate hoisting equipment, attach a cable from the boom, crane, or tripod to the loose cartridge. Contact CONTECH for suggested attachment devices.

> Important: **Cartridges containing leaf media (CSF) do not require unscrewing from their connectors. Do not damage the manifold connectors. They should remain installed in the manifold and can be capped during the maintenance activity to prevent sediments from entering the under drain manifold.**

B. Remove the used cartridges (up to 250 lbs.) from the vault.

> **Important: Avoid damaging the cartridges during removal and installation.**

C. Set the used cartridge aside or load onto the hauling truck.

D. Continue steps A through C until all cartridges have been removed.

Method 2:

A. Enter the vault using appropriate confined space protocols.

B. Unscrew the cartridge cap.

C. Remove the cartridge hood screws (3) hood and float.

D. At location under structure access, tip the cartridge on its side.

> **Important: Note that cartridges containing media other than the leaf media require unscrewing from their threaded connectors. Take care not to damage the manifold connectors. This connector should remain installed in the manifold and capped if necessary.**

E. Empty the cartridge onto the vault floor. Reassemble the empty cartridge.

F. Set the empty, used cartridge aside or load onto the hauling truck.

G. Continue steps a through E until all cartridges have been removed.

8. Remove accumulated sediment from the floor of the vault and from the forebay. Use vacuum truck for highest effectiveness.
9. Once the sediments are removed, assess the condition of the vault and the connectors. The connectors are short sections of 2-inch schedule 40 PVC, or threaded schedule 80 PVC that should protrude about 1" above the floor of the vault. Lightly wash down the vault interior.
   a. If desired, apply a light coating of FDA approved silicon lube to the outside of the exposed portion of the connectors. This ensures a watertight connection between the cartridge and the drainage pipe.
   b. Replace any damaged connectors.
10. Using the vacuum truck boom, crane, or tripod, lower and install the new cartridges. Take care not to damage connections.
11. Close and fasten the door.
12. Remove safety equipment.
13. Finally, dispose of the accumulated materials in accordance with applicable regulations. Make arrangements to return the used empty cartridges to CONTECH.

Material Disposal

The accumulated sediment must be handled and disposed of in accordance with regulatory protocols. It is possible for sediments to contain measurable concentrations of heavy metals and organic chemicals. Areas with the greatest potential for high pollutant loading include industrial areas and heavily traveled roads.

Sediments and water must be disposed of in accordance with applicable waste disposal regulations. Coordinate disposal of solids and liquids as part of your maintenance procedure. Contact the local public works department to inquire how they disposes of their street waste residuals.

800.925.5240
contechstormwater.com

Appendix G: Filterra Maintenance Guidelines

CONTECH® ENGINEERED SOLUTIONS

filterra® Bioretention Systems
A Growing Idea in Stormwater Filtration

Filterra® Maintenance Steps

1. Inspection of Filterra and surrounding area

2. Removal of tree grate and erosion control stones

3. Removal of debris, trash and mulch

4. Mulch replacement

5. Clean area around Filterra

6. Complete paperwork and record plant height and width

Contech has created a network of Certified Maintenance Providers (CCMP's) to provide maintenance on Filterra systems. To find a CCMP in your area please visit www.conteches.com/maintenance

Appendix H: Contech CDS Maintenance Guidelines

CONTECH®
ENGINEERED SOLUTIONS

CDS Guide
Operation, Design, Performance and Maintenance

CDS®

Using patented continuous deflective separation technology, the CDS system screens, separates and traps debris, sediment, and oil and grease from stormwater runoff. The indirect screening capability of the system allows for 100% removal of floatables and neutrally buoyant material without blinding. Flow and screening controls physically separate captured solids, and minimize the re-suspension and release of previously trapped pollutants. Inline units can treat up to 6 cfs, and internally bypass flows in excess of 50 cfs (1416 L/s). Available precast or cast-in-place, offline units can treat flows from 1 to 300 cfs (28.3 to 8495 L/s). The pollutant removal capacity of the CDS system has been proven in lab and field testing.

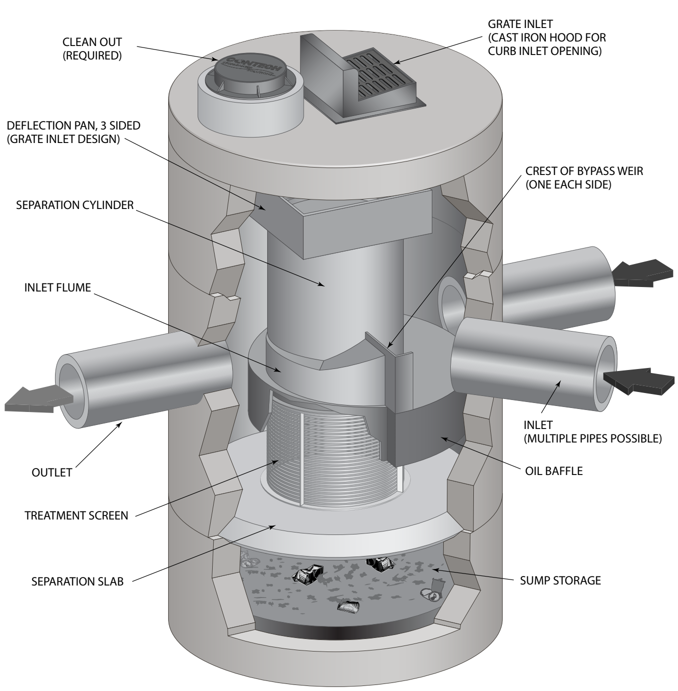
Operation Overview

Stormwater enters the diversion chamber where the diversion weir guides the flow into the unit's separation chamber and pollutants are removed from the flow. All flows up to the system's treatment design capacity enter the separation chamber and are treated.

Swirl concentration and screen deflection force floatables and solids to the center of the separation chamber where 100% of floatables and neutrally buoyant debris larger than the screen apertures are trapped.

Stormwater then moves through the separation screen, under the oil baffle and exits the system. The separation screen remains clog free due to continuous deflection.

During the flow events exceeding the treatment design capacity, the diversion weir bypasses excessive flows around the separation chamber, so captured pollutants are retained in the separation cylinder.



Design Basics

There are three primary methods of sizing a CDS system. The Water Quality Flow Rate Method determines which model size provides the desired removal efficiency at a given flow rate for a defined particle size. The Rational Rainfall Method™ or the and Probabilistic Method is used when a specific removal efficiency of the net annual sediment load is required.

Typically in the Unites States, CDS systems are designed to achieve an 80% annual solids load reduction based on lab generated performance curves for a gradation with an average particle size (d50) of 125 microns (μm). For some regulatory environments, CDS systems can also be designed to achieve an 80% annual solids load reduction based on an average particle size (d50) of 75 microns (μm) or 50 microns (μm).

Water Quality Flow Rate Method

In some cases, regulations require that a specific treatment rate, often referred to as the water quality design flow (WQQ), be treated. This WQQ represents the peak flow rate from either an event with a specific recurrence interval, e.g. the six-month storm, or a water quality depth, e.g. 1/2-inch (13 mm) of rainfall.

The CDS is designed to treat all flows up to the WQQ. At influent rates higher than the WQQ, the diversion weir will direct most flow exceeding the WQQ around the separation chamber. This allows removal efficiency to remain relatively constant in the separation chamber and eliminates the risk of washout during bypass flows regardless of influent flow rates.

Treatment flow rates are defined as the rate at which the CDS will remove a specific gradation of sediment at a specific removal efficiency. Therefore the treatment flow rate is variable, based on the gradation and removal efficiency specified by the design engineer.

Rational Rainfall Method™

Differences in local climate, topography and scale make every site hydraulically unique. It is important to take these factors into consideration when estimating the long-term performance of any stormwater treatment system. The Rational Rainfall Method combines site-specific information with laboratory generated performance data, and local historical precipitation records to estimate removal efficiencies as accurately as possible.

Short duration rain gauge records from across the United States and Canada were analyzed to determine the percent of the total annual rainfall that fell at a range of intensities. US stations' depths were totaled every 15 minutes, or hourly, and recorded in 0.01-inch increments. Depths were recorded hourly with 1-mm resolution at Canadian stations. One trend was consistent at all sites; the vast majority of precipitation fell at low intensities and high intensity storms contributed relatively little to the total annual depth.

These intensities, along with the total drainage area and runoff coefficient for each specific site, are translated into flow rates using the Rational Rainfall Method. Since most sites are relatively small and highly impervious, the Rational Rainfall Method is appropriate. Based on the runoff flow rates calculated for each intensity, operating rates within a proposed CDS system are determined. Performance efficiency curve determined from full scale laboratory tests on defined sediment PSDs is applied to calculate solids removal efficiency. The relative removal efficiency at each operating rate is added to produce a net annual pollutant removal efficiency estimate.

Probabilistic Rational Method

The Probabilistic Rational Method is a sizing program Contech developed to estimate a net annual sediment load reduction for a particular CDS model based on site size, site runoff coefficient, regional rainfall intensity distribution, and anticipated pollutant characteristics.

The Probabilistic Method is an extension of the Rational Method used to estimate peak discharge rates generated by storm events of varying statistical return frequencies (e.g. 2-year storm event). Under the Rational Method, an adjustment factor is used to adjust the runoff coefficient estimated for the 10-year event, correlating a known hydrologic parameter with the target storm event. The rainfall intensities vary depending on the return frequency of the storm event under consideration. In general, these two frequency dependent parameters (rainfall intensity and runoff coefficient) increase as the return frequency increases while the drainage area remains constant.

These intensities, along with the total drainage area and runoff coefficient for each specific site, are translated into flow rates using the Rational Method. Since most sites are relatively small and highly impervious, the Rational Method is appropriate. Based on the runoff flow rates calculated for each intensity, operating rates within a proposed CDS are determined. Performance efficiency curve on defined sediment PSDs is applied to calculate solids removal efficiency. The relative removal efficiency at each operating rate is added to produce a net annual pollutant removal efficiency estimate.

Treatment Flow Rate

The inlet throat area is sized to ensure that the WQQ passes through the separation chamber at a water surface elevation equal to the crest of the diversion weir. The diversion weir bypasses excessive flows around the separation chamber, thus preventing re-suspension or re-entrainment of previously captured particles.

Hydraulic Capacity

The hydraulic capacity of a CDS system is determined by the length and height of the diversion weir and by the maximum allowable head in the system. Typical configurations allow hydraulic capacities of up to ten times the treatment flow rate. The crest of the diversion weir may be lowered and the inlet throat may be widened to increase the capacity of the system at a given water surface elevation. The unit is designed to meet project specific hydraulic requirements.

Performance

Full-Scale Laboratory Test Results

A full-scale CDS system (Model CDS2020-5B) was tested at the facility of University of Florida, Gainesville, FL. This CDS unit was evaluated under controlled laboratory conditions of influent flow rate and addition of sediment.

Two different gradations of silica sand material (UF Sediment & OK-110) were used in the CDS performance evaluation. The particle size distributions (PSDs) of the test materials were analyzed using standard method "Gradation ASTM D-422 "Standard Test Method for Particle-Size Analysis of Soils" by a certified laboratory.

UF Sediment is a mixture of three different products produced by the U.S. Silica Company: "Sil-Co-Sil 106", "#1 DRY" and "20/40 Oil Frac". Particle size distribution analysis shows that the UF Sediment has a very fine gradation (d50 = 20 to 30 μm) covering a wide size range (Coefficient of Uniformity, C averaged at 10.6). In comparison with the hypothetical TSS gradation specified in the NJDEP (New Jersey Department of Environmental Protection) and NJCAT (New Jersey Corporation for Advanced Technology) protocol for lab testing, the UF Sediment covers a similar range of particle size but with a finer d50 (d50 for NJDEP is approximately 50 μm) (NJDEP, 2003).

The OK-110 silica sand is a commercial product of U.S. Silica Sand. The particle size distribution analysis of this material, also included in Figure 1, shows that 99.9% of the OK-110 sand is finer than 250 microns, with a mean particle size (d50) of 106 microns. The PSDs for the test material are shown in Figure 1.

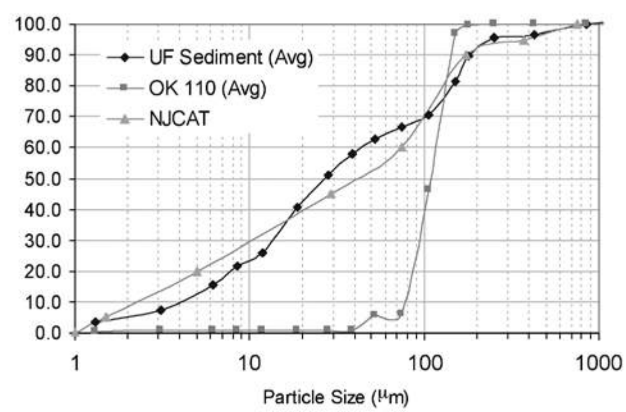


Figure 1. Particle size distributions

Tests were conducted to quantify the performance of a specific CDS unit (1.1 cfs (31.3-L/s) design capacity) at various flow rates, ranging from 1% up to 125% of the treatment design capacity of the unit, using the 2400 micron screen. All tests were conducted with controlled influent concentrations of approximately 200 mg/L. Effluent samples were taken at equal time intervals across the entire duration of each test run. These samples were then processed with a Dekaport Cone sample splitter to obtain representative sub-samples for Suspended Sediment Concentration (SSC) testing using ASTM D3977-97 "Standard Test Methods for Determining Sediment Concentration in Water Samples", and particle size distribution analysis.

Results and Modeling

Based on the data from the University of Florida, a performance model was developed for the CDS system. A regression analysis was used to develop a fitting curve representative of the scattered data points at various design flow rates. This model, which demonstrated good agreement with the laboratory data, can then be used to predict CDS system performance with respect to SSC removal for any particle size gradation, assuming the particles are inorganic sandy-silt. Figure 2 shows CDS predictive performance for two typical particle size gradations (NJCAT gradation and OK-110 sand) as a function of operating rate.

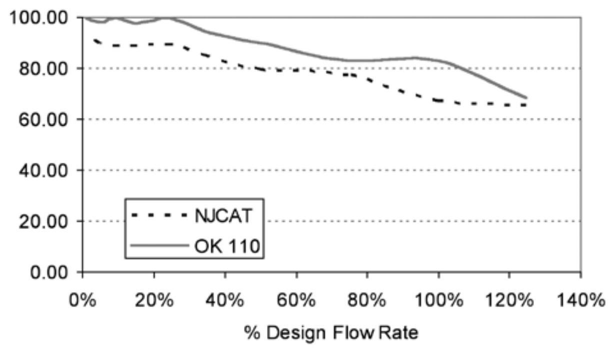


Figure 2. CDS stormwater treatment predictive performance for various particle gradations as a function of operating rate.

Many regulatory jurisdictions set a performance standard for hydrodynamic devices by stating that the devices shall be capable of achieving an 80% removal efficiency for particles having a mean particle size (d50) of 125 microns (e.g. Washington State Department of Ecology — WASDOE - 2008). The model can be used to calculate the expected performance of such a PSD (shown in Figure 3). The model indicates (Figure 4) that the CDS system with 2400 micron screen achieves approximately 80% removal at the design (100%) flow rate, for this particle size distribution (d50 = 125 μm).

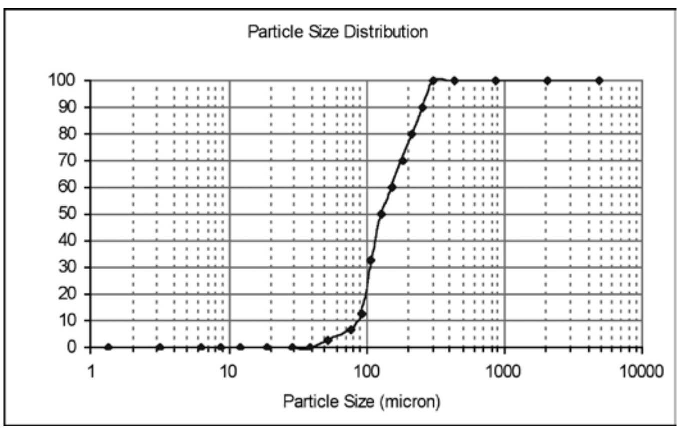


Figure 3. WASDOE PSD

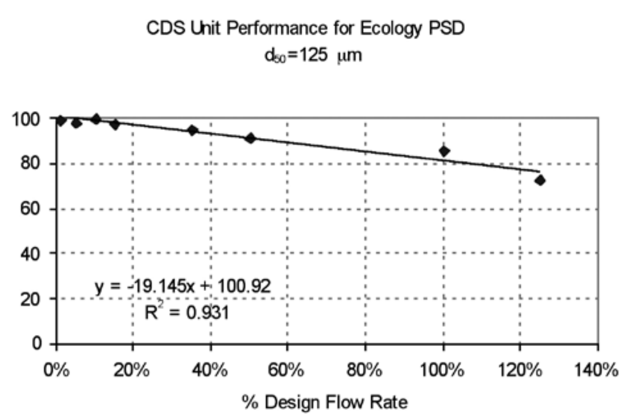


Figure 4. Modeled performance for WASDOE PSD.

Maintenance

The CDS system should be inspected at regular intervals and maintained when necessary to ensure optimum performance. The rate at which the system collects pollutants will depend more heavily on site activities than the size of the unit. For example, unstable soils or heavy winter sanding will cause the grit chamber to fill more quickly but regular sweeping of paved surfaces will slow accumulation.

Inspection

Inspection is the key to effective maintenance and is easily performed. Pollutant transport and deposition may vary from year to year and regular inspections will help ensure that the system is cleaned out at the appropriate time. At a minimum, inspections should be performed twice per year (e.g. spring and fall) however more frequent inspections may be necessary in climates where winter sanding operations may lead to rapid accumulations, or in equipment washdown areas. Installations should also be inspected more frequently where excessive amounts of trash are expected.

The visual inspection should ascertain that the system components are in working order and that there are no blockages or obstructions in the inlet and separation screen. The inspection should also quantify the accumulation of hydrocarbons, trash, and sediment in the system. Measuring pollutant accumulation can be done with a calibrated dipstick, tape measure or other measuring instrument. If absorbent material is used for enhanced removal of hydrocarbons, the level of discoloration of the sorbent material should also be identified

during inspection. It is useful and often required as part of an operating permit to keep a record of each inspection. A simple form for doing so is provided.

Access to the CDS unit is typically achieved through two manhole access covers. One opening allows for inspection and cleanout of the separation chamber (cylinder and screen) and isolated sump. The other allows for inspection and cleanout of sediment captured and retained outside the screen. For deep units, a single manhole access point would allows both sump cleanout and access outside the screen.

The CDS system should be cleaned when the level of sediment has reached 75% of capacity in the isolated sump or when an appreciable level of hydrocarbons and trash has accumulated. If absorbent material is used, it should be replaced when significant discoloration has occurred. Performance will not be impacted until 100% of the sump capacity is exceeded however it is recommended that the system be cleaned prior to that for easier removal of sediment. The level of sediment is easily determined by measuring from finished grade down to the top of the sediment pile. To avoid underestimating the level of sediment in the chamber, the measuring device must be lowered to the top of the sediment pile carefully. Particles at the top of the pile typically offer less resistance to the end of the rod than consolidated particles toward the bottom of the pile. Once this measurement is recorded, it should be compared to the as-built drawing for the unit to determine weather the height of the sediment pile off the bottom of the sump floor exceeds 75% of the total height of isolated sump.

Cleaning

Cleaning of a CDS systems should be done during dry weather conditions when no flow is entering the system. The use of a vacuum truck is generally the most effective and convenient method of removing pollutants from the system. Simply remove the manhole covers and insert the vacuum hose into the sump. The system should be completely drained down and the sump fully evacuated of sediment. The area outside the screen should also be cleaned out if pollutant build-up exists in this area.

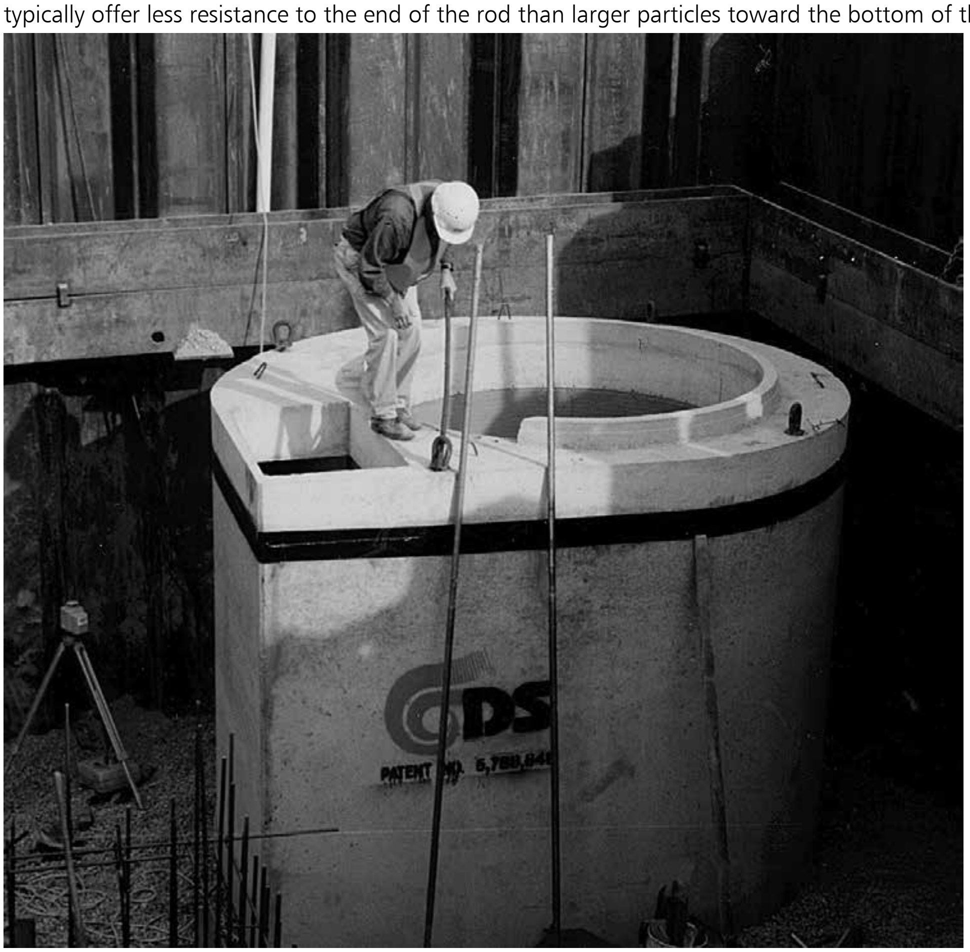
In installations where the risk of petroleum spills is small, liquid contaminants may not accumulate as quickly as sediment. However, the system should be cleaned out immediately in the event of an oil or gasoline spill. Motor oil and other hydrocarbons that accumulate on a more routine basis should be removed when an appreciable layer has been captured. To remove these pollutants, it may be preferable to use absorbent pads since they are usually less expensive to dispose than the oil/water emulsion that may be created by vacuuming the oily layer. Trash and debris can be netted out to separate it from the other pollutants. The screen should be cleaned to ensure it is free of trash and debris.

Manhole covers should be securely seated following cleaning activities to prevent leakage of runoff into the system from above and also to ensure that proper safety precautions have been followed. Confined space entry procedures need to be followed if physical access is required. Disposal of all material removed from the CDS system should be done in accordance with local regulations. In many jurisdictions, disposal of the sediments may be handled in the same manner as the disposal of sediments removed from catch basins or deep sump manholes. Check your local regulations for specific requirements on disposal.

CDS Model	Diameter		Distance from Water Surface to Top of Sediment Pile		Sediment Storage Capacity	
	ft	m	ft	m	y³	m³
CDS1515	3	0.9	3.0	0.9	0.5	0.4
CDS2015	4	1.2	3.0	0.9	0.9	0.7
CDS2015	5	1.5	3.0	0.9	1.3	1.0
CDS2020	5	1.5	3.5	1.1	1.3	1.0
CDS2025	5	1.5	4.0	1.2	1.3	1.0
CDS3020	6	1.8	4.0	1.2	2.1	1.6
CDS3025	6	1.8	4.0	1.2	2.1	1.6
CDS3030	6	1.8	4.6	1.4	2.1	1.6
CDS3035	6	1.8	5.0	1.5	2.1	1.6
CDS4030	8	2.4	4.6	1.4	5.6	4.3
CDS4040	8	2.4	5.7	1.7	5.6	4.3
CDS4045	8	2.4	6.2	1.9	5.6	4.3
CDS5640	10	3.0	6.3	1.9	8.7	6.7
CDS5653	10	3.0	7.7	2.3	8.7	6.7
CDS5668	10	3.0	9.3	2.8	8.7	6.7
CDS5678	10	3.0	10.3	3.1	8.7	6.7

Table 1: CDS Maintenance Indicators and Sediment Storage Capacities

Note: To avoid underestimating the volume of sediment in the chamber, carefully lower the measuring device to the top of the sediment pile. Finer silty particles at the top of the pile may be more difficult to feel with a measuring stick. These finer particles typically offer less resistance to the end of the rod than larger particles toward the bottom of the pile.



CDS Inspection & Maintenance Log

CDS Model: ______________________ Location: ______________________

Date	Water depth to sediment[1]	Floatable Layer Thickness[2]	Describe Maintenance Performed	Maintenance Personnel	Comments

1. The water depth to sediment is determined by taking two measurements with a stadia rod: one measurement from the manhole opening to the top of the sediment pile and the other from the manhole opening to the water surface. If the difference between these measurements is less than the values listed in table 1 the system should be cleaned out. **Note: to avoid underestimating the volume of sediment in the chamber, the measuring device must be carefully lowered to the top of the sediment pile**.

2. For optimum performance, the system should be cleaned out when the floating hydrocarbon layer accumulates to an appreciable thickness. In the event of an oil spill, the system should be cleaned immediately.

SUPPORT

- Drawings and specifications are available at www.ContechES.com.
- Site-specific design support is available from our engineers.

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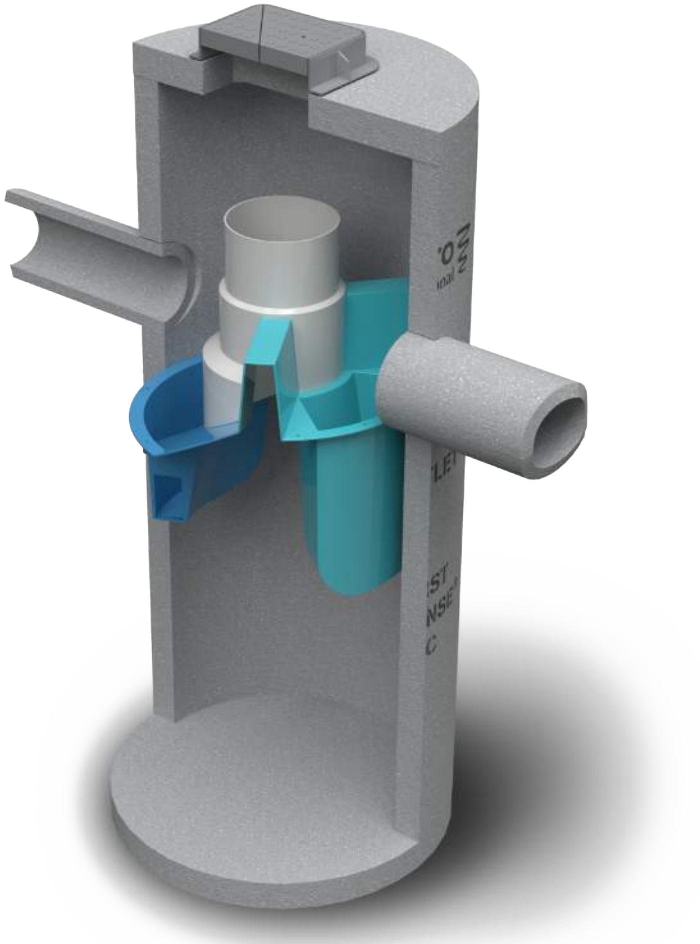
Contech Engineered Solutions provides site solutions for the civil engineering industry. Contech's portfolio includes bridges, drainage, sanitary sewer, earth stabilization and stormwater treatment products. For information on other Contech division offerings, visit www.ContechES.com or call 800.338.1122

RECYCLED PAPER

Appendix I: First Defense Hydro International Maintenance Guidelines



Operation and Maintenance Manual

First Defense® and First Defense® High Capacity

Vortex Separator for Stormwater Treatment

Table of Contents

I. First Defense® by Hydro International

Introduction

The First Defense® is an enhanced vortex separator that combines an effective and economical stormwater treatment chamber with an integral peak flow bypass. It efficiently removes total suspended solids (TSS), trash and hydrocarbons from stormwater runoff without washing out previously captured pollutants. The First Defense® is available in several model configurations (refer to *Section II. Model Sizes & Configurations*, page 4) to accommodate a wide range of pipe sizes, peak flows and depth constraints.

Operation

The First Defense® operates on simple fluid hydraulics. It is self-activating, has no moving parts, no external power requirement and is fabricated with durable non-corrosive components. No manual procedures are required to operate the unit and maintenance is limited to monitoring accumulations of stored pollutants and periodic clean-outs. The First Defense® has been designed to allow for easy and safe access for inspection, monitoring and clean-out procedures. Neither entry into the unit nor removal of the internal components is necessary for maintenance, thus safety concerns related to confined-space-entry are avoided.

Pollutant Capture and Retention

The internal components of the First Defense® have been designed to optimize pollutant capture. Sediment is captured and retained in the base of the unit, while oil and floatables are stored on the water surface in the inner volume (Fig.1).

The pollutant storage volumes are isolated from the built-in bypass chamber to prevent washout during high-flow storm events. The sump of the First Defense® retains a standing water level between storm events. This ensures a quiescent flow regime at the onset of a storm, preventing resuspension and washout of pollutants captured during previous events.

Accessories such as oil absorbent pads are available for enhanced oil removal and storage. Due to the separation of the oil and floatable storage volume from the outlet, the potential for washout of stored pollutants between clean-outs is minimized.

Applications

- Stormwater treatment at the point of entry into the drainage line
- Sites constrained by space, topography or drainage profiles with limited slope and depth of cover
- Retrofit installations where stormwater treatment is placed on or tied into an existing storm drain line
- Pretreatment for filters, infiltration and storage

Advantages

- Inlet options include surface grate or multiple inlet pipes
- Integral high capacity bypass conveys large peak flows without the need for "offline" arrangements using separate junction manholes
- Proven to prevent pollutant washout at up to 500% of its treatment flow
- Long flow path through the device ensures a long residence time within the treatment chamber, enhancing pollutant settling
- Delivered to site pre-assembled and ready for installation

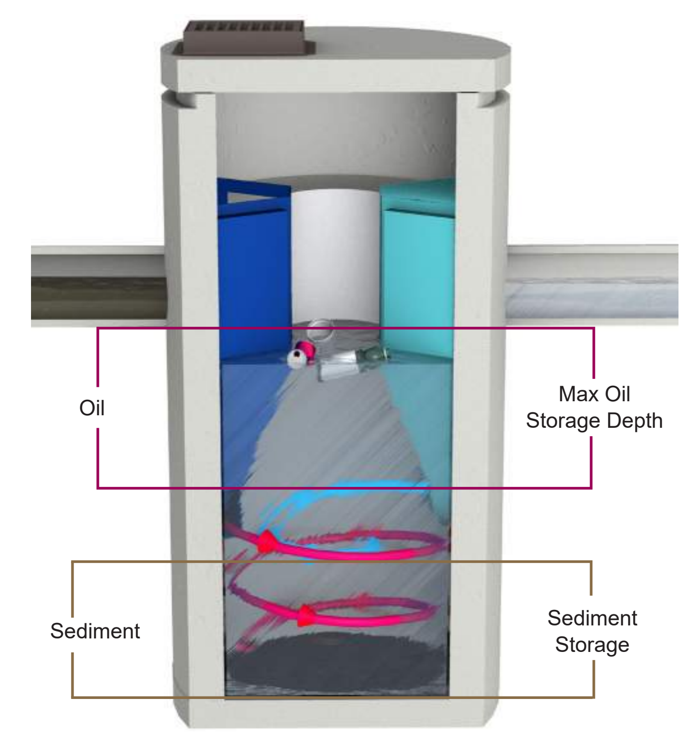


Fig.1 Pollutant storage volumes in the First Defense®.

II. Model Sizes & Configurations

The First Defense® inlet and internal bypass arrangements are available in several model sizes and configurations. The components of the First Defense®-4HC and First Defense®-6HC have modified geometries as to allow greater design flexibility needed to accommodate various site constraints.

All First Defense® models include the internal components that are designed to remove and retain total suspended solids (TSS), gross solids, floatable trash and hydrocarbons (Fig.2a - 2b). First Defense® model parameters and design criteria are shown in Table 1.

First Defense® Components

1. **Built-In Bypass**
2. **Inlet Pipe**
3. **Inlet Chute**
4. **Floatables Draw-off Port**
5. **Outlet Pipe**
6. **Floatables Storage**
7. **Sediment Storage**
8. **Inlet Grate or Cover**

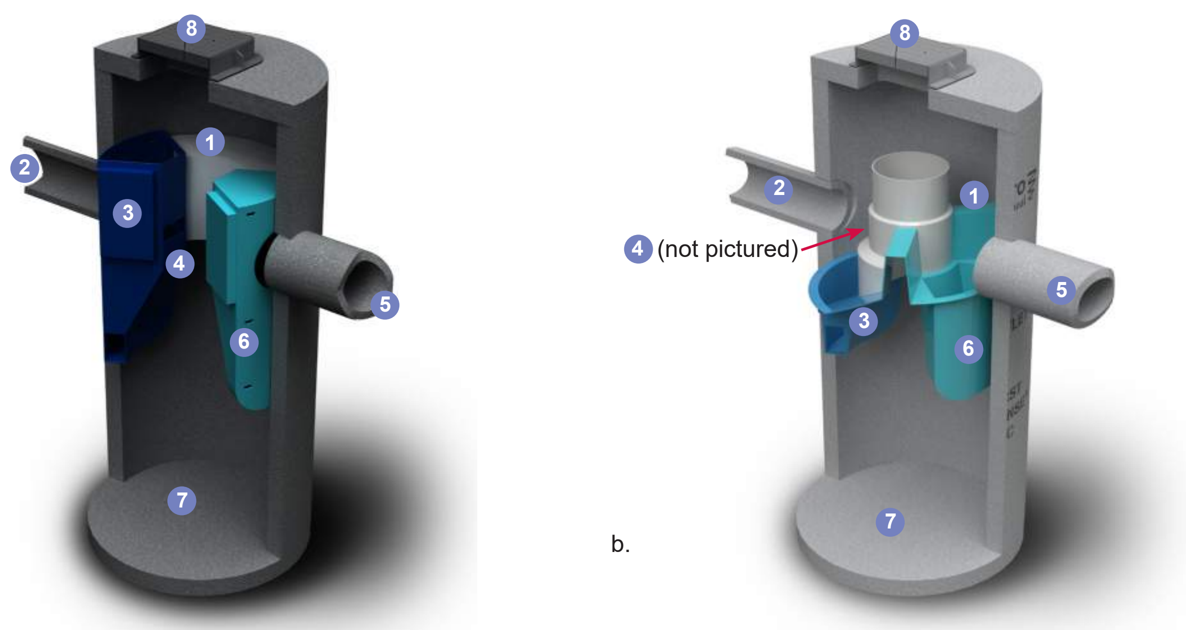


Fig.2a) First Defense®-4 and First Defense®-6; b) First Defense®-4HC and First Defense®-6HC, with higher capacity dual internal bypass and larger maximum pipe diameter.

First Defense® High Capacity Model Number	Diameter	Typical TSS Treatment Flow Rates NJDEP Certified	Peak Online Flow Rate	Maximum Pipe Diameter[1]	Oil Storage Capacity	Typical Sediment Storage Capacity[2]	Minimum Distance from Outlet Invert to Top of Rim[3]	Chamber Depth
	(ft / m)	(cfs / L/s)	(cfs / L/s)	(in / mm)	(gal / L)	(yd³ / m³)	(ft / m)	(ft / m)
FD-3HC	3 / 0.9	0.85 / 24.0	15 / 424	18 / 457	125 / 473	0.4 / 0.3	2.0 - 3.5 / 0.6 - 1.0	3.75 / 1.14
FD-4HC	4 / 1.2	1.50 / 42.4	18 / 510	24 / 600	191 / 723	0.7 / 0.5	2.3 - 3.9 / 0.7 - 1.2	5.00 / 1.52
FD-5HC	5 / 1.5	2.35 / 66.2	20 / 566	24 / 609	300 / 1135	1.1 / .84	2.5 - 4.5 / 0.7 - 1.3	5.25 / 1.60
FD-6HC	6 / 1.8	3.38 / 95.7	32 / 906	30 / 750	496 / 1878	1.6 / 1.2	3.0 - 5.1 / 0.9 - 1.6	6.25 / 1.90
FD-7HC	7 / 2.1	4.60 / 130.2	40 / 1133	42 / 1067	750 / 2839	2.1 / 1.9	3.0 - 5.5 / 0.9 - 1.7	7.25 / 2.20
FD-8HC	8 / 2.4	6.00 / 169.9	50 / 1,415	48 / 1219	1120 / 4239	2.8 / 2.1	3.0 - 6.0 / 0.9 -1.8	8.00 / 2.43

[1]Contact Hydro International when larger pipe sizes are required.
[2]Contact Hydro International when custom sediment storage capacity is required.
[3]Minimum distance for models depends on pipe diameter.

III. Maintenance

Overview

The First Defense® protects the environment by removing a wide range of pollutants from stormwater runoff. Periodic removal of these captured pollutants is essential to the continuous, long-term functioning of the First Defense®. The First Defense® will capture and retain sediment and oil until the sediment and oil storage volumes are full to capacity. When sediment and oil storage capacities are reached, the First Defense® will no longer be able to store removed sediment and oil. Maximum pollutant storage capacities are provided in Table 1.

The First Defense® allows for easy and safe inspection, monitoring and clean-out procedures. A commercially or municipally owned sump-vac is used to remove captured sediment and floatables. Access ports are located in the top of the manhole.

Maintenance events may include Inspection, Oil & Floatables Removal, and Sediment Removal. Maintenance events do not require entry into the First Defense®, nor do they require the internal components of the First Defense® to be removed. In the case of inspection and floatables removal, a vactor truck is not required. However, a vactor truck is required if the maintenance event is to include oil removal and/or sediment removal.

Maintenance Equipment Considerations

The internal components of the First Defense®-HC have a centrally located circular shaft through which the sediment storage sump can be accessed with a sump vac hose. The open diameter of this access shaft is 15 inches in diameter (Fig.3). Therefore, the nozzle fitting of any vactor hose used for maintenance should be less than 15 inches in diameter.

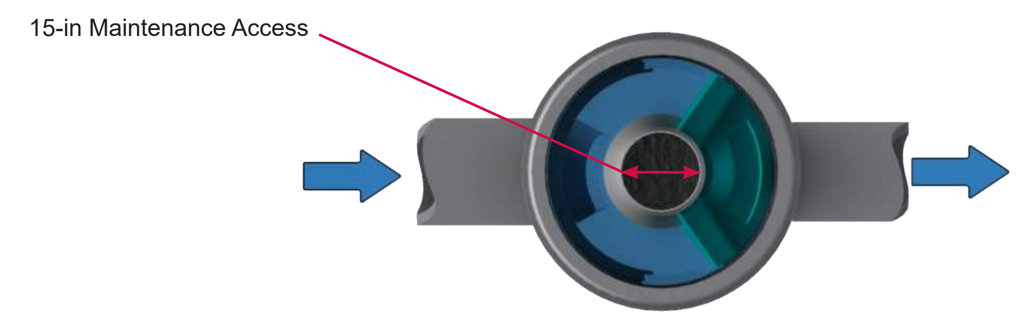


Fig.3 The central opening to the sump of the First Defense®-HC is 15 inches in diameter.

Determining Your Maintenance Schedule

The frequency of clean out is determined in the field after installation. During the first year of operation, the unit should be inspected every six months to determine the rate of sediment and floatables accumulation. A simple probe such as a Sludge-Judge® can be used to determine the level of accumulated solids stored in the sump. This information can be recorded in the maintenance log (see page 9) to establish a routine maintenance schedule.

The vactor procedure, including both sediment and oil / flotables removal, for a 6-ft First Defense® typically takes less than 30 minutes and removes a combined water/oil volume of about 765 gallons.

Inspection Procedures

1. Set up any necessary safety equipment around the access port or grate of the First Defense® as stipulated by local ordinances. Safety equipment should notify passing pedestrian and road traffic that work is being done.

2. Remove the grate or lid to the manhole.

3. Without entering the vessel, look down into the chamber to inspect the inside. Make note of any irregularities. Fig.4 shows the standing water level that should be observed.

4. Without entering the vessel, use the pole with the skimmer net to remove floatables and loose debris from the components and water surface.

5. Using a sediment probe such as a Sludge Judge®, measure the depth of sediment that has collected in the sump of the vessel.

6. On the Maintenance Log (see page 9), record the date, unit location, estimated volume of floatables and gross debris removed, and the depth of sediment measured. Also note any apparent irregularities such as damaged components or blockages.

7. Securely replace the grate or lid.

8. Take down safety equipment.

9. Notify Hydro International of any irregularities noted during inspection.

Floatables and Sediment Clean Out

Floatables clean out is typically done in conjunction with sediment removal. A commercially or municipally owned sump-vac is used to remove captured sediment and floatables (Fig.5).

Floatables and loose debris can also be netted with a skimmer and pole. The access port located at the top of the manhole provides unobstructed access for a vactor hose and skimmer pole to be lowered to the base of the sump.

Scheduling

- Floatables and sump clean out are typically conducted once a year during any season.

- Floatables and sump clean out should occur as soon as possible following a spill in the contributing drainage area.

Fig.4 Floatables are removed with a vactor hose (First Defense model FD-4, shown).

Recommended Equipment

- Safety Equipment (traffic cones, etc)
- Crow bar or other tool to remove grate or lid
- Pole with skimmer or net (if only floatables are being removed)
- Sediment probe (such as a Sludge Judge®)
- Vactor truck (flexible hose recommended)
- First Defense® Maintenance Log

First Defense® Operation and Maintenance Manual

Floatables and sediment Clean Out Procedures

1. Set up any necessary safety equipment around the access port or grate of the First Defense® as stipulated by local ordinances. Safety equipment should notify passing pedestrian and road traffic that work is being done.

2. Remove the grate or lid to the manhole.

3. Without entering the vessel, look down into the chamber to inspect the inside. Make note of any irregularities.

4. Remove oil and floatables stored on the surface of the water with the vactor hose (Fig.5) or with the skimmer or net (not pictured).

5. Using a sediment probe such as a Sludge Judge®, measure the depth of sediment that has collected in the sump of the vessel and record it in the Maintenance Log (page 9).

6. Once all floatables have been removed, drop the vactor hose to the base of the sump. Vactor out the sediment and gross debris off the sump floor (Fig.5).

7. Retract the vactor hose from the vessel.

8. On the Maintenance Log provided by Hydro International, record the date, unit location, estimated volume of floatables and gross debris removed, and the depth of sediment measured. Also note any apparent irregularities such as damaged components, blockages, or irregularly high or low water levels.

9. Securely replace the grate or lid.

Fig.5 Sediment is removed with a vactor hose (First Defense model FD-4, shown).

Maintenance at a Glance

Inspection	- Regularly during first year of installation - Every 6 months after the first year of installation
Oil and Floatables Removal	- Once per year, with sediment removal - Following a spill in the drainage area
Sediment Removal	- Once per year or as needed - Following a spill in the drainage area
NOTE: For most clean outs the entire volume of liquid does not need to be removed from the manhole. Only remove the first few inches of oils and floatables from the water surface to reduce the total volume of liquid removed during a clean out.	

Hydro International

First Defense® Installation Log

HYDRO INTERNATIONAL REFERENCE NUMBER:	
SITE NAME:	
SITE LOCATION:	
OWNER:	CONTRACTOR:
CONTACT NAME:	CONTACT NAME:
COMPANY NAME:	COMPANY NAME:
ADDRESS:	ADDRESS:
TELEPHONE:	TELEPHONE:
FAX:	FAX:

INSTALLATION DATE: / /

MODEL SIZE (CIRCLE ONE): **FD-3HC FD-4 FD-4HC FD-5HC FD-6 FD-6HC FD-7HC FD-8HC**

INLET (CIRCLE ALL THAT APPLY): **GRATED INLET (CATCH BASIN) INLET PIPE (FLOW THROUGH)**

Hydro International (Stormwater), 94 Hutchins Drive, Portland ME 04102
Tel: (207) 756-6200 Fax: (207) 756-6212 Web: www.hydro-int.com

Hydro International

First Defense® Inspection and Maintenance Log

Date	Initials	Depth of Floatables and Oils	Sediment Depth Measured	Volume of Sediment Removed	Site Activity and Comments

Hydro International (Stormwater), 94 Hutchins Drive, Portland ME 04102
Tel: (207) 756-6200 Fax: (207) 756-6212 Web: www.hydro-int.com

Notes

Stormwater Solutions

94 Hutchins Drive
Portland, ME 04102

Tel: (207) 756-6200
Fax: (207) 756-6212
stormwaterinquiry@hydro-int.com

www.hydro-int.com

Turning Water Around...®

FDHC_O+M_H_1703

Appendix J: VortClarex Oil/Water Separator Maintenance Guidelines

BI # 47

VortClarex®

Design and Operation

Basic Operation

Conventional oil/water separators operate on the principal of gravity separation, using baffles or T-pipe sections to retain free-floating oils. With their limited treatment capacities, they are only effective on oil droplets greater than 150 microns. The VortClarex® system builds on this conventional oil/water separator design by incorporating an innovative media designed to maximize the surface area available for the coalescing of oil droplets. A typically sized VortClarex is capable of removing oil droplets down to 60 microns.

The coalescing media or corrugated plates provide a surface onto which oil droplets coalesce. The calcium filled polypropylene media attracts oily substances because of its affinity for hydrocarbons (oleophilic). Oil droplets are then able to combine, forming larger droplets that rise to the surface more quickly - increasing the separation rate and reducing hydrocarbon levels in the effluent. When properly sized the VortClarex system will provide an effluent quality of 10 ppm (parts per million) or less for most stormwater applications.

Flow enters the VortClarex system via a non-clog diffuser that distributes it across the chamber width. The influent passes over a solids baffle wall where settleable solids drop out, reducing the amount of solids in the flow as it enters the coalescing media. As the flow passes through the media, oil droplets accumulate on the surface and come into contact with others to form larger, more buoyant droplets. These larger droplets rise upward through the media and are released near the water surface. The oil is trapped behind the outlet T-pipe, and treated water exits the system.

Maintenance

Inspection

The VortClarex system should be checked periodically to determine if excessive amounts of solids and/or oils have accumulated. Solids accumulation in the lower sections of the VortClarex coalescing media will reduce oil removal efficiencies. Regular inspection and maintenance will eliminate any compromise in performance due to solids build-up.

After the first six (6) months of operation, the inlet area should be inspected and cleaned as follows:
1. Remove separator cover.
2. Dispose of separated oil per regulatory procedures.
3. Remove water from separator.
4. Clean the vault by flushing with a hose and examine the plates for blockage.
5. Remove accumulated sediment with a vacuum truck or positive displacement pump such as an air operated diaphragm pump. The sediment will contain hydrocarbons so proper disposal is required.

Note: Measure and record the depth of the solids in the inlet chamber. If sediment level is 6 inches or more, the cleaning interval should be shortened. If the sediment is less than 6 inches deep, the interval can be increased.

Cleaning

The VortClarex coalescing media can be cleaned either while in the system or after removal from the system.

Cleaning in place

1. Using a water hose, direct spray (10-15 psi) into plate spacing on top of the plate packs.
2. Using a vacuum suction hose, remove any sediment or oily contaminants that are flushed out of the coalescing media.

Cleaning after removal

1. Pump all water and oily contaminants from the VortClarex system.
2. Remove coalescing media.
3. Place media on an impervious surface lined with 6 mil plastic sheeting surrounded by a berm to prevent discharge of contaminated water into surface or groundwater.
4. Flush media with water hose (10-15 psi) to remove heavy oil coating or sludge from between the corrugated plates.
5. Examine tank interior for damage and repair any damage to internal coating.
6. Re-Install plate packs one at a time, one row in length and one row in width, being sure the outer packs are adequately sealed against the vault wall in the same manner as before they were removed.
7. After all packs are installed, check to ensure that the packs are even and touching, forming one (or two if provided) rows of packs across the channel and that they are securely butted against the backing angle at the bottom of the separator. Install the upper channel to ensure the plates are secured in place.
8. Secure hold down channel ensuring it is snugly in place.
9. Check to see that there is no possibility of fluid bypassing around the plates and the side wall of the vault, as well as between plate pack assemblies, since this could adversely affect the efficiency of the separator.

Appendix K: Commercial/Private Facility Inspection Procedure

Appendix K

Commercial/Private Facility Inspection Procedure

Work Flow Tracking (Setting up Inboxes)

Cityworks has been formatted to track the Commercial Inspection process. The Commercial Inspection Program Manager will need to follow these instructions to manage work flow.

The work flow tracking relies on Inboxes using the Work Order panel's Cur Insp Status drop down box and the Actual Start date, and the Projected Finish date. *These must be kept current to track the work flow.* Correspondence to the landowners will be generated as Reports, also based on the Current Inspection Status, Actual Start date, and Projected Finish date.

When initially creating inboxes from Saved Work Order Searches, they will have these Search parameters in common:

1. Entity Group = Surface Water
2. Entity Type = Stormwater Facility
3. Description = Commercial Inspection
4. Projected Start = Projected Start date for that year
5. Closed = N

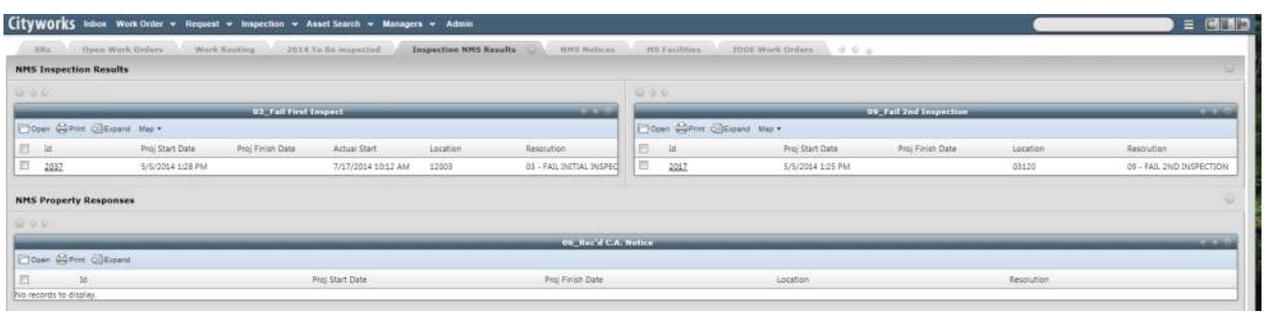
Each Inbox should have these Fields Visible in Search Results:

1. Description
2. Location
3. Address
4. Projected Start Date
5. Actual Start Date
6. Resolution
7. Status

The following Inboxes are required to track work status, and create correspondence:

1. To Be Inspected
    a. Send Initial Inspection Notice: Based on the generic search parameters above, and Resolution = 00 – Send Initial Notice of Inspection
    b. Ready for Initial Inspection: Based on the generic search parameters above, and Resolution = 01 - Initial Notice of Inspection Sent
    c. Reinspection Required: Based on the generic search parameters above, and Resolution = 07 - Rec'd DIY-2nd Inspection

2. Not Met Standards (NMS) Facilities
    a. Fail First Inspection: Based on the generic search parameters above, and Resolution = 03 - Fail Initial Inspection
    b. Fail Second (or more) Inspection: Based on the generic search parameters above, and Resolution = 09 - Fail 2nd Inspection
3. NMS Notices
    a. Send 1st Failure Notice: Based on the generic search parameters above, and Resolution = 04 - Send Initial Notice of Failure
    b. 1st Failure Notice Sent: Based on the generic search parameters above, and Resolution = 05 - 1st Notice of Failure Sent
    c. Send Final Failure Notice-Reinspection, based on the generic search parameters above, and Resolution = 10 - Send Certified Final Notice of Failure-Reinspect
    d. Send Final Failure Notice, based on the generic search parameters above, and Resolution = 11 - Send Certified Final Notice of Failure
    e. Final Failure Notice Sent, based on the generic search parameters above, and Resolution = 12 - Certified Final Notice of Failure Sent
    f. Final Failure: Based on the generic search parameters above, and Resolution = 16 - Does Not Meet Standards for the Year
4. Met Standards (MS) Facilities
    a. Pass Initial Inspection: Based on the generic search parameters above, and Resolution = 02 - Pass Initial Inspection
    b. Professional Corrective Action Received: Based on the generic search parameters above, and Resolution = 06 - Received C.A. Notice and Receipt
    c. Pass Upon Correction: Based on the generic search parameters above, and Resolution = 08 - Pass Upon Correction
5. MS Notices
    a. Send Notice of Pass Initial Inspection: Based on the generic search parameters above, and Resolution = 13 - Send Notice of Pass-Initial
    b. Send Notice of Pass Reinspection: Based on the generic search parameters above, and Resolution = 14 – Send Notice of Pass-Reinspect
    c. Notice of Pass Sent: Based on the generic search parameters above, and Resolution = 15 - Notice of Pass Sent



(Sample of select Inboxes in the Commercial Inspection process)

Initial Inspection Set-up – Create a Saved Search

1. Create an Asset Search based on the facility inspection cycles. The inspection cycles are:
   - Annually
   - Even Year
   - Odd Year

   a. In the Entity Group drop down box, select Surface Water.

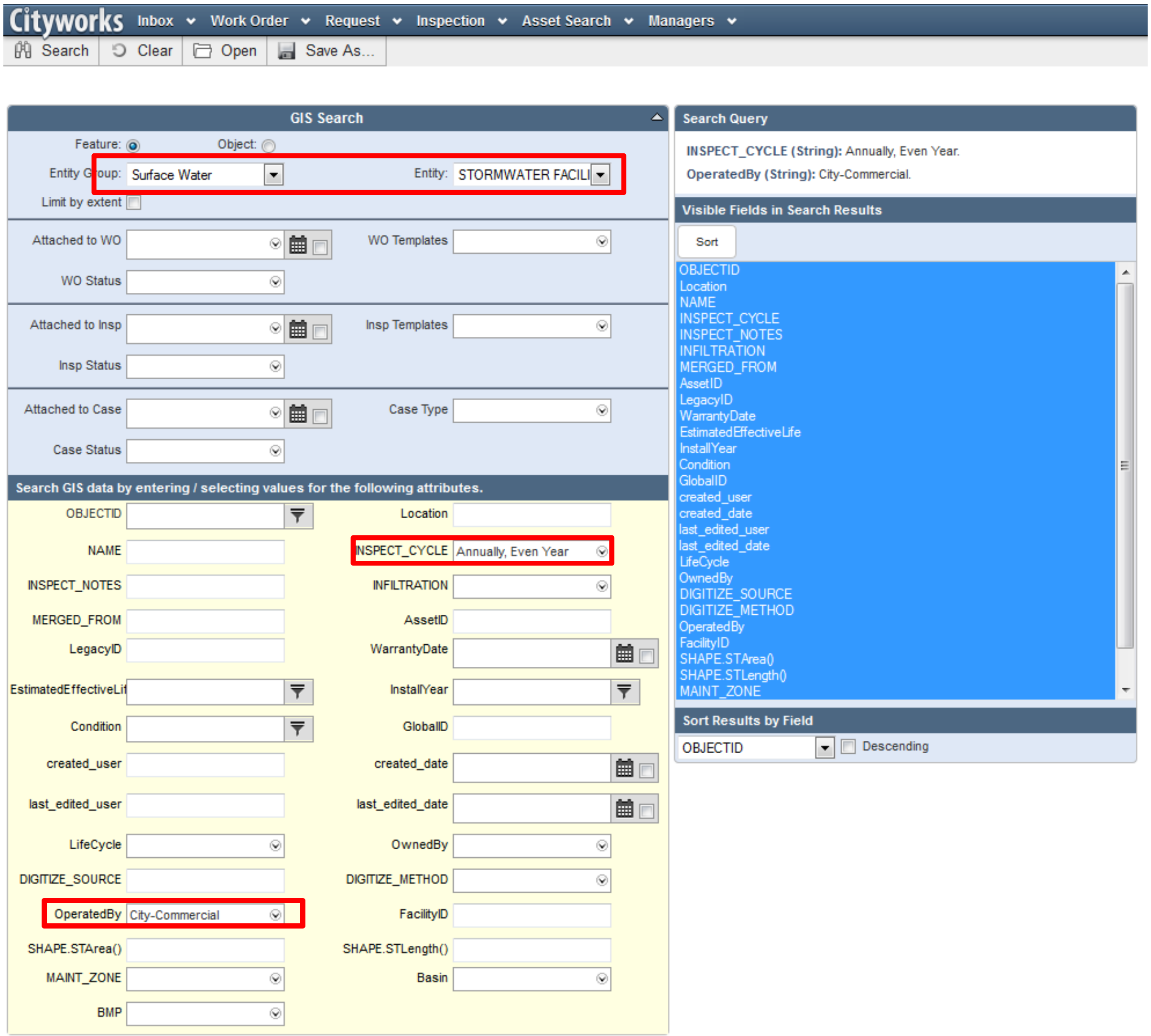
   b. In the Entity drop down box, select Stormwater Facility.

   c. In the Inspect_Cycle drop down box, select the inspection cycle appropriate for that year. For example, in 2016, the City will inspect all facilities on an Annual cycle and on the Even Year cycle, so use the 'Ctrl' button to select both inspection cycles.

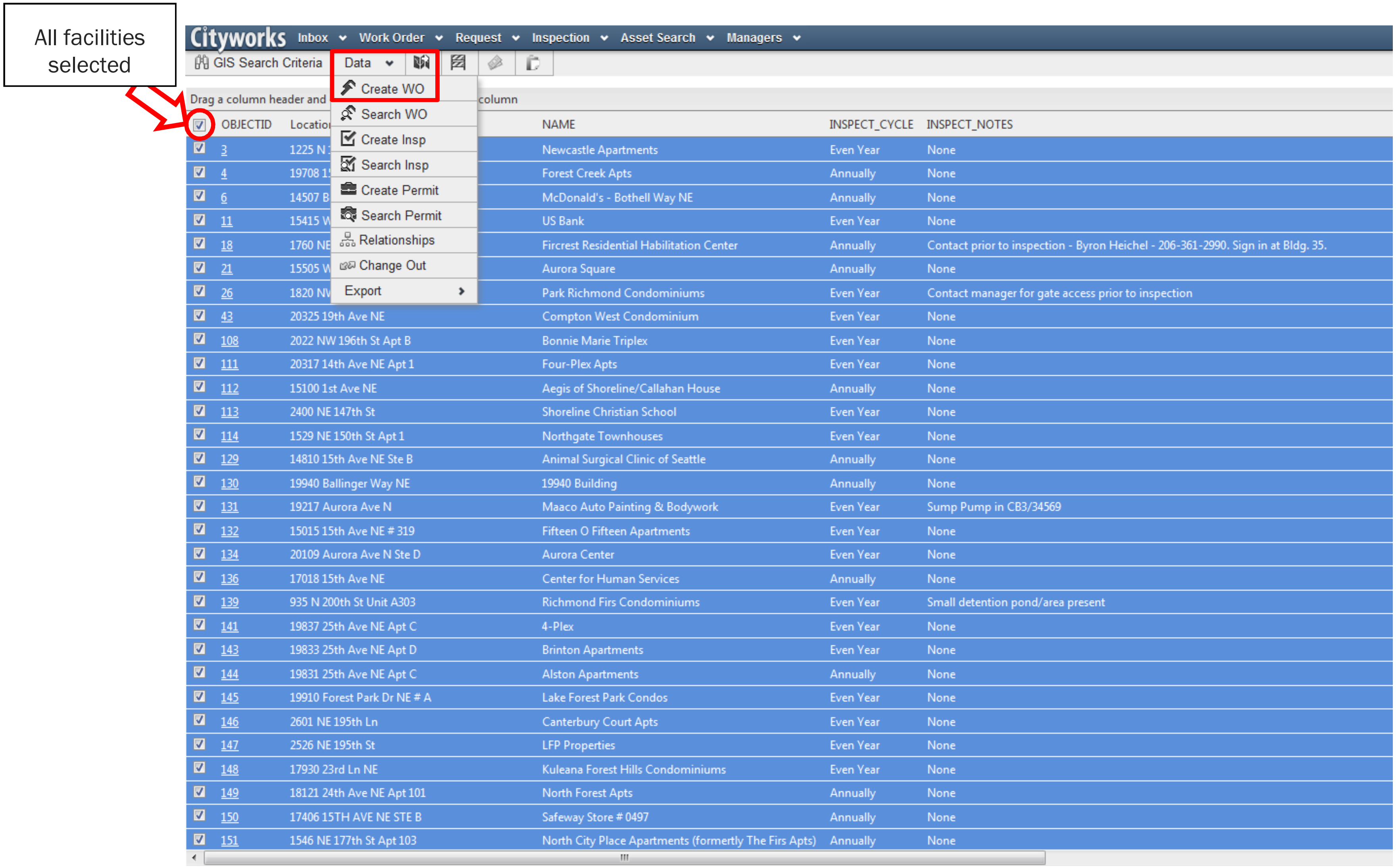
   d. In the OperatedBy drop down box, select City-Commercial.

   e. Click Save As…

f. Name the Asset Search “Even/Odd Year Commercial Inspections”, as appropriate.



2. Open the Saved Asset Search, created in Step 1 above.
3. Create a Commercial Inspection Work Order for **each** Facility.
   a. From the Asset Search, select the facilities.
   b. From the **Data tab**, select **Create WO**.
   c. A new **Select Template** Work Order panel will open.
   d. From the **Entity Group** drop down, choose Surface Water. In the selection boxes, choose **Stormwater Facility** and **Commercial Inspection**.



OBJECTID	Locatio	NAME	INSPECT_CYCLE	INSPECT_NOTES
3	1225 N	Newcastle Apartments	Even Year	None
4	19708 1	Forest Creek Apts	Annually	None
6	14507 B	McDonald's - Bothell Way NE	Annually	None
11	15415 W	US Bank	Even Year	None
18	1760 NE	Fircrest Residential Habilitation Center	Annually	Contact prior to inspection - Byron Heichel - 206-361-2990. Sign in at Bldg. 35.
21	15505 W	Aurora Square	Annually	None
26	1820 NV	Park Richmond Condominiums	Even Year	Contact manager for gate access prior to inspection
43	20325 19th Ave NE	Compton West Condominium	Even Year	None
108	2022 NW 196th St Apt B	Bonnie Marie Triplex	Even Year	None
111	20317 14th Ave NE Apt 1	Four-Plex Apts	Even Year	None
112	15100 1st Ave NE	Aegis of Shoreline/Callahan House	Annually	None
113	2400 NE 147th St	Shoreline Christian School	Even Year	None
114	1529 NE 150th St Apt 1	Northgate Townhouses	Even Year	None
129	14810 15th Ave NE Ste B	Animal Surgical Clinic of Seattle	Annually	None
130	19940 Ballinger Way NE	19940 Building	Annually	None
131	19217 Aurora Ave N	Maaco Auto Painting & Bodywork	Even Year	Sump Pump in CB3/34569
132	15015 15th Ave NE # 319	Fifteen O Fifteen Apartments	Even Year	None
134	20109 Aurora Ave N Ste D	Aurora Center	Even Year	None
136	17018 15th Ave NE	Center for Human Services	Annually	None
139	935 N 200th St Unit A303	Richmond Firs Condominiums	Even Year	Small detention pond/area present
141	19837 25th Ave NE Apt C	4-Plex	Even Year	None
143	19833 25th Ave NE Apt D	Brinton Apartments	Even Year	None
144	19831 25th Ave NE Apt C	Alston Apartments	Annually	None
145	19910 Forest Park Dr NE # A	Lake Forest Park Condos	Even Year	None
146	2601 NE 195th Ln	Canterbury Court Apts	Even Year	None
147	2526 NE 195th St	LFP Properties	Even Year	None
148	17930 23rd Ln NE	Kuleana Forest Hills Condominiums	Even Year	None
149	18121 24th Ave NE Apt 101	North Forest Apts	Annually	None
150	17406 15TH AVE NE STE B	Safeway Store # 0497	Annually	None
151	1546 NE 177th St Apt 103	North City Place Apartments (formertly The Firs Apts)	Annually	None

e. In the **General** panel, set these parameters:

   i. Status = **Initiated**

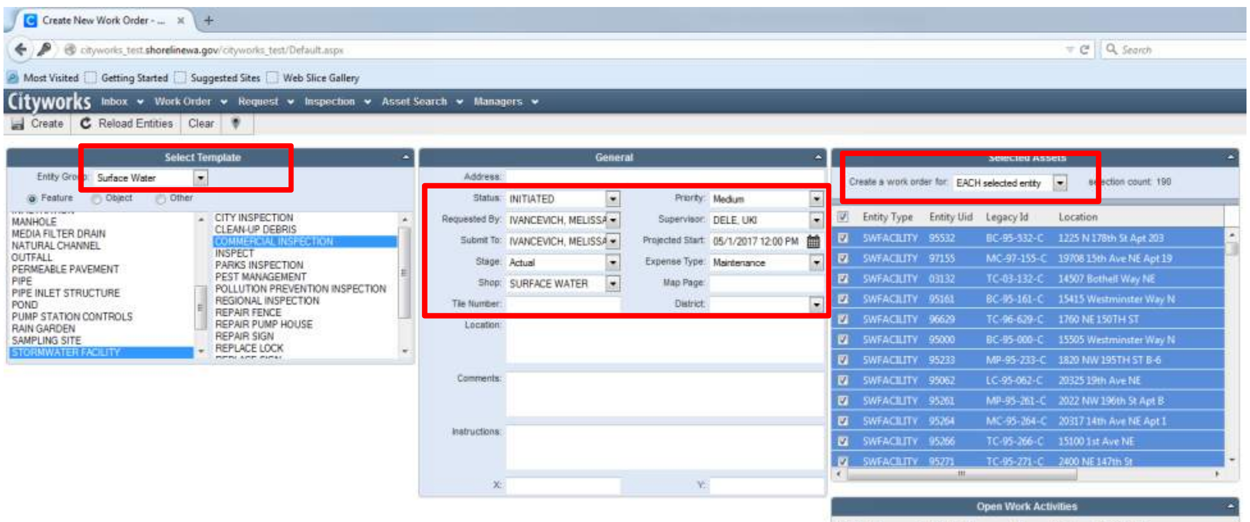
   ii. Requested by = **Your Name**

   iii. Submit to = **Default**

   iv. Projected Start = **Date projected to start, usually May**

   v. Expense Type = **Maintenance**

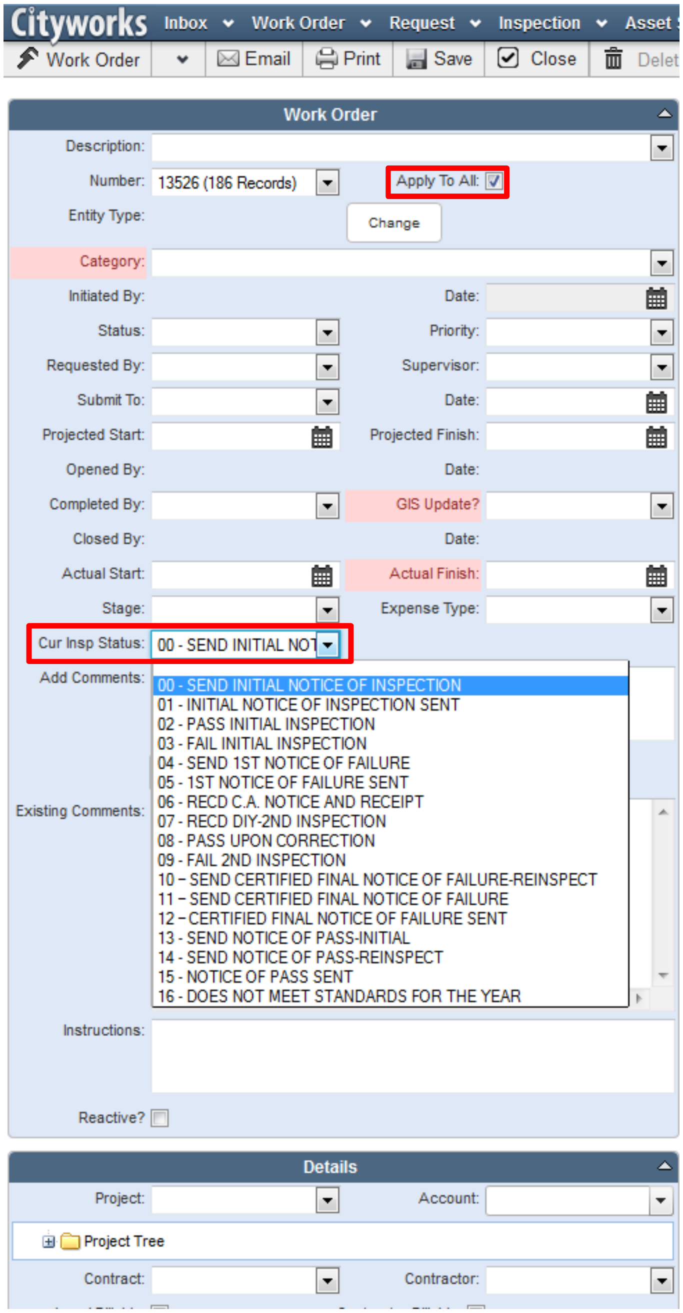
f. Go to the Selected Assets panel. In the Create a work order for drop down box, select <u>EACH selected entity</u>.



g. Select **Create.** Separate Commercial Inspection Work Orders will be created for each facility.

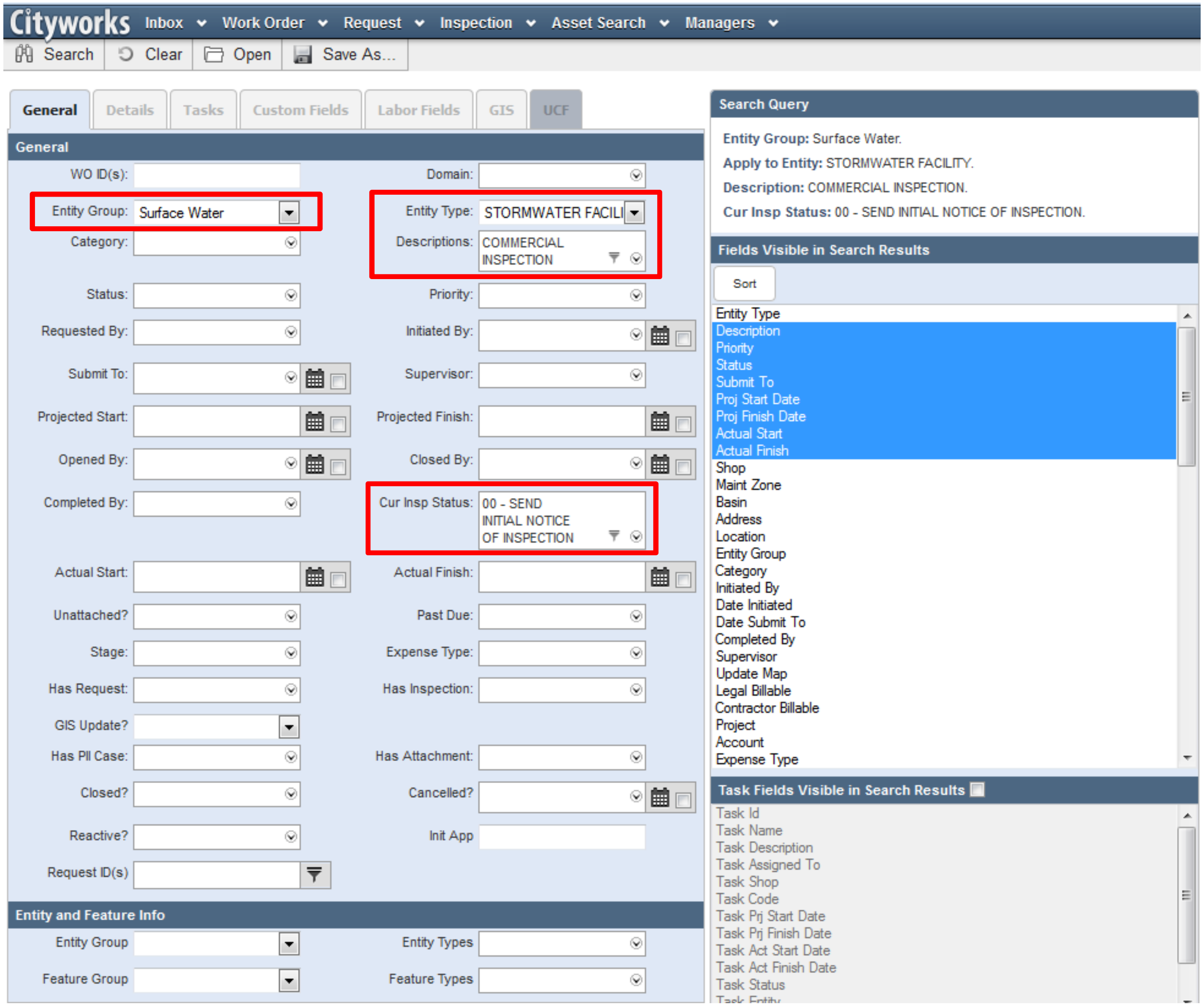
h. Select the **Apply to All** check box.

i. In the **Work Order** panel, find the **Cur Insp Status** drop down box. Select **00 – Send Initial Notice of Inspection.**



   j. Save the Work Orders.

4. Create a **Work Order** search for the Work Orders created in the step above.
   a. In the **Entity Group** drop down box, select **Surface Water.**
   b. In the **Entity** drop down box, select **Stormwater Facility.**
   c. In the **Descriptions** drop down box, select **Commercial Inspection.**
   d. In the **Work Order** panel, find the **Cur Insp Status** drop down box. Select **00 – Send Initial Notice of Inspection.**
   e. Click **Save As…**
   f. Name the Work Order search “Commercial Inspections - Send Initial Inspection Notice”.

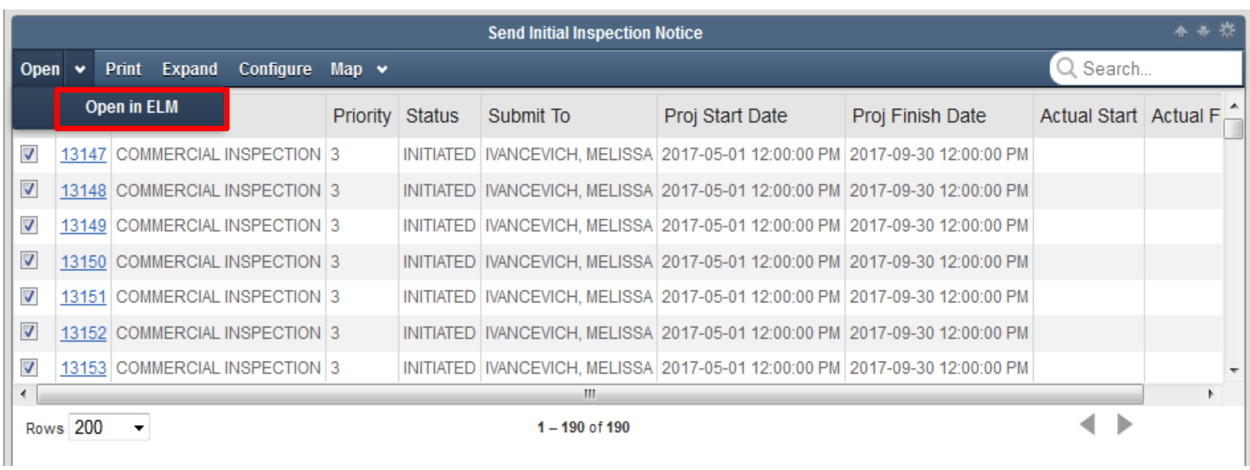


Initial Inspection Set-up - Create the Initial Notice of Inspection Report

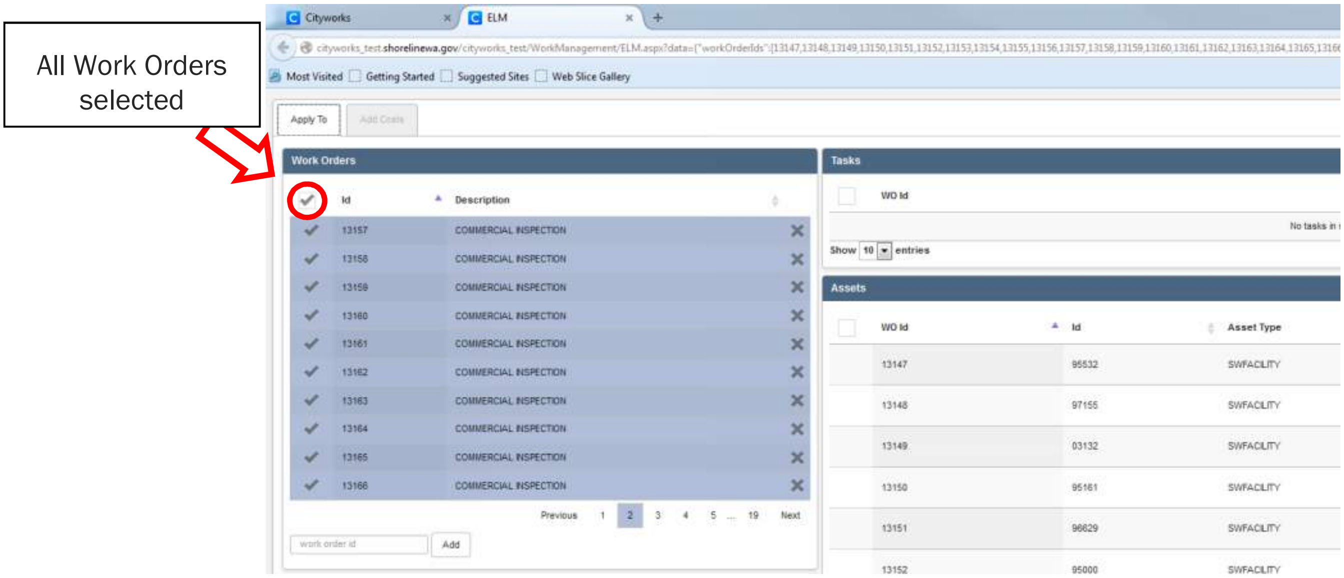
1. Open Managers → SSRS Reports
2. Open the PWORKS Folder

3. Select "SW_Letter_Pre_Inspection_Notice"
4. Export the letters to PDF.

5. Print Letters.
   a. Envelopes need to be generated from this table: J:\GIS\UTIL\Cityworks\StormwaterFacilityContacts_Open.xlsx
   b. Select “Enable Content”, then “No” in the popup window for ‘Do you want to make this file a Trusted Document’. Go to the **Data** tab and select “Refresh All.”
   c. Filter the resolution status for “00 – Send Initial Notice of Inspection”.
   d. Save spreadsheet in the current year folder at: G:\PWORKS\OPERATIONS\SWM\Commercial Facilities\2_Annual_Inspections
   e. Open the Envelopes template, located here: G:\PWORKS\OPERATIONS\SWM\Commercial Facilities\3_Letter Templates\1_Current Letter Templates\Envelopes Template.docx
   f. Select “Yes” to open the document.
   g. Go to the **Mailings** tab and Select “**Use an Existing List**” from the **“Select Recipients”** dropdown within **Start Mail Merge.**
      i. Navigate to the spreadsheet you saved in step d.
      ii. Select “OK”.
   h. Select **“Edit Individual Documents”** from the “Finish & Merge” dropdown.
      i. Select “OK”. A new Word document will open.
   i. Save the document in the current year folder at: G:\PWORKS\OPERATIONS\SWM\Commercial Facilities\2_Annual_Inspections
   j. Print Envelopes.
6. Once the letters have been mailed, open the **Send Initial Inspection Notice** Inbox tab.
7. Select all Work Orders in the **Send Initial Inspection Notice** Inbox.
8. Add the labor associated with the creation and mailing of the Initial Notice of Inspection.
   a. Select **Open in ELM** in the Open dropdown. A new tab titled **ELM** will open.



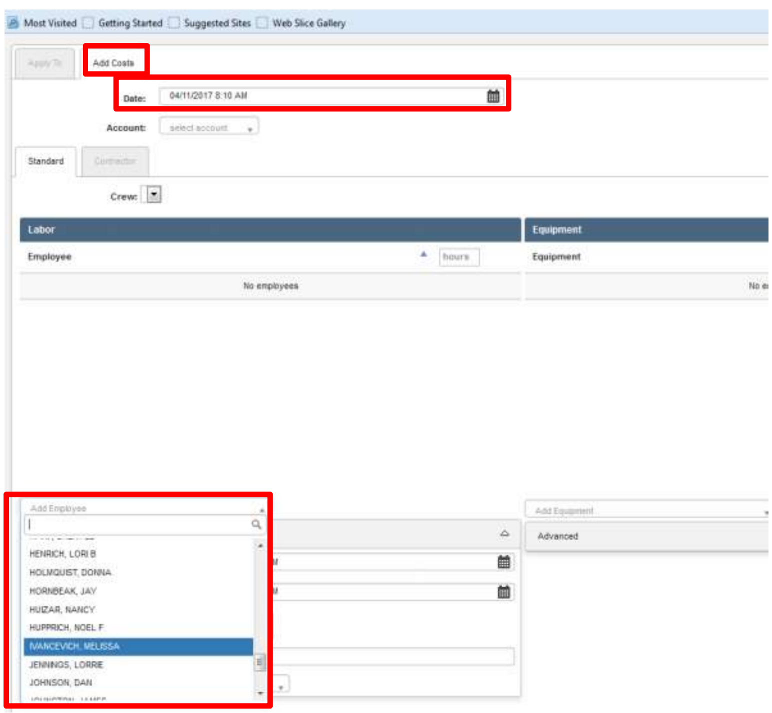
b. In the **Apply To** tab, select all Work Orders.



c. Then select the **Add Costs** tab.

d. Enter the **Date** at the top of the **Standard page**.

e. In the **Labor** section, select the employee from the **Add Employee** dropdown.

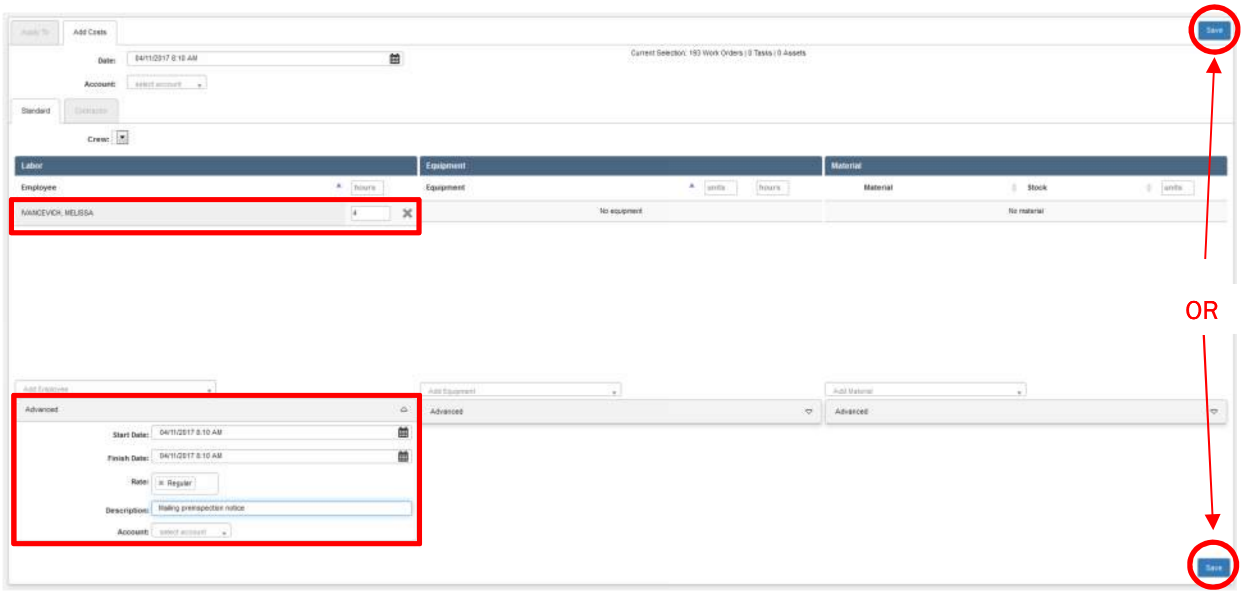


The employee will be added to the Labor section.

f. Add the number of hours for the employee.
   i. The hours will be divided amongst all of the Work Orders and will appear in the Existing Costs section at the bottom of the Add Costs tab once you select **Save.**

g. Expand the **Advanced** section within the **Labor** section.
   i. Enter "Mailing Preinspection Notice" in the **Description** section.

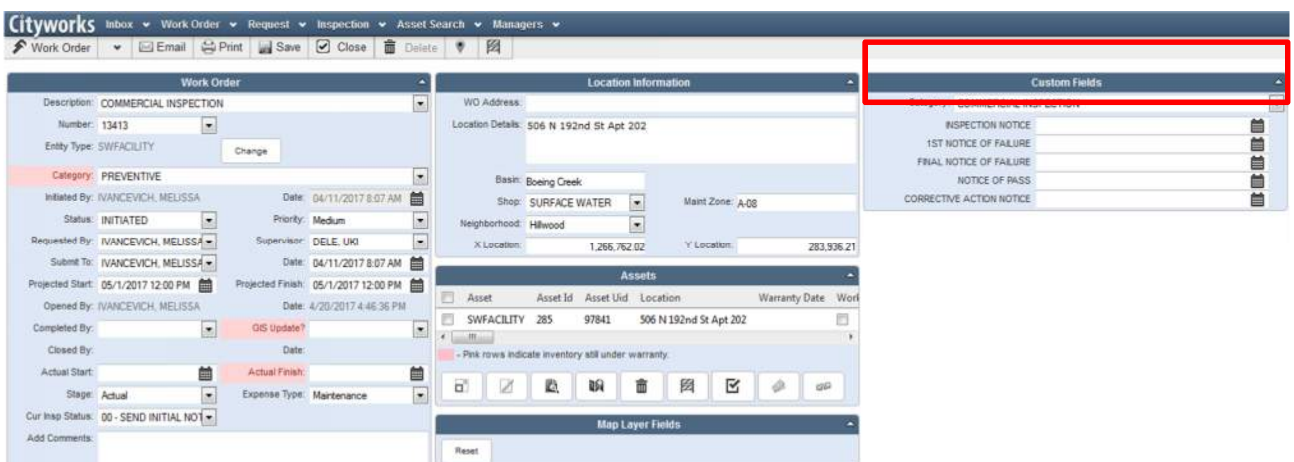
h. Select **Save** on the right side of the screen.



i. Close the ELM tab.

9. **Select and Open** all Work Orders in the **Send Initial Inspection Notice** Inbox again.

10. In the **Custom Fields** panel, enter the date the letters were mailed in the **Inspection Notice** field. Save the Work Order and repeat for each Work Order until all are completed (Apply to All does not work for the Custom Fields).



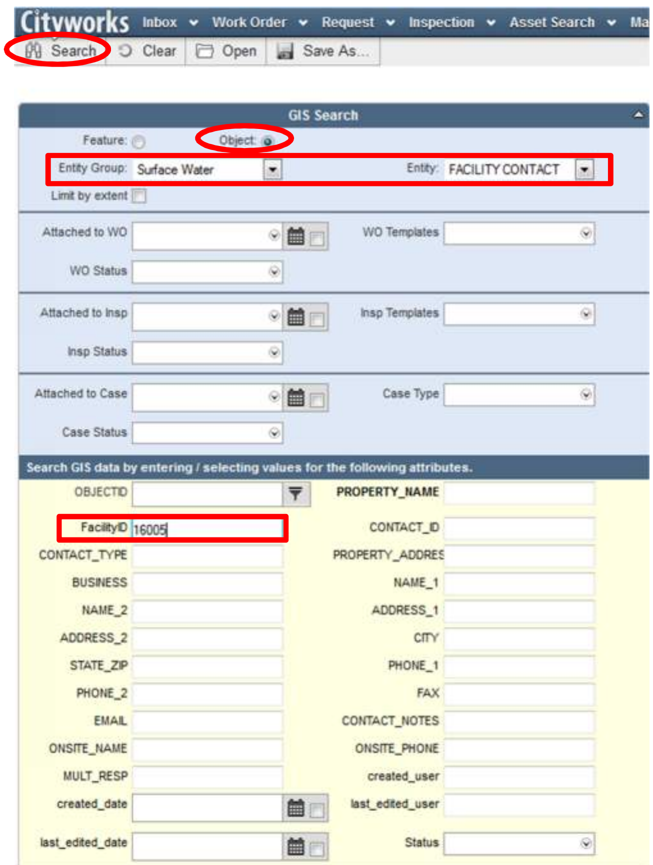
11. **Select and Open** all Work Orders in the **Send Initial Inspection Notice** Inbox again.

12. Select **Apply to All** in the **Work Order** panel.

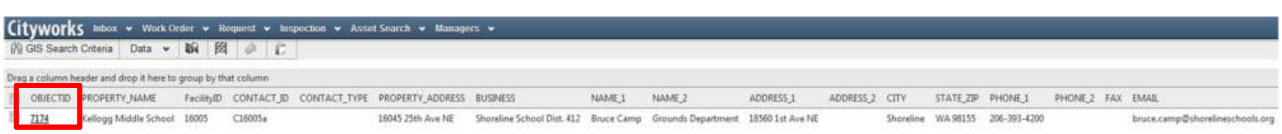
13. In the **Work Order** panel, find the **Cur Insp Status** drop down box. **Select 01 – Initial Notice of Inspection Sent.**
14. Save the **Work Orders** (These should now appear in your Inbox for "Ready for Initial Inspection".)

Initial Inspection Set-up – Updating Facility Information

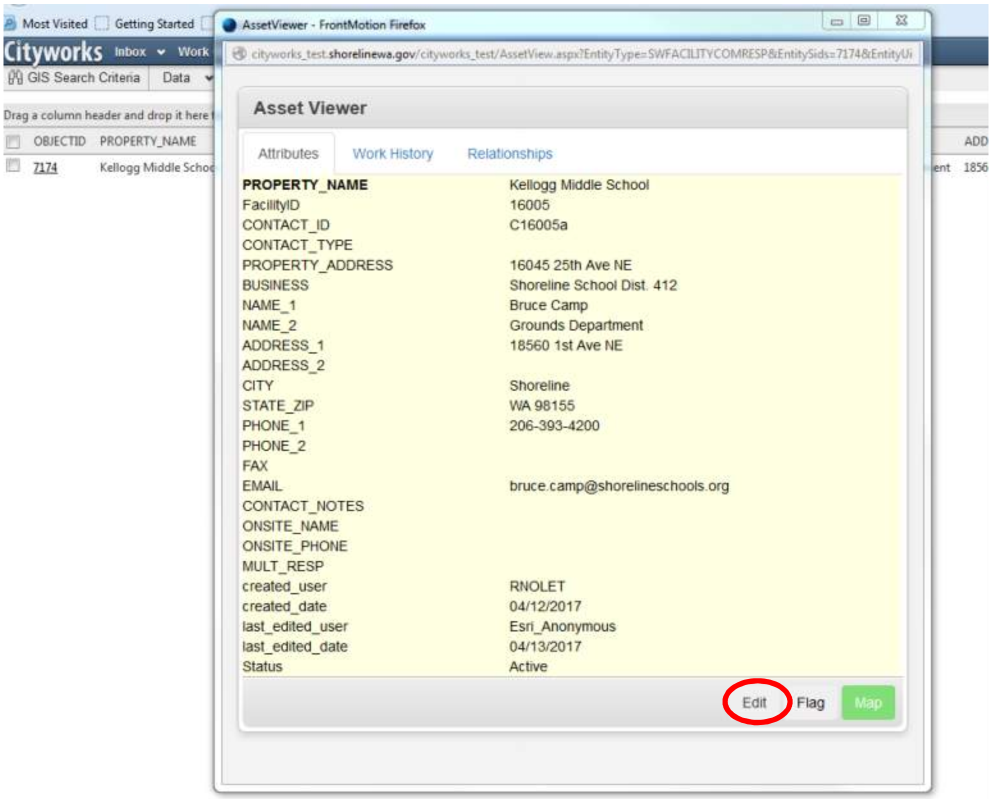
1. Updating Facility Contact Information.
    a. Open an Asset Search.
    b. Select the radial button for Object.
    c. In the Entity Group drop down box, select Surface Water.
    d. In the Entity drop down box, select Facility Contact.
    e. In the FacilityID field, enter the Facility Number. Search.



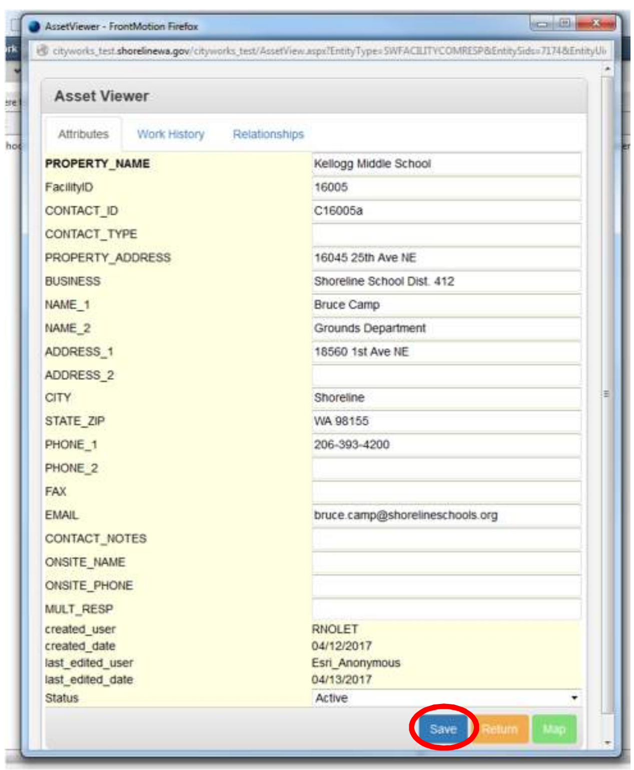
    f. A new page will open with the contact(s) listed. Select the link in the **ObjectID** field for the contact that needs to be updated.



g. A new window titled **Asset Viewer** will open. Select **Edit** at the bottom of the Attributes tab.



h. Complete any edits, then Select **Save.**



2. Updating Facility Name.

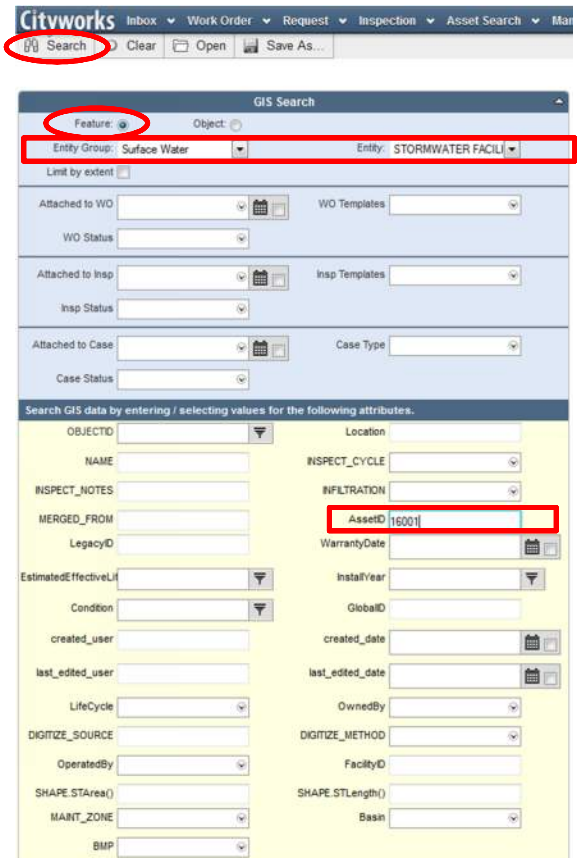
   a. If the name of the Facility/Property has changed, you will need to follow the steps above to update the name in the Facility Contact page in addition to the following steps: Open an **Asset Search.**

   b. The radial button for **Feature** should already be selected.

   c. In the **Entity Group** drop down box, select **Surface Water.**

   d. In the **Entity** drop down box, select **Stormwater Facility.**

   e. In the **AssetID** field, enter the **Facility Number.** Search.



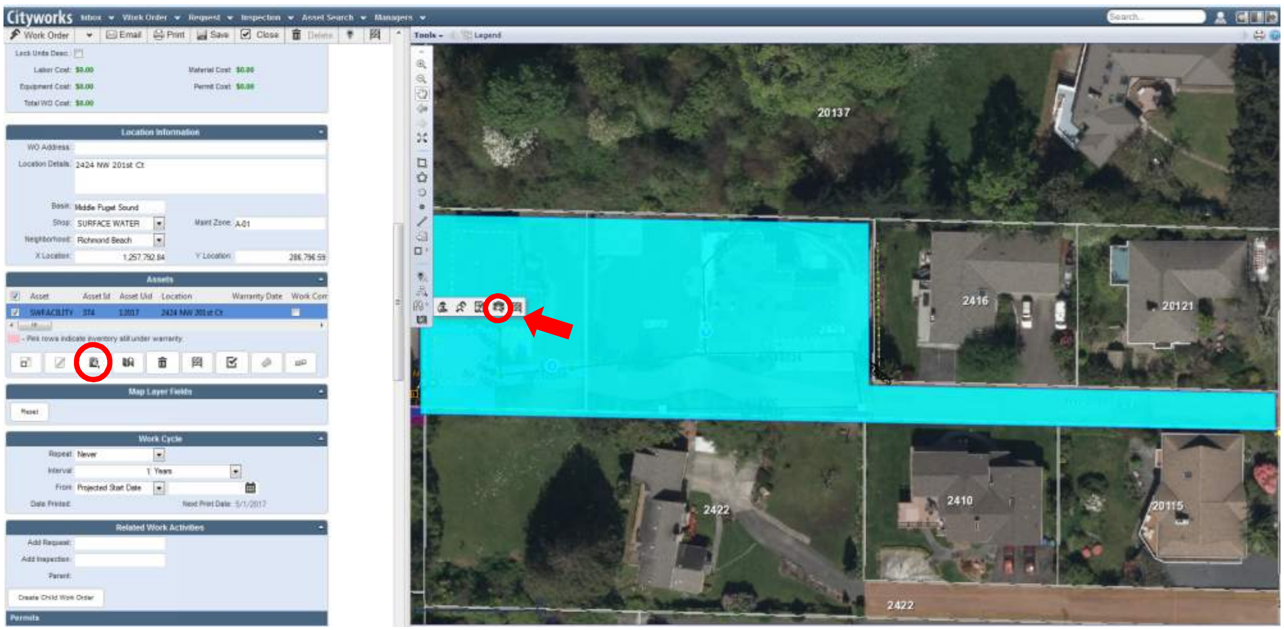
   f. A new page will open with the Facility listed. Select the link in the **ObjectID** field.

   g. A new window titled **Asset Viewer** will open. Select **Edit** at the bottom of the Attributes tab.

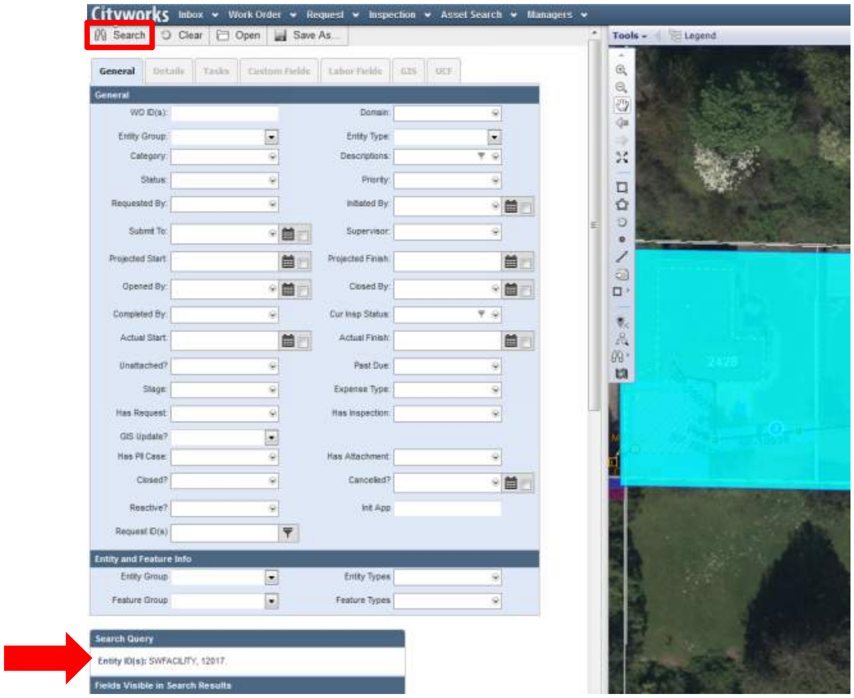
   h. Edit the **Name** and Save.

Initial Inspection Set-up – Add Assets to the WO

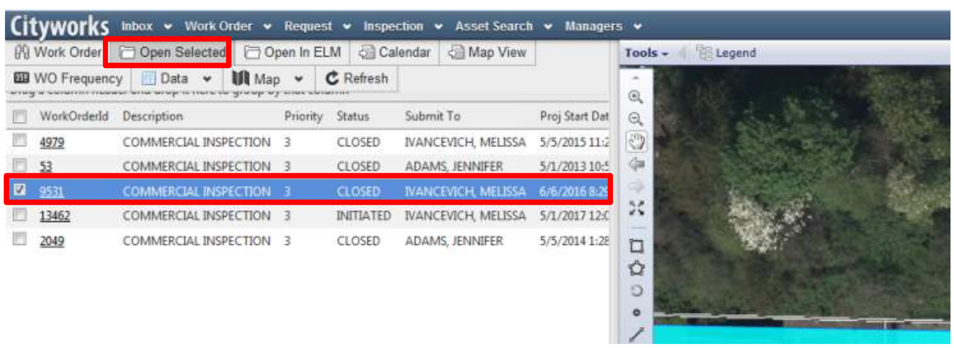
1. Open a WO.
2. In the Assets panel, select the SWFacility. Select the icon to "Highlight selected assets on the map". This will show the facility on the map.
3. In the map view, select the binoculars icon to "Search work management…"
4. Select the wrench with the magnifying glass to "Search work orders."



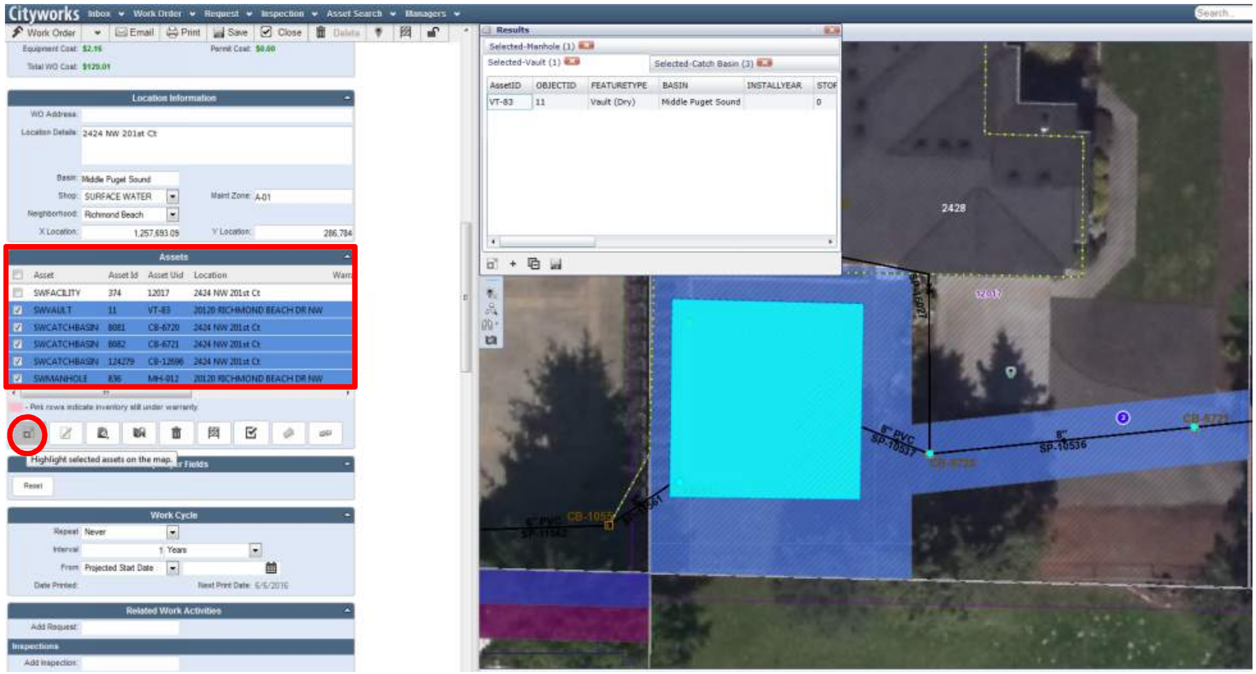
5. The WO Search tab will open with the facility selected in the Search Query Field. Select Search at the top of the page.
   a. The WO search will show all related WO's for the selected facility.



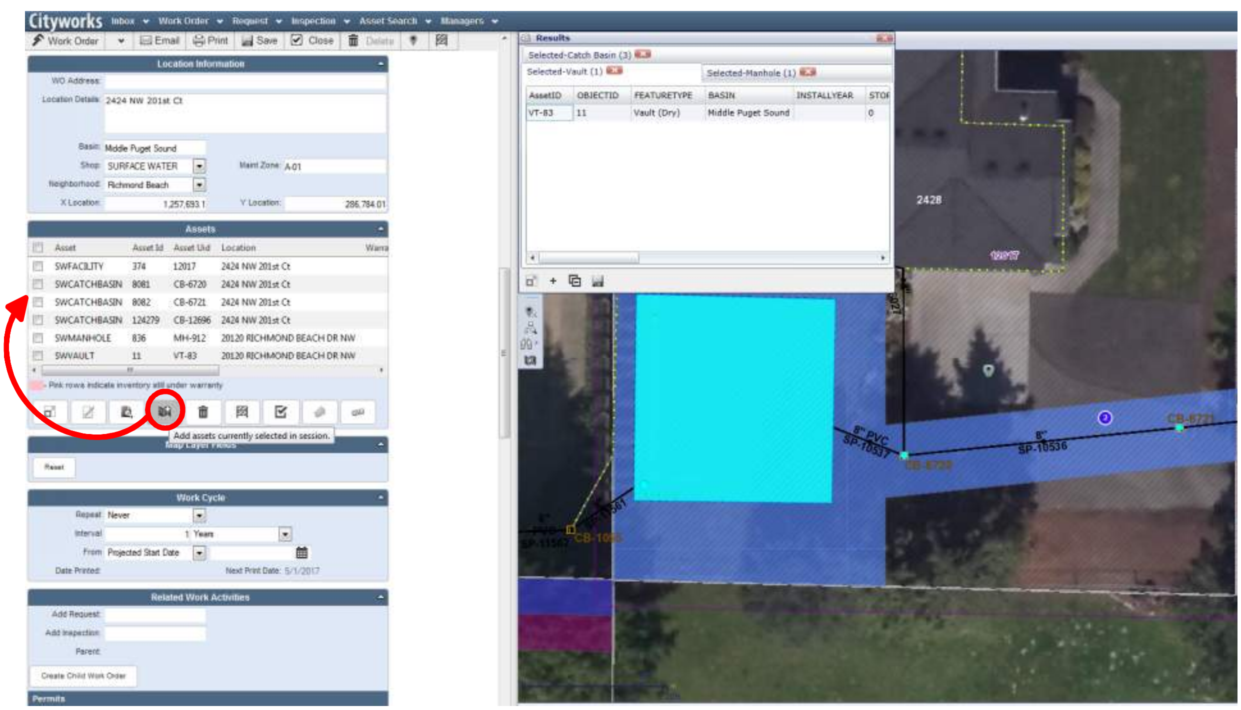
6. Select the most recent year's closed WO and Open Selected.



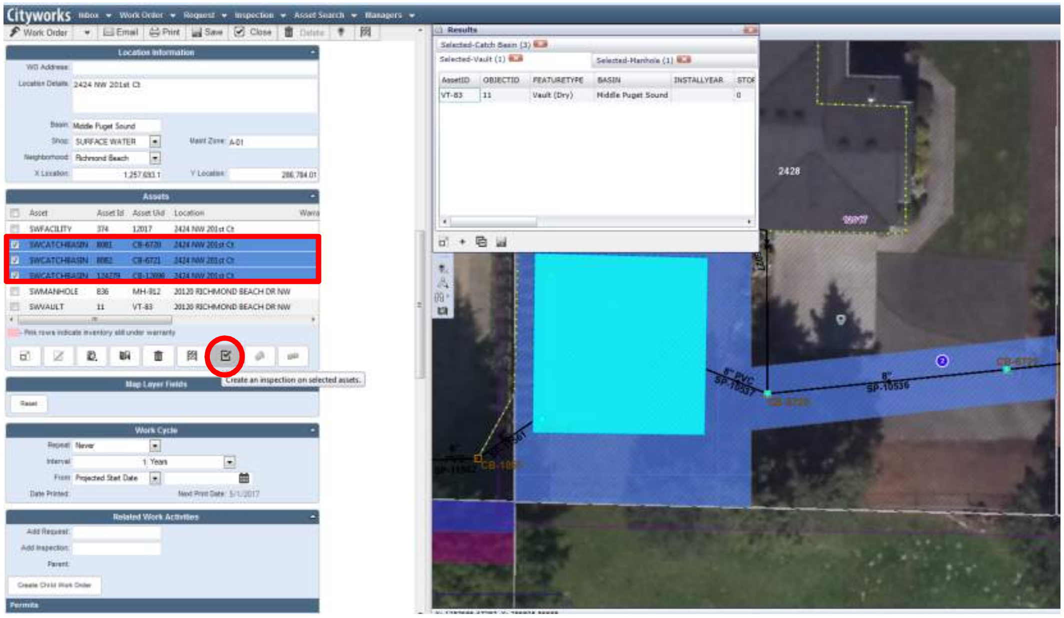
7. In the Assets panel, select all of the assets in the asset list, de-selecting SWFacility. Select the icon to "Highlight selected assets on the map". All of the assets associated with that facility will now be selected.



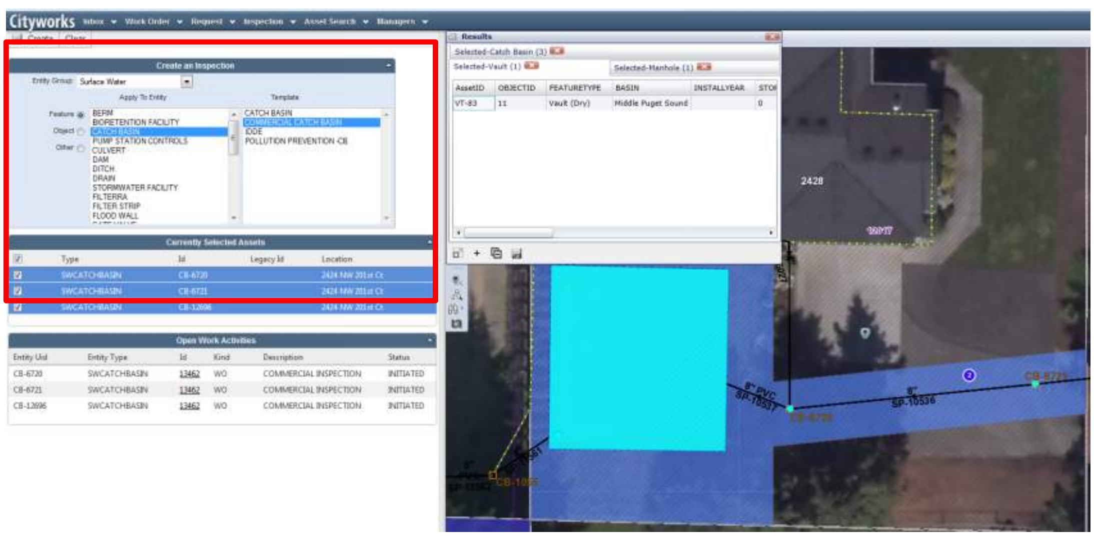
8. Hit the back button on the browser page to take you back to the WO's associated with the facility.
9. Select the current year's WO (the WO in the "Initiated" status) for the facility and select **Open Selected.**
10. In the **Assets** panel, select the icon to "Add assets currently selected in session." This will add all of the facility's assets to the current year's WO.



11. Create an inspection form for each asset, grouped by asset type (i.e. SWCatchBasin, SWManhole, SWVault, etc.).
    a. In the **Assets** panel, select all assets within an asset group by checking the box next to the asset.
    b. In the **Assets** panel, select the check mark for "Create an inspection on selected assets". A new Inspection form will open.



    c. In the **Create an Inspection** panel, select the appropriate Feature for the **Entity**, and the appropriate **Commercial Template.** Create the Inspection.



    d. Repeat these steps for all WOs.

Field Inspections

Field inspections will require the use of a tablet to log observations. Every asset within the perimeter of the facility will be inspected and an inspection form completed for each asset.

1. Configure AMS layer to locate inspections, based on the same Saved Search used for "Ready for Initial Inspection"

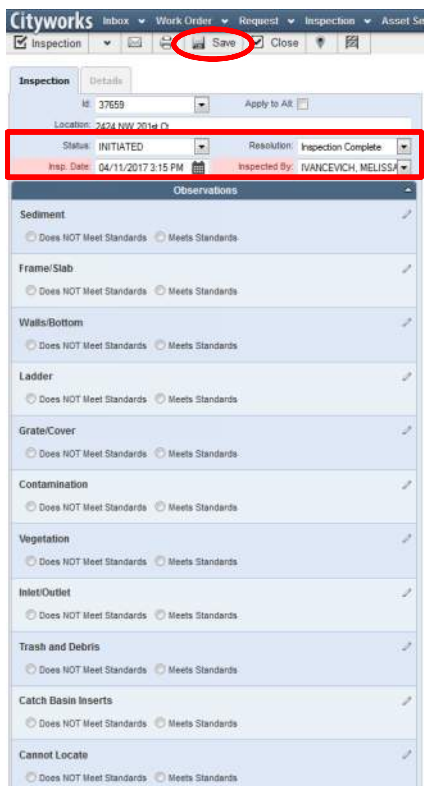
2. Hover over the facility to be inspected. Ctrl+Click to open the associated Work Order.

3. In the **Assets** window, select the SWFacility. Select the icon to "Highlight selected asset on the map". This will show the facility for inspection on the map.

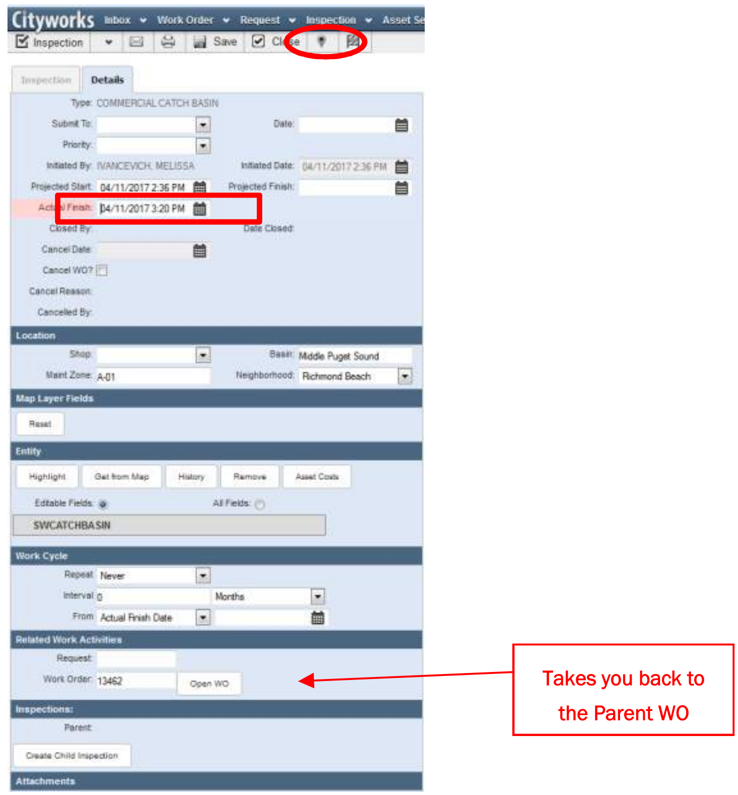
4. Find the asset that connects to the City's MS4 – start with that asset and work your way "upstream".

5. Complete the Inspection form. In the **Observations** panel, only select categories where the asset Does NOT Meet Standards. All areas with no Observation will be assumed to Meet Standards.

6. If an asset meets standards, select "Inspection Complete" in the **Resolution** field on the **Inspection** tab, and complete the **Insp. Date** and **Inspection By** fields, then Save.



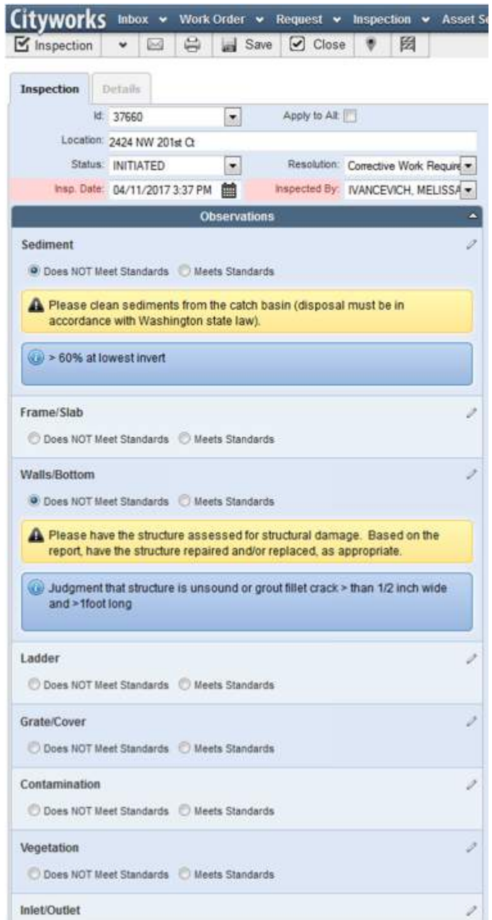
7. Select the **Details** tab and complete the **Actual Finish** field, then **Close** the Inspection.



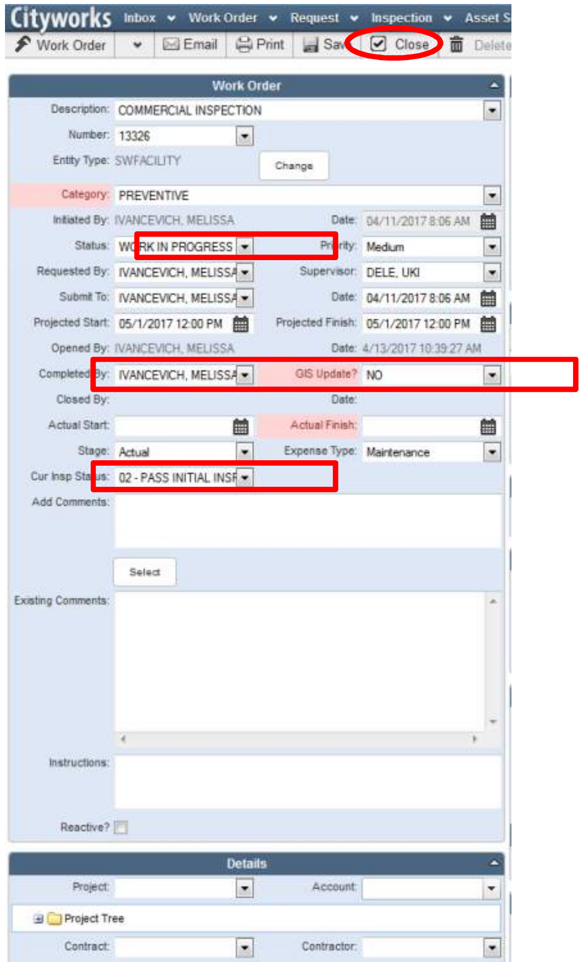
8. Return to the Parent Work Order.

9. If an asset within the Facility does NOT meet maintenance standards, select the radial button for Does NOT Meet Standards in the Observations section for each failure.

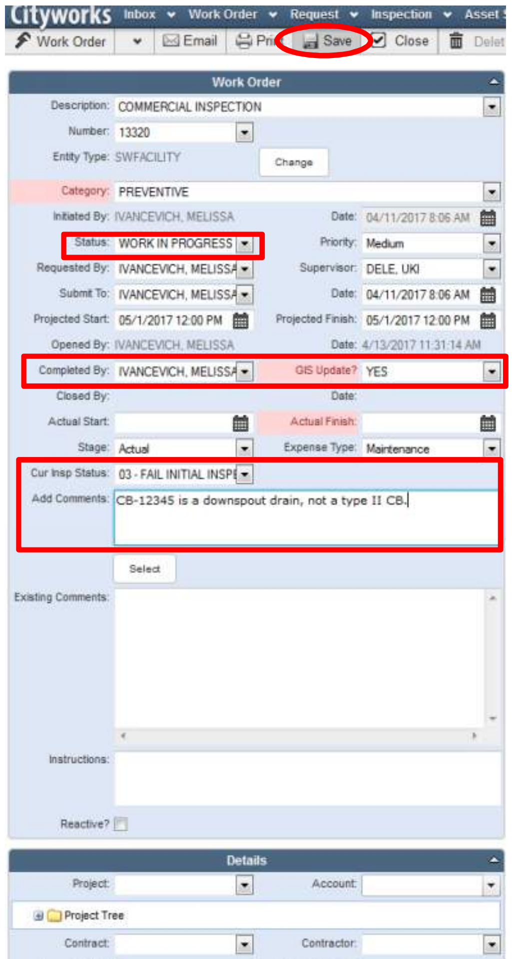
10. Once the inspection is complete for that asset, select "Corrective Work Required" in the Resolution field on the Inspection tab, and complete the Insp. Date and Inspection By fields, then Save.



11. For any observations that do not fit the generic categories, mark "Other" and record the findings in the Observation portion of the Summary section. The Reports (below) to owners are triggered by a radio dial selection of Does Not Meet Standards. If you want to convey information to an owner, you must select this and record in observations.
12. Save the Inspection – do not close an inspection for an asset that has not met standards.
13. Return to the Parent Work Order.
14. If all assets within the Facility MEET maintenance standards, complete the following fields in the Work Order:
    a. Status: Work in Progress
    b. Completed by: Your name
    c. GIS Update? Y/N
    d. Any Comments you may have about the Facility in general
    e. Change Cur Insp Status to: 02 – Pass Initial Inspection
    f. Save Work Order



15. If any asset within the Facility Does Not Meet Standards, then the Facility fails its initial inspection. Complete the following field in the Work Order:
    a. Status: Work in Progress
    b. Completed by: Your name
    c. GIS Update? Y/N
    d. Any Comments you may have about the Facility in general
    e. Change **Cur Insp Status to: 03 – Fail Initial Inspection**
    f. Save Work Order



1. Some Facilities will require a re-inspection.

    a. Create another Inspection record for any of the assets that did not meet standards during the initial inspection. Close the Inspection record from the initial inspection.

    b. Follow steps 5-13 above for completing the inspection.

    c. If all re-inspected assets Meet Standards, simply change the **Cur Insp Status** in the Work Order panel to **08 – Pass Upon Correction.**

    d. If an asset Does NOT Meet Standards upon re-inspection, return to the Parent Work Order after recording the failed re-inspection Observations. Update the **Cur Insp Status** to: **09 – Fail 2nd Inspection.**

2. **Record the labor and equipment after each inspection.**

    b. Before exiting the Facility Work Order, select **ELM** in the dropdown next to Work Order. A new tab titled **ELM** will open.

    c. Select the **Add Costs** tab.

    d. Enter the **Date** at the top of the **Standard page.**

e. In the Labor section, select the employee from the Add Employee dropdown.

f. Select all employees conducting the inspection – the employees will be added to the Labor section.

g. Add the number of hours for each employee.

h. Expand the Advanced section within the Labor section.

   i. Enter description of work activity in the Description section (i.e. "Initial Inspection")

i. In the Equipment section, select the vehicle from the Add Equipment dropdown.

j. Add the number of hours for the vehicle.

k. Select Save on the right side of the screen.

l. Close the ELM tab.

3. Save, but DO NOT CLOSE the Work Order.

Generating Inspection Findings Reports (Correspondence)

You will use SSRS Reports in Cityworks to generate correspondence to the owners of the inspected commercial Facilities. Several Reports have been created, including:

- Notice of Pass-Initial Letter *without* a Corrective Action Form
- Notice of Pass-ReInspect Letter *without* a Corrective Action Form
- 1st Notice of Failure Letter *with* a Corrective Action Form
- Final Notice of Failure-ReInspect Letter *with* a Corrective Action Form
- Final Notice of Failure Letter *with* a Corrective Action Form

These Reports are generated off of the Current Inspection Status. All Work Orders that have the reportable inspection status will be included in the report. For example, when the "Send Notice of Pass-Initial" Report is run, it will include all Work Orders with the Current Inspection Status of 14 - Send Notice of Pass-Initial.

How to Utilize the Date Fields to Track Inspection Status

- Projected Start = This Projected Start date is the Work Order trigger. It is automatically set through the recurring Work Order cycle. It does not change through the lifecycle of the Work Order.

- Actual Start = The Actual Start date always refers to the date of the Initial Inspection. It should be updated when the initial inspection takes place, in conjunction with recording ELM.

- Projected Finish = The Projected Finish date tracks the notification timeclock. For example, if a property owner is given "four weeks" from the date of notification, the Projected Finish date should be set to four weeks after the date the letter was sent. This date is used to trigger the timing for subsequent notifications.

- o Note that failure notice dates are also recorded in the "**Commercial Inspection**" category in the **Custom Fields** panel.

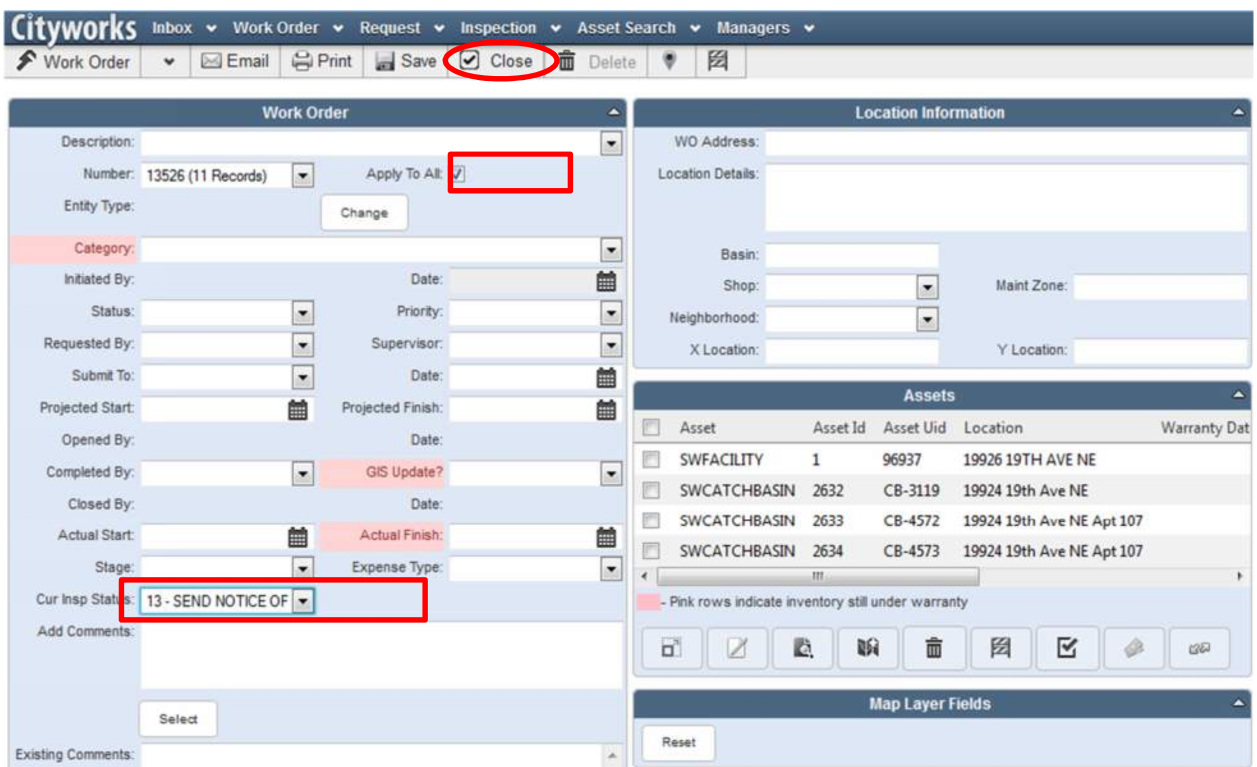
- Actual Finish = The **Actual Finish** date refers to the entire inspection procedure and associated notifications. It will only be entered when the Work Order is being closed.

How to Track the Commercial Inspection Process

The Commercial Inspection Process takes several different routes, depending on the inspection results. Each Inbox tracks a group of Work Orders in the same **Current Inspection Status.** You can create a **Report** (letter) to all property owners in the same **Current Inspection Status.**

To send notices to those who passed the initial inspection, follow these steps:

1. Navigate to the **Pass Initial Inspection** Inbox.
2. **Select and Open** all Work Orders in the Inbox.
3. Select **Apply to All** in the **Work Order** panel.
4. Change the **Cur Insp Status to: 13 – Send Notice of Pass-Initial.**
5. **Save** the Work Order(s).



6. These Work Orders will now appear in your Send Notice of Pass-Initial Inbox.

Create the Notice of Pass-Initial Report

1. Open Managers → SSRS Reports.
2. Open PWORKS Folder.
3. Select the "13 – Send Notice of Pass-Initial" Report.
    a. The Report will automatically run.
4. Export the letters as a PDF.
5. Print Letters.
6. Once the letters have been printed, open the Send Notice of Pass Inbox tab.
7. Select and Open all Work Orders in the Send Notice of Pass Inbox.
8. Select Apply to All in the Work Order panel.
9. Change the Cur Insp Status to 15 – Notice of Pass Sent.
10. Select and Open all Work Orders in the Notice of Pass Sent Inbox.
11. In the Custom Fields panel, enter the date the letters were mailed in the Notice of Pass field. Save the Work Order and repeat for each Work Order until all are completed (Apply to All does not work for the Custom Fields).
12. Envelopes need to be generated from this table: J:\GIS\UTIL\Cityworks\StormwaterFacilityContacts_Open.xlsx

NOTE: The Notice of Pass-Reinspect Report is generated in a similar fashion.

Create the Notice of Fail Report

1. To send notices to those who failed initial inspection, navigate to the Fail Initial Inspection Inbox.
2. Select and Open all Work Orders in the Inbox.
3. Select Apply to All in the Work Order panel.
4. Change the Cur Insp Status to: 04 – Send 1st Notice of Failure.
5. Save the Work Order(s). These Work Orders will now appear in your Send 1st Notice of Failure Inbox.
6. Open Managers → SSRS Reports.
7. Open PWORKS Folder.

8. Select the "04 – Send 1st Notice of Failure" Report.

    a. The Report will automatically run.

9. Export the letters as a PDF.

10. Print Letters.

11. Once the letters have been printed, open the Send 1st Notice of Failure Inbox tab.

12. Select and Open all Work Orders in the Send 1st Notice of Failure Inbox.

13. Select Apply to All in the Work Order panel.

14. Change the Cur Insp Status to: 05 –1st Notice of Failure Sent.

15. Change the Projected Finish date in the Work Order tab to reflect the allowed response time. Save the Work Orders.

16. This batch of work orders should now appear in your 1st Notice of Failure Sent Inbox.

17. Select and Open all Work Orders in the 1st Notice of Failure Sent Inbox.

18. In the Custom Fields panel, enter the date the letters were mailed in the 1st Notice of Failure field. Save the Work Order and repeat for each Work Order until all are completed (Apply to All does not work for the Custom Fields).

19. Envelopes need to be generated from this table:
    J:\GIS\UTIL\Cityworks\StormwaterFacilityContacts_Open.xlsx

20. Accompanying maps should be updated in GIS, then run as data driven pages. Found in:
    J:\GIS\users\MIvancevich\Commercial Inspections\Commercial_Facility_Template_Final.mxd

21. Include a Maintenance Contractor List with each fail letter, located here:
    G:\PWORKS\OPERATIONS\SWM\Commercial Facilities\4_Vendor Lists\vactor_contractor_List.pdf

NOTE: The Final Notice of Failure Reports are generated in a similar fashion.

Logging Work Completed

1. When completed Corrective Action forms have been submitted by the owner, update the Cur Insp Status and Save the Work Order.

    a. If work was completed professionally, update the Cur Insp Status to 06 – Recd C.A. Notice and Receipt.

    b. If work was do-it-yourself, update the Cur Insp Status to 07 – Recd DIY-2nd Inspection.

2. Attach the document from the owner to the Work Order by dragging the icon to the Attachments section of the work order.

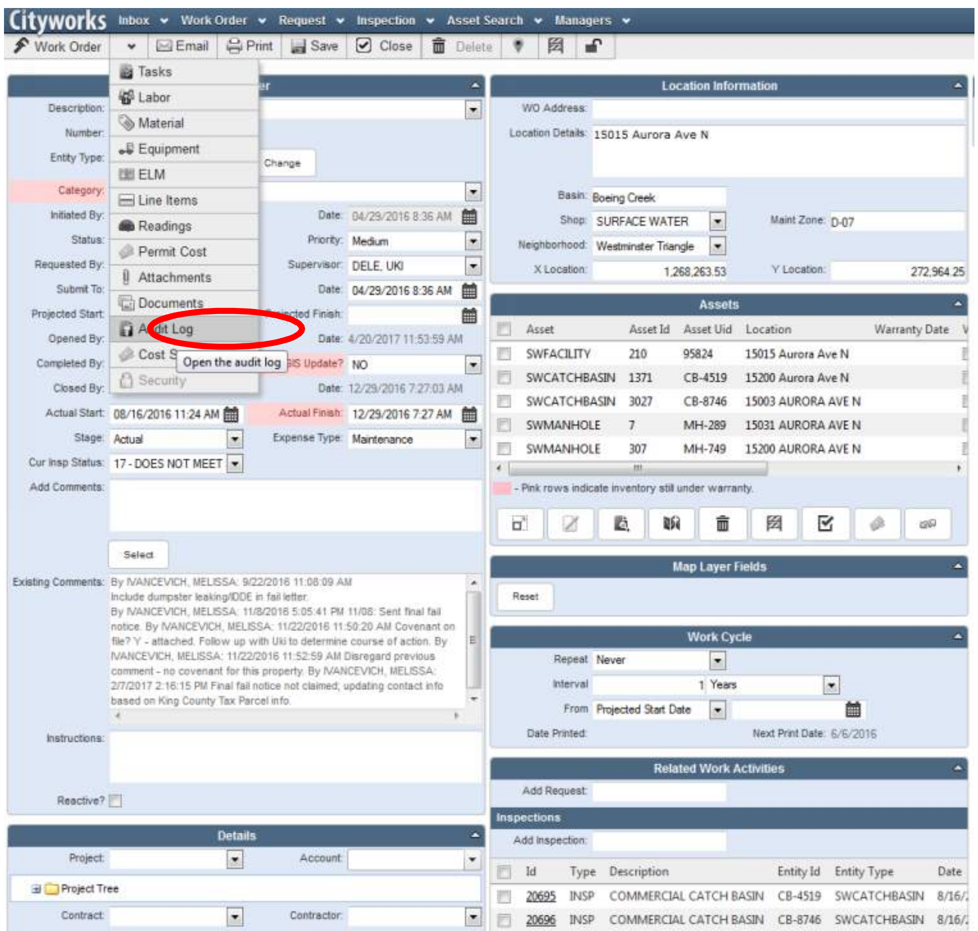
3. In the **Custom Fields** panel, enter the date the Corrective Action form was received in the **Corrective Action Notice** field. Save the Work Order.

Facility History

You can research the history for a particular facility. For example, you can look up when inspection status changes occurred.

1. Open the Work Order for the Facility you want to track.

2. Click on the dropdown next to Work Order and Select **Audit Log.**



3. A new window titled Audit Log will open.

4. The history of the **Current Inspection Status** will be visible. For example, in the Audit Log below, on 9/16/2016 at 11:26am, the status of the Work Order was changed from "01 – Initial Notice of Inspection Sent" to "03 – Fail Initial Inspection."

Audit Log - Cityworks - FrontMotion Firefox

cityworks_test.shorelinewa.gov/cityworks_test/WorkManagement/AuditLog.aspx?lightenform=true&TableName=WORKORDER&CWId=9414

Id	Date	Field	Old Value	New Value	Login Name
9414	5/16/2016 11:51:43 AM	RESOLUTION		01 - INITIAL NOTICE OF INSPECTION SENT	MIVANCEVICH
9414	9/16/2016 11:26:30 AM	RESOLUTION	01 - INITIAL NOTICE OF INSPECTION SENT	03 - FAIL INITIAL INSPECTION	MIVANCEVICH
9414	9/27/2016 10:13:30 AM	RESOLUTION	03 - FAIL INITIAL INSPECTION	04 - SEND 1ST NOTICE OF FAILURE	MIVANCEVICH
9414	9/29/2016 11:36:50 AM	RESOLUTION	04 - SEND 1ST NOTICE OF FAILURE	05 - 1ST NOTICE OF FAILURE SENT	MIVANCEVICH
9414	11/3/2016 11:21:48 AM	RESOLUTION	05 - 1ST NOTICE OF FAILURE SENT	06 - RECD C.A. NOTICE AND RECEIPT	MIVANCEVICH
9414	3/13/2017 3:31:03 PM	RESOLUTION	14 - SEND NOTICE OF PASS-INITIAL	06 - RECD C.A. NOTICE AND RECEIPT	MIVANCEVICH
9414	3/13/2017 3:30:22 PM	RESOLUTION	15 - SEND NOTICE OF PASS-REINSPECT	14 - SEND NOTICE OF PASS-INITIAL	MIVANCEVICH
9414	3/13/2017 3:29:28 PM	RESOLUTION	06 - RECD C.A. NOTICE AND RECEIPT	15 - SEND NOTICE OF PASS-REINSPECT	MIVANCEVICH

Appendix L: Property Access Permission Form

CITY OF SHORELINE

Property Access Permission Form

Please complete this permission form and return in the enclosed postage paid envelope to Daniel Sinkovich, City of Shoreline Public Works, 17500 Midvale Avenue North, Shoreline, WA 98133-4905 (phone 206-801-2454).

I, the Owner(s) of the property located at______________________________, give permission to the City of Shoreline and/or its contractors the right to enter upon and to conduct inspections and maintenance of the storm drainage pipe on my property prior to and after significant rain events or in the event flooding occurring at nearby properties.

______________________________ Owner Signature

______________________________ Print Name

______________________________ Phone

If you have any special instructions regarding access to your property, please provide details:

Appendix M: Stormwater Drainage Facility Covenant Example

RECORDING REQUESTED BY AND
WHEN RECORDED MAIL TO:
Applicant Name
Applicant Address
Applicant City, State, Zip

DECLARATION OF COVENANT AND GRANT OF EASEMENT
For Stormwater Best Management Practices

Grantor(s):
Grantee: City of Shoreline
Tax Parcel ID No.:
Property Address:
Legal Description:

IN CONSIDERATION of the surface water improvements constructed under City of Shoreline Permit No. *Permit #* relating to the real property described legally described above ("Property"), the Grantor, the owner in fee of the Property, hereby covenants with the Grantee, City of Shoreline, a political subdivision of the state of Washington ("City of Shoreline"), the he/she/they will observe, consent to, and abide by the conditions and obligations set forth herein with regard to the Property and hereby grants an access easement over the portions of the Property to the City of Shoreline for the purposes described herein.

THEREFORE, the Grantor hereby grant, covenant, and agree as follows:

1. The Grantor or his/her/their successor in interest and assigns shall at their own cost, operate, maintain, and keep in good repair the Property's stormwater facilities and/or best management practices ("BMPs") shown on the approved "SITE PLAN" for the property attached hereto as Exhibit B with "DETAILS" sheets attached hereto as Exhibit C. The Property's stormwater facilities and/or BMPs shall be maintained in compliance with the "Operation and Maintenance Requirements" attached hereto as Exhibit A.

2. The City of Shoreline shall have a perpetual access easement over those portions of the Property for the sole purpose of performing inspection and/or monitoring of the stormwater facilities and BMPs and conducting any maintenance or repair activity specified in this Declaration of Covenant.

3. If the City of Shoreline determines that maintenance or repair work is required to be done to any of the stormwater facilities or BMPs, the Public Works Director for the City of Shoreline shall give written notice of the specific maintenance and/or repair work required. In this written notice, the City shall set a reasonable time in which such work is to be completed by the Grantor(s). If the required work is not completed within the time set by the City, the City may perform the required work. Written notice will be sent to the Grantor stating the City's intention to perform the required work. Such notice shall state that the City will not commence any work until at least seven (7) days after mailing of the notice. If, within the sole discretion of the Public Works Director for the City of Shoreline, there exists an imminent or present danger to the public health, safety or welfare, or the

environment, the Grantor hereby waive the seven (7) day notice period and the required work may begin immediately.

4. The Grantor shall assume all responsibility for the cost of any maintenance or repair work completed by the City. Such responsibility shall include reimbursement to the City within thirty (30) days of the receipt of the invoice for any such work performed. Overdue payments will require payment of interest at the prime rate at the time of the work plus two (2) percent as liquidated damages. In the event that City of Shoreline does not receive reimbursement within the required time frame, it may elect to place a lien on the Property and act upon the lien in accordance with the terms and procedures specified in the City of Shoreline Code Title 20, as amended from time to time. If legal action is taken to enforce the provisions of the Paragraph, the prevailing party is entitled to costs and attorney's fees.

5. The Grantor is hereby required to obtain written approval from the Planning and Community Development Services Director of the City of Shoreline prior to performing any alterations or modifications to the stormwater facilities and/or BMPs, except for performance of routine landscape maintenance.

6. Any notice or consent required to be given or otherwise provided for by the provisions of this Declaration of Covenant and Grant of Easement shall be effective upon personal delivery, or three (3) days after mailing by Certified mail, return receipt requested, whichever occurs sooner.

7. This Declaration of Covenant and Grant of Easement is intended to promote the efficient and effective management of surface water drainage on the Property, and it shall inure to the benefit of all the citizens of Shoreline, its successors and assigns. This Declaration of Covenant and Grant of Easement shall run with the land and be binding upon Grantor, and Grantor's successors in interest and assigns.

8. This Declaration of Covenant and Grant of Easement may be terminated by execution of a written agreement by Grantor and the City of Shoreline expressing their mutual agreement to terminate this Declaration of Covenant and Grant of Easement.

IN WITNESS WHEREOF, this Declaration of Covenant and Grant of Easement is executed this

_____day of _____________, 20___.

GRANTOR:

_____________________________________ ____________________________________

By _________________________________ By _________________________________

Its _________________________________ Its _________________________________

STATE OF WASHINGTON)
) ss.
COUNTY OF KING)

I certify that I know or have satisfactory evidence that ___________________________________ is the person(s) who appeared before me, and acknowledged that he/she/they signed and delivered this instrument as his/her/their free and voluntary act for the uses and purposes set forth.

Dated this ______ day of _________________, 20___ .

____

Notary Public in and for the State of Washington,

Residing at ________________________________

My commission expires ____________________

EXHIBIT A
OPERATION AND MAINTENANCE REQUIREMENTS

MAINTENANCE REQUIREMENTS

Your property contains stormwater management BMPs (best management practices) called " ," " ," " ," " ," which were installed to mitigate the stormwater quantity and quality impacts of some or all of the impervious surfaces on your property. The size, placement, composition, and downstream flow paths of these devices as depicted by Exhibit B Site Plan and Exhibit C Details must be maintained and may not be changed without written approval from the City of Shoreline or through a future development permit from the City.

Appendix N: Surface Water Hot Spots

Table N1 lists the City of Shoreline Hot Spot locations inspected during and after storms as of 12/28/2017.

Table N-1. Seasonal and Storm Triggered Hot Spot Inspection Locations				
Asset ID	Name	Concern	Location	Operated By
HS-1	Pan Terra Pump Station	Susceptible to debris on grates	18500 DAYTON AVE N	City-Regional
HS-2	Hillwood Park	Susceptible to debris buildup on fence and culvert	336 NW 189TH ST	City-Parks
HS-3	8th NW	Susceptible to localized flooding	NW 191ST PL & 8TH AVE NW	City-ROW
HS-4	Storm Creek Crossing	Susceptible to debris buildup on grate	17TH PL NW & 16TH AVE NW	City-Regional
HS-5	Springdale CT Catch Basins	Inspect catch basins for debris	18532 SPRINGDALE CT NW	City-ROW
HS-6	Hidden Lake	Inspect outfall	1005 NW 166TH ST	City-Regional
HS-7	Shoreview Pond, outfall	Inspect outfall	401 NW 175TH ST	City-Regional
HS-8	Boeing Creek M1 Dam	Inspect outfall	NW 171ST ST & 2ND AVE NW	City-Regional
HS-9	Palatine Place	Infiltration / Capacity problems	15508 PALATINE LN N	City-Regional
HS-10	Linden Ave Pump Station	Susceptible to debris on grates	749 N 148TH ST	City-Regional
HS-11	Interurban trail	Susceptible to debris buildup on grate	15310 LINDEN AVE N	City-Regional
HS-12	Darnell Park	Susceptible to debris buildup on grate	1125 N 165TH ST	City-Regional
HS-13	Mr. VanGard Storage	Capacity issues	N 178TH ST & MIDVALE AVE N	City-ROW
HS-14	Cromwell Park	Outfall susceptible to leaf build up	18006 | MERIDIAN | AVE | N |	City-Regional
HS-15	Echo Lake, outfall	Inspect outfall	19815 ASHWORTH AVE N	City-Regional
HS-16	North Ridge	Inspect culvert	NE 200TH ST & 6TH AVE NE	City-ROW
HS-17	Ballinger Park Creek	Inspect outfall	19857 25TH AVE NE APT 301	City-Regional
HS-18	KC Construction Yard	Susceptible to localized flooding	19553 25TH AVE NE	City-ROW
HS-19	McAleer Creek R/D Pond	Inspect outfall	1661 NE 195TH ST	City-Regional
HS-20	12th Ave NE Ditch	Keep trench on south side of ditch open.	19211 12TH AVE NE	City-ROW
HS-21	Shoreline Eastern Border	Susceptible to debris buildup	17721 25TH AVE NE	City-ROW
HS-22	Pump Station 26	Capacity problems	18351 10TH AVE NE	City-Regional
HS-23	Serpentine Pump Station	Capacity issues	5TH AVE NE & NE 178TH ST	City-Regional
HS-24	Pump Station 25	Localized flooding	17738 2ND PL NE	City-Regional
HS-25	Catch Basin	Susceptible to localized flooding	110 NE 174TH ST	City-ROW
HS-26	NE 175th St.	Capacity problems	17408 10TH AVE NE	City-Regional
HS-27	10th NE	Susceptible to localized flooding	17100 10TH AVE NE	City-ROW
HS-28	Ghezzi Pond	Capacity issues	17029 11TH AVE NE	City-ROW
HS-29	Pump Station 30	Capacity problems during power outage	1241 NE 170TH ST	City-Regional
HS-30	Ronald Bog Drainage	Inspect outfall	CORLISS AVE N & N 172ND ST	City-Regional
HS-31	196th NW	Susceptible to debris on grates	26TH AVE NW & NW 196TH ST	City-ROW

Appendix O: Integrated Mosquito Management Plan

Appendix O

Integrated Mosquito Management Plan

Mosquito-borne diseases pose both human-health and ecological risks. Mosquitoes have always been potential vectors for diseases, and West Nile Virus became an increasing concern after it was first detected in the eastern United States in 1999. The virus spread rapidly to the West Coast. The following presents the Integrated Mosquito Management Plan (IMM) for the City of Shoreline (City).

Introduction

As a facility owner/operator, employer, drainage system owner/operator, and municipality, the City can help manage the risk of West Nile Virus by initiating efforts to minimize mosquito breeding habitat, control mosquito larvae in City facilities when the City determines it is appropriate, and educate City employees about personal protection.

The City will expect and rely on the Public Health – Seattle and King County and Washington State health departments to perform primary surveillance and primary public education and outreach functions for the purposes of general public health.

All mosquito management activities must comply with the requirements of the current version of the *Aquatic Mosquito Control General Permit* (Ecology 2015), National Pollutant Discharge Elimination System (NPDES), and State Waste Discharge General Permit issued by the State of Washington Department of Ecology (Ecology).

Plan Objectives

This Integrated Mosquito Management (IMM) plan has two main objectives:

- To adequately control adult mosquitoes while minimizing the incidental discharges to waters of concern
- Document the decision process of where, when, and how mosquito control is implemented within a Permittee's permit coverage area.

General Information

Contact Information

For information regarding this plan please contact:

Uki Dele, P.E.
Surface Water & Environmental Services Manager
(206) 801-2451
udele@shorelinewa.gov

This plan covers all areas included within the city limits of Shoreline, as delineated on Figure 1.

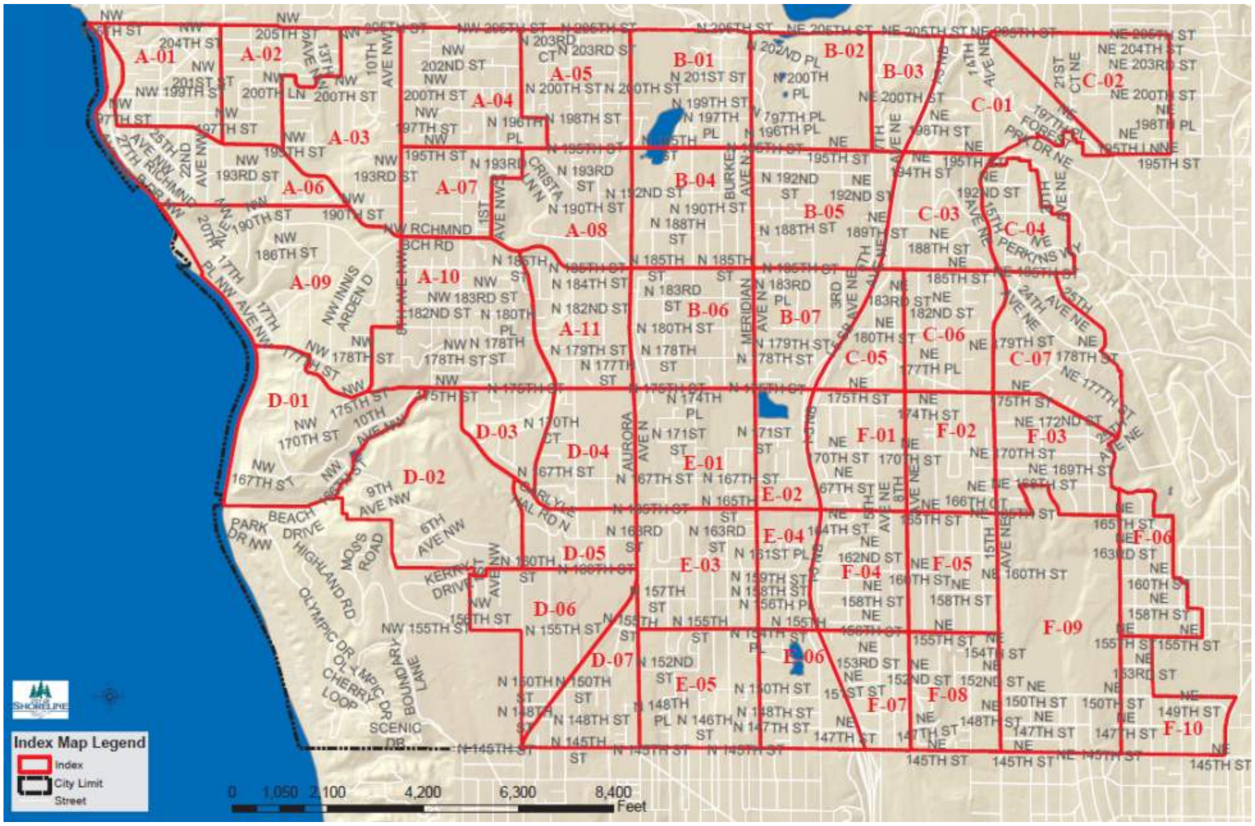


Figure 1. Shoreline City Limits

Emergency Reporting. In the case of emergencies such as pesticide exposure or spills to waters of the state, the City will implement the following plans;

- Spill Response Plan as documented in http://www.shorelinewa.gov/government/departments/public-works/surface-water-utility/services/spill-response

Surveillance

Two primary surveillance techniques may be used to control the local mosquito population including:

- Larval Mosquito Surveillance. At the time this plan was prepared, the City is not required to perform pretreatment surveillance. Information regarding the threat from mosquito-borne disease can be viewed on King County's website at: http://www.kingcounty.gov/depts/health/communicable-diseases/disease-control/west-nile-virus/mosquito-control.aspx

  If it is requested by citizens who reside within the direct treatment area, the City will conduct post-larviciding surveillance to determine the effectiveness of the larvicide.
- Adult Mosquito General Surveillance. To determine whether pesticides used to control adult mosquitoes (adulticides) may be applied, the City may use a variety of procedures. Citizen reports will be recorded to identify potential sites. When a sufficient number of reports have been received, the City will conduct firsthand surveillance at the potential site. The City will also evaluate whether a site is a high-priority area due to regular high usage or planned outdoor events. Finally, the City will take into account whether a potential site has a history of excessive mosquito populations.

Mapping

The City uses a variety of mapping techniques, as appropriate, in an effort to control mosquito populations including:

- Mosquito breeding sites: The City employs a GIS database to record locations where high mosquito activity has been identified. The City also keeps records of complaints made by citizens in order to track historical and new breeding sites.
- No-spray zones: There are no known areas that need to be avoided when spraying adulticides. However, the City will always take into consideration any citizen request for a no-spray zone.
- Endangered species critical habitat: The City will rely upon the National Oceanic and Atmospheric Administration, Ecology, Environmental Protection Agency (EPA), and Washington Department of Fish and Wildlife (WDFW) in circumstances in which any species listed under these authorities are present.
- Other relevant information: This section will be updated if other relevant information becomes apparent.

Action Thresholds

1. Larval Mosquito Action Thresholds

   The City may choose to apply larvicide if any of the following threshold conditions are met:

   a. The City conducts pretreatment surveillance of a potential larvicide application site and finds at least one larvae/pupae in at least one of three dips. In the event that the City finds larvae/pupae, and the area is treated, the City may continue preemptive larvicide treatments without dipping for the remainder of the treatment season.

b. The Permit Area includes intermittently flooded areas that have a historical record of mosquito hatches following flooding. In that event, the City may use Methoprene as a pre-emergent dry-land treatment in those areas without pretreatment dipping.
c. The City has developed and obtained Ecology approval of a large-site sampling protocol prior to treatment.
d. The application site is in, or adjacent to, a county in which mosquito, bird, animal, or human mosquito-borne disease cases are confirmed during the current treatment season.
e. The treatment site is a catch basin, storm drain, or utility or transportation vault.
f. State or local health authorities declare a public health threat or emergency related to mosquito-borne disease.

2. Adult Mosquito Action Thresholds

The City considers a variety of factors when determining whether to apply adulticides. These factors include citizen reports, firsthand surveillance, whether the site in question is a high-traffic public area, whether large events have been planned for the site, and if the site has a history of mosquito problems.

Adulticiding is generally less effective than the methods to control larvae, as described above. Adulticiding may be considered when there is a severe nuisance problem to provide relief from heavy swarms of biting mosquitoes or when public health officials have determined that the risk from mosquito-borne diseases outweighs the potential risks from the use of adulticides.

The City will rely on the expertise of the Seattle - King County Health Department and Washington State Department of Health in determining when the nuisance is severe enough to provide relief from heavy swarms of biting mosquitoes or when public health officials have determined that the risk from mosquito-borne diseases outweighs the potential risks from the use of adulticides. If the city chooses to use a licensed contractor the City will rely on the contractor's professional judgment for surveillance and action thresholds.

Mosquito Control Methods

The City will use a variety of mosquito control methods in its permit coverage area. The City's primary focus will be physical control and source reduction. Some approved forms of biological controls and larvicide will be used, and adulticide will be employed as a last resort, primarily in city parks. The City will also focus on educating the public about eliminating standing water to reduce mosquito breeding sites, since most of the property in the permit area is not owned or maintained by the City.

1. Physical Control and/or Source Reduction

The City employs propane traps as a physical control for mosquitoes. These traps are maintained by the Parks Department at the beginning of each mosquito season. To reduce sources for mosquito breeding, all City-owned facilities are regularly examined to eliminate standing water wherever possible.

2. Biological Mosquito Control

The City uses Bacillus thuringiensis israelenis, commonly known as Bti. This is a natural mosquito control product that does not harm other wildlife, is easy to apply, and kills larvae quickly and efficiently. The City also uses Altosid, which contains (S)-Methoprene, an insect growth regulator (IGR) that stops mosquitos from becoming breeding, biting adults. (S)-Methoprene is target-specific, and will not affect fish, waterfowl, mammals or beneficial predatory insects. In addition, the City also encourages property owners to install bat houses as a means of mosquito control.

3. Pesticide-Based Larval Mosquito Control
   a. Allowed larvicides: Appendix 1 includes labels for all larvicide products that will be used by the City and those that are allowable in the permit.
   b. Equipment calibration and maintenance: Pesticide application equipment will be maintained in proper operating condition, including calibration, cleaning, and repair. This work will be performed by a licensed contractor on a regular basis with the exception of the propane traps, which will be maintained by the Parks Department staff.
4. Pesticide-Based Adult Mosquito Control
   a. Allowed adulticides: Appendix 1 includes labels for all adulticide products that will be used by the City and those allowable in the Permit.
   b. Equipment calibration and maintenance: Pesticide application equipment will be maintained in proper operating condition, including calibration, cleaning, and repair. This work will be performed by a licensed contractor on a regular basis.

Monitoring for Efficacy/Resistance

The City will monitor pesticide resistance through GIS tracking of application sites and records from citizen reports.

Record-Keeping and Reporting

Annual Report The City will submit the required Annual Report by December 31 each year in both electronic and hard-copy formats. For more details and to see a template of this report, please refer to Appendix 2

Noncompliance Notifications

In the event that the City violates or is unable to comply with any permit condition, the City will immediately take action to minimize potential pollution or otherwise stop the noncompliance and correct the problem.

The City will also provide a written report to Ecology per the requirements of this permit. These requirements are detailed in Section S8.D of the Mosquito Control Permit. Finally, the City will update its IMM plan to address the noncompliance to reduce the likelihood of the incident occurring again.

Education and Outreach

The City of Shoreline conducts a number of public outreach and education activities. Among these, the City contributes articles to local newspapers providing information about source reduction, encourages landowners to invest in biological controls such as bat houses, and holds in-field educational opportunities for citizens.

New Staff Training and Continuing Training for Existing Staff

City staff receive regular Illicit Discharge Detection and Elimination (IDDE) training to ensure property detection and response in the event of a spill. When necessary, the City contracts pesticide application to licensed contractors and ensures that contractors are certified and licensed in aquatic pest control.

Signature Requirements

"I certify under penalty of law, that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering information, the information in the IMM is, to the best of my knowledge and belief, true, accurate, and complete and will be updated as necessary. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations. Unless the Department of Ecology Permit has more stringent requirements, all FIFRA label directions and requirements will be followed."

____

[INSERT SIGNATURE BLOCK FOR RESPONSIBLE STAFF]

Public Access to IMM Plans

The City of Shoreline shall provide access to the IMM plan to the public through the City's website.

Notification to Public

The City of Shoreline shall provide public notice of mosquito control activities at least 10 days before the first pesticide application of the season. The City shall do one of the following:

1) Provide public notice on the City's website and distribute the notice to identified parties through email or other electronic means.
2) Publish a public notice in a newspaper with general circulation within the area where the larvicides or adulticide application will take place.

   The Notice will include:

   a) The pesticide(s) planned for use and the active ingredient(s).
   b) The approximate date ranges of planned treatments.
   c) The approximate treatment location(s).
   d) The online location where the public may find pesticide application updates (if available online).
   e) The application area posting procedures if the use of the larvicides with water-use restrictions is planned.
   f) The name and telephone number of the Aquatic Pesticides Permit Manager.
   g) The telephone number, email address or website where a person may contact to have their name put on a "No Spray" list.

Appendix 1 - Active Ingredients Authorized for Use

1. Bacillus sphaericus (H-5a5b)
2. Bacillus thuringiensis israelensis (Bti)
3. Malathion
4. Methoprene
5. Monomolecular Surface Films (MSF)
6. Paraffinic White Mineral Oil
7. Spinosad
8. Temephos
9. Etofenprox
10. Naled
11. Natural Pyrethrins
12. Permethrin
13. Piperonyl Butoxide (PBO)
14. Prallethrin
15. Resmethrin
16. Sumithrin (d-phenothrin)

Appendix 2 - Annual Report

By December 31 of each year, the Permittees must submit an annual report electronically through Ecology's online data management system (Secure Access Washington at

https://secureaccess.wa.gov. A signed and dated hard copy of the annual report must also

be mailed to:

Department of Ecology

Water Quality Program

Attn: Aquatic Pesticide Permit Manager

PO Box 47696

Olympia, WA 98504-7696

The annual report must include:

a. Permit Number.

b. Permittee Name.

c. Name of the location treated. The location is the area for which the Permittee has permit coverage for (e.g., ABC Golf Club, ABC City storm drain system, ABC County, ABC Mosquito Control District).

d. Total amount of each active ingredient applied during the season in pounds.

e. Whether treatment occurred in areas identified as vulnerable species habitat

f. Total amount of each active ingredient applied during the season in pounds to areas identified as vulnerable species habit.

Appendix P: Spill Response Plan

Appendix P

Spill Response Plan

1.0 Overview

It is the City of Shoreline's obligation under the NPDES Phase II Western Washington Municipal Stormwater Permit to provide spill prevention, spill response planning and training, and spill cleanup. This spill response manual provides City staff with basic information on how to respond to spills.

The primary goal of this spill response plan is to prevent contaminants from entering the storm drain system and local waterways. Spills of this nature typically have the potential to be more mobile in the environment and cause a greater threat to human health and the environment. However, releases to land and water also require cleanup and proper notification.

The spill response plan provides guidance to City of Shoreline staff who may respond to spills. Three levels of response are outlined in the plan. Staff are responsible for placing themselves in the proper response level category based on their job description, their likelihood of encountering a spill in the field, and experience with spills. All staff are responsible for reporting any spill encountered in the field or that they may have caused. The other two response levels involve spill containment and cleanup. Only qualified staff should perform those activities.

Spill containment and clean up may require assistance from other agency staff, depending on the nature of the material spilled and the size of the spill. Generally, if a spill is larger than a 1 gallon or over 1-pound, or is a hazardous substance, other agencies or city departments will need to be notified. If the spill is smaller than that, not hazardous, and not entering a storm drain or waterway, you may clean up the spill yourself, and reporting is not required. You may always contact Surface Water and Environmental Services (SWES) staff for advice or disposal assistance regardless of size.

In addition to this manual, appropriate staff shall receive spill response training from the City of Shoreline Water Quality Specialist or other SWES representative. Staff should familiarize themselves with this manual to ensure a coordinated approach while responding to spills. Use of this manual is intended to decrease the inherent risk to those responding to the spill and to surface waters within the City of Shoreline.

2.0 What is a Spill?

The Environmental Protection Agency generally describes a spill as an accidental or intentional discharge of chemicals, hazardous substances, or petroleum product which has the potential to contaminate bodies of water, soil, underground water sources or get into storm and sewer systems.

A "spill" is any unauthorized discharge. The term "hazardous materials" referred to in this plan includes all types of petroleum products related to vehicles (gasoline, diesel, motor oil, brake fluid, transmission fluid, etc.) and other liquids and solids that pose a threat to human health and the health of the environment. The most common non-petroleum materials are anti-freeze and pesticides (herbicides, insecticides, and fungicides).

3.0 Types of Incidents

Generally, there are two classes of spills that will be encountered in the field or found when City employees arrive at a site:

1) Emergency Spill – Spills of high-risk nature (hazardous or unknown material, large quantity or any time that the contaminant discharges from the City system into a receiving water body). There is an imminent danger to the public and/or the environment. This applies to spills within the right-of-way or on private property.
2) Incident (non-emergency) Spill
   a. City Right-of-Way – Spills of low-risk nature (identifiable material and small quantity). These spills can be contained and cleaned up by the City (or its Contractors). If a known private party is responsible for the spill, this party shall be billed any clean up cost incurred by the City.
   b. Private Property – Spills of low-risk nature (identifiable material and small quantity). City will assist to prevent entry of material into the public drainage system, followed by thorough cleanup by the responsible party.

4.0 Staff Response Level

The response levels below are general guidelines. Your personal safety is always the first priority. City staff are responsible for determining the level that best fits the description of their job position, comfort level and experience. Level 1 is the minimum level that must be performed by all staff.

Response Level	Description of Staff	Action
Level 1	• Staff with a low probability of encountering a spill in the field or within City limits. • Generally, have not encountered a spill before and are not comfortable performing any kind of containment or cleanup activities. • Examples of level 1 staff include PADS Planners, City Clerks, Spartan Gym Parks staff, most Managers, and City Administration staff.	**Assess** **Report/call** • Call 911 immediately if it is an emergency. • Always notify CRT, SWES, and ROADS staff of the spill.
Level 2	• Staff with a moderate probability of encountering a spill in the field or within City limits. • Generally, staff have had some previous exposure to spills and are somewhat comfortable with containment or cleanup activities. • Examples of level 2 staff include Traffic Engineer/ Technicians, Right-of-Way Inspectors, Facilities, Police, and Parks Maintenance staff.	**Assess** **Report/call** • Call 911 immediately if it is an emergency. • Always notify CRT, SWES, and ROADS staff of the spill. **Contain** and Cleanup • Contain the spill and secure the scene *if comfortable.* • Begin cleanup activities *if comfortable.*
Level 3	• Staff with a high probability of encountering a spill in the field or within City limits. Spill response is part of their job duty. • Generally, staff have had moderate or frequent exposure to spills and are comfortable with containment or cleanup activities. • Examples of level 3 staff include Roads, CRT, and SWES staff.	**Assess** **Report/call** • Call 911 immediately if it is an emergency. • Always notify SWES staff of the spill. **Contain and Cleanup** • Contain the spill and secure the scene. • Begin cleanup activities if comfortable. • Procure outside cleanup assistance if needed.

Making notifications in the case of the spill is primarily the responsibility of SWES staff. However, if SWES staff cannot be reached and immediate action is necessary, this document will provide CRT, Roads, or other qualified City staff with the information needed to make the contacts on the behalf of SWES.

5.0 Spill Response Steps

This section outlines the steps that should be taken by the first City-representative that arrives at the scene of a spill or the City staff person responsible for the spill. Take the actions outlined according to your appropriate response level.

You may not be the first person on the scene (for example, in the case of a spill caused by a contractor or resident) but as a City representative you shall notify the appropriate City staff (see section 5.2.1 for contact phone numbers) and verify that cleanup procedures are being generally followed by the responsible party.

For any type of spill response, ***providing for the safety of the public and activation of other emergency services is first priority***. When you arrive at a spill scene and you find an emergency situation, call 911 and ask to be transferred to the Shoreline Fire Department so they can assess the situation and call for a HazMat team if needed. Always report a spill, except a small spill of non-hazardous material less than 1 gallon, to SWES, CRT, or ROADS staff and take the appropriate steps according to your staff response level.

1. Obtain Information about the Incident
2. Notify the Appropriate Authorities
3. Secure the Scene
4. Contain the Spill
5. Cleanup the spill and document the Cleanup efforts

Details of each step are provided in the sections below.

For major spills, follow these steps closely. For minor spills, choose the steps necessary to protect human health and the environment and to expeditiously clean up the spill. In most cases, it may be necessary to perform the steps out of order in order or simultaneously to protect human health and the environment (for example, containing the spill prior to notifying the appropriate authorities).

5.1 Obtain information About the Incident

This information will be relayed to the appropriate regulatory agencies.

- Your name, location, organization, and telephone number
- Name and address of the party responsible for the incident
- Date and time of the incident
- Weather conditions at the incident location
- Location of the incident
- Source and cause of the release or spill
- Types of material(s) released or spilled
- Quantity of materials released or spilled (See Appendix C to estimate the quantities of oil in water)
- Danger or threat posed by the release or spill
- Number and types of injuries (if any)

This information should be entered in to Cityworks, but can be summarized in the Hazardous Materials Spill Report Form located in Appendix A if you do not have immediate access to Cityworks.

Always take photographs of the incident if possible as part of the documentation process. Use your best judgment to get as accurate information as possible.

5.2 Notify the Appropriate Authorities

When a spill occurs, the appropriate authorities must be notified. The appropriate notifications depend whether the spill is classified as an emergency or non-emergency. Please review Section 3.0 of the Spill Response Plan for the definition of each type of spill if you are unsure. Make contact with proper authorities immediately after arriving on scene.

If the spill is classified as an emergency, first call 911 and ask to be transferred to the Shoreline Fire Department so they can assess the situation and call for a HazMat team if needed. After you have called 911, immediately notify the City's CRT, SWES, and ROADS staff.

For incident (non-emergency) spills, the City's SWES or CRT staff must be notified.

Telephone numbers are provided in section 5.2.1 below, as well as in Appendix B, the Spill Response Notification Flow Chart.

It will be the responsibility of the City's SWES staff to report the spill to additional agencies if necessary.

5.2.1 Contact List

IF THERE IS AN IMMINENT THREAT TO HUMANS OR THE ENVIRONMENT, IMMEDIATELY CALL 911.

Also, for all emergencies and incidents, contact:

CRT
(206) 801-2700

→

SWES

Surface Water Quality Specialist
Office: (206) 801-2453
Cell: (206) 571-7100

OR

Utility Operations Specialist – contact for vactor service
Office: (206) 801- 2454
Cell: (206) 819-4468

OR

SWES Manager

→

ROADS

Maintenance Supervisor – contact for vactor service
Office: (206) 801-2441
Cell: (206) 793-0228

OR

Senior Maintenance Worker
Office: (206) 801-2442

If unable to notify CRT, SWES, or ROADS, call:

Washington Department of Ecology Northwest Region 24-hour response: (425) 649-7000.

<u>If unable to notify, respond to spill with persons and equipment on hand and call:</u>

Ventilation Power Company[1]: (206) 634-2750

- Only call Ventilation Power if it is an imminent threat to public health and/or the environment (e.g. oil is entering the storm drain).
- Ventilation Power can bring a vactor truck to vacuum up large quantities of free product from the stormwater system. In some cases they can skim product off of the water. Call them and describe the site, nature of the spill (product and quantity) and cleanup requirements. They will tell you if they have the capability to respond.

Washington Department of Ecology Northwest Region 24-hour response: (425) 649-7000

Call the Department of Ecology (DOE) Northwest Regional Office's Emergency Reporting Tracking System (ERTS) 24-hour response and describe the site, nature of the spill (product and quantity) and cleanup requirements. Inform them that the City is unable to respond to the spill and outside assistance is needed.

National Response Center: (800) 424-8802

If the spill is large-scale, call the National Response Center after reporting to the Department of Ecology.

5.2.2 NPDES Required Notifications

Any time there is a spill or discharge into or from the City's stormwater drainage system that *poses a threat to human health, welfare, or the environment,* the City's NPDES permit requires that the proper authorities be notified. The table below outlines the conditions in which notification is necessary and provides the phone numbers to call.

Type of Discharge	Who to Notify	Time to Notify	Special Reporting
A spill or discharge into or from my MS42, which could constitute a threat to human health, welfare, or the environment.	Ecology Northwest Regional Office: (425) 649-7000	Immediately, but no later than 24- hours after obtaining the knowledge.	Notify jurisdictions, or secondary permittees, with inter-connected MS4s as needed.
A spill or discharge of oil or hazardous substances into or from my MS4, which presents a threat to human health, welfare, or the environment.	Ecology Northwest Regional Office: (425) 649-7000 AND Washington Emergency Management Division: (800) 258-5990 OR (800) OILS-911 AND National Response Center: (800) 424-8802	Immediately	None
A spill or discharge into or from my MS4, which might cause bacterial contamination of shellfish. (Western Washington only)	Ecology Northwest Regional Office: (425) 649-7000 AND WA State Department of Health: (360) 236-3330	Immediately	None

1 Ventilation Power Company is the Surface Water Utility's current on-call contractor – this information will be updated if the on-call contractor changes.

2 The NPDES permit refers to City's storm drainage system as a MS4 (municipal separate storm sewer system).

5.2.3 Resource Impact Notification Requirements

If the spill impacts resources in addition to water or soil, the proper agencies shall be notified. Below are the necessary contacts based on the resources impacted.

Resources Impacted	Agency to Notify	Phone Number
Air Quality	Puget Sound Clean Air Agency Complaint Hotline	(800) 552-3565 Extension 6
Fish and Wildlife	Washington Department of Emergency Management	(800) 258-5990
Puget Sound (for large spills)	US Coast Guard Seattle district command center	(206) 220-7001
Drinking Water – East of I-5	North City Water District	(206) 362-8100
Drinking Water – West of I-5	Seattle Public Utilities District	(206) 386-1800
Sewer (also for spills caused by sewage overflow)	Ronald Wastewater Management	(206) 546-2494 (After hours emergency: (206) 533-0177)

5.3 Secure the Scene

- Keep all persons as far away from the incident as is practical. If necessary to take actions to control traffic and protect motorists, contact the Shoreline Police at 911 or City staff trained in appropriate traffic control procedures.
- Observe and size-up the incident from a safe distance. Providing rescue and first aid shall be at the employee's discretion.
- Avoid contact with spilled material and avoid breathing vapors, smoke, or dust originating from the material.
- Stay upwind of any fires and spills; keep out of low areas.
- Do not clean up any unfamiliar, unknown, or suspected hazardous material. Avoid spreading contamination (i.e., liquids, solids, or gases).
- Call for additional City resources to secure the scene or to help with the other aspects of the spill response.
- Obtain names and contact information and encourage all persons involved with the incident to remain at the scene. If detention is necessary, please call 911 for the Shoreline Police.

5.4 Contain the Spill

- If safe, stop the source of the spill and keep the spilled substance from migrating away from the source using spill kits or other appropriate equipment, to the extent practicable.
- Prevent the spilled material from entering storm inlets (catch basins) and entering sanitary sewer lines.
  - Confine the spill and direct flow away from drains, streams, and wetlands by using absorbent booms, sandbags, or berms.
  - Block off storm or sewer inlets with sandbags or a rubber drain cover mat if available.

More information on spill containment and cleanup can be found in section 6.0 of this document.

5.5 Cleanup the Spill and Document the Cleanup Efforts

Proper clean-up procedures are described in section 6.0 below. Document how the spill was cleaned up (absorbent pads, booms, vactor truck, etc.). You must also document where the cleaned up material was disposed. All this information, as well as the information collected in step 1 (obtain information about the incident), should be documented in Cityworks.

6.0 Spill Cleanup

The following procedures describe the steps to cleaning up a spill.

6.1 Spill Response Equipment - Spill Response Kit

Your vehicle may be equipped with a spill response kit. Vehicles typically driven by Level 2 staff are equipped with a 5-gallon response kit at a minimum. Vehicles for Level 3 staff are generally equipped with a spill kit capable of containing and cleaning up larger spills. There may also be a spill kit on site (for example: there is a spill kit on site for the generator at the Spartan Gym).

A spill kit is typically contained in a yellow bag or container and contains absorbent materials (granular, pads, and booms) and PPE (gloves and safety glasses). Below are the typical spill kit contents that you will find in the City Vehicles for Level 2 and 3 staff.

- Level 2 - General spill kit contents (for a spill kit that absorbs up to 3 gallons) are:
  - Instruction sheet
  - 1 pair Nitrile gloves
  - 2 - 3" x 4' socks
  - 10 - 16" x 20" pads
  - 1 disposal bag
- Level 3 - General spill kit contents (for a spill kit that absorbs up to 15 gallons) are:
  - 1 emergency response book
  - 1 pair Nitrile gloves
  - 1 pair goggles
  - 3 – 3” x 4’ socks
  - 2 – 3” x 10’ socks
  - 20 – 17” x 19” pads
  - 1 disposal bags/ties
  - SPAGH SORB® or other granular absorbent (optional)
  - Absorbent products contained in the spill kits, besides granular absorbents, are colored according to the type of material they are effective for:
  - White absorbents are hydrophobic (do not absorb water) and attract oil. They are good for skimming product off of the water surface and absorbing oil off of hard surfaces.
  - Grey or light green absorbents are multi-purpose, good at soaking up almost everything, including water. Use these when cleaning up spills that are not in water.
  - Pink absorbents - the City does not generally use pink absorbents, but if they are available they are specially treated to soak up the widest range of corrosive liquids (acids or bases) or unknown liquids. They are good for cleaning up chemical spills.

Please contact SWES for information about obtaining a spill kit or the replenishment of spill kit contents.

6.2 Spill Cleanup Procedures

Important: Always follow these safety precautions:

- Wear appropriate personal protective equipment at all times.
- Do not enter confined spaces!
- Do not enter trenches or excavations, buildings in danger of collapse, and areas with strong vapor, chemical clouds, or odor.
- Do not smoke or eat during cleanup.
- Always wash your hands after cleanup.

6.2.1 Released On Land

6.2.1.1 Impervious Surface (e.g., asphalt, concrete, tile)

Place SPHAG SORB® or granular absorbent on the product, being sure to cover all wet areas. When as much of the product has been absorbed as possible (it may have to be left on the spill a while to absorb all of the product), sweep up the absorbent, place inside of a trash bag and seal the bag.

6.2.1.2 Soil

Contaminants that enter soil are not generally mobile and will not further contaminate surrounding areas. When there is a release of a contaminant to the soil, please contact SWES and staff will determine the best course of action for cleanup.

6.2.2 Release to water

6.2.2.1 Flowing In a Stream of Water on the Pavement into a Ditch or Storm Drain

Place white absorbent pads or booms, as appropriate, at the source of the contaminants to skim them off of the surface of the water and prohibit the flow of the contaminants from the source. Follow the flow of contaminants downstream to the first ditch, catch basin or receiving water body you come to (receiving feature). Place absorbent pads or booms at the point where contaminants are flowing into a receiving feature. Also place absorbent pads inside the receiving feature, as necessary, to remove as many contaminants as possible. These absorbents typically need to be left at the scene for an extended period of time in order to capture as much of the contaminants as possible. When the absorbents become saturated, or a spill has been completely contained, pick up the absorbents, place them inside a plastic bag and seal the bag.

See Section 6.2.3 below for disposal instructions.

6.2.2.2 In a Stream or Lake

If the spill enters into a water body, immediately contact SWES, CRT, or ROADS. They will respond immediately to the scene. Please begin cleanup procedures while you are waiting for their arrival.

If the spill was not directly into the water body, follow the cleanup instructions provided in Section 6.2.2.1 AND take the following actions:

- For spills directly into a water body, place, if safe to do so, white absorbent pads or booms on the spill to skim the contaminants from the surface of the water. Leave these absorbent materials in place until SWES, CRT, or ROADS staff arrives on scene.

6.2.3 Disposal of Cleanup Materials

Dispose of the absorbent materials in an appropriate manner consistent with the nature and volume of the spill and consistent with State law. In most instances, small quantities of materials can be sealed inside a plastic bag and placed in a solid waste container.

If you are unsure of the proper disposal method please contact SWES, CRT, or ROADS and they will advise you.

Several hard copies of this plan are available with Surface Water and Environmental Services, the Customer Response Team, and Roads.

7.0 Appendices

Appendix A. Hazardous Materials Spill Report Form

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HAZARDOUS MATERIALS SPILL REPORT FORM

NOTE: COMPLETE THIS FORM ONLY IF YOU ARE UNABLE TO COMPLETE A SERVICE REQUEST IN CITYWORKS.

1. Location:________________________________ **2. Date/Time:** ________________

3. Person Reporting Spill:____

4. Person in Charge On Scene: __________________ **5. Phone:** ____________________

6. Material(s) released: _________________________ **7. Quantity:** _________________

8. Weather conditions at time of Spill: ____

9. Source/Cause of Spill:

____

____

10. Describe Any Injuries or Potential Threats to Human Safety:

____

____

____

11. Contamination of: soil _____ water bodies______ drains_____ streets_____

plants______ people ____ vehicles/equipment ____ other (explain)___________

12. Estimated Affected Area: ____

13. Name and Contact Information of Responsible Party for Spill and Cleanup:

____

____

14. List Any Other Entities or Agencies Involved in the Cleanup (contractors, etc):

____

____

15. Other Agencies on Scene: ____

16. Response Actions Taken: ____

____

____

17. Response Actions Planned:

____

____

18. Name , organization, and Phone # of person completing this report:

____

19. Map of Spill Area and Affected Structures

N

Complete and submit this to Surface Water Management, Water Quality Specialist, within 24 hours of the incident (fax 206-801-2785).

Appendix H: Asset Management Work Plan

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Technical Memorandum

701 Pike Street, Suite 1200
Seattle, WA 98101
T: 206.624.0100
F: 206.749.2200

Prepared for: City of Shoreline

Project Title: Shoreline Surface Water Master Plan

Project No.: 149479

Deliverable D06

Subject: Asset Management Work Plan

Date: April 12, 2017

To: Uki Dele, Surface Water and Environmental Services Manager, City of Shoreline

From: Nathan Foged, Managing Engineer, Brown and Caldwell

Copy to: Margaret Ales, Senior Engineer, Brown and Caldwell

Scott Bash, President, FCS Group

Prepared by: Scott Bash

Reviewed by: Steffran Neff

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List of Abbreviations

AM Committee	Asset Management Committee
AMWP	Asset Management Work Plan
BC	Brown and Caldwell
CCTV	closed-circuit television
City	City of Shoreline
CIP	capital improvement plan
CMMS	computerized maintenance management system
COM	communication
Consultant Team	Brown and Caldwell and FCS Group
DEV	development
EUL	estimated useful life
FCSG	FCS Group
FIN	financing
FIS	financial information system
GASB 34	Governmental Accounting Standards Board Summary of Statement 34
GIS	geographic information system
IT	information technology
KNO	knowledge
Master Plan	Surface Water Master Plan
MON	monitoring
NASSCO	National Association of Sewer Service Companies
NPDES	National Pollutant Discharge Elimination System
O&M	operations and maintenance
ORG	organization
PLN	planning
PM	preventive maintenance
PRG	program development
R&R	rehabilitation and replacement
REP	reporting
RSI	Required Supplemental Information
SOP	standard operating procedure
SYS	systems
UBME	Utility Business Management Evaluation
Utility	Surface Water Utility
VIS	vision and support

Executive Summary

Brown and Caldwell (BC) and FCS Group (FCSG) (Consultant Team) are working with the City of Shoreline (City) to prepare an updated Surface Water Master Plan (Master Plan) for the Surface Water Utility (Utility) that will address drainage and water quality issues associated with growth, increasing regulations, and aging infrastructure. The Master Plan will guide Utility activities for the next 5 to 10 years, and will include recommendations for capital improvement projects, policies, programs, and a financial plan for long-term asset management.

The City has identified asset management as a key element of the Master Plan. The City believes that a strong Asset Management Program will improve stewardship of the surface water system infrastructure and assure customers that funds are spent responsibly and effectively. Asset management ties Utility expenditures to customer service levels, and through increased accountability, aims to ensure that all asset decisions reflect the lowest life-cycle cost needed to meet customer expectations at responsible levels of risk.

This Asset Management Work Plan (AMWP) is intended for the Utility, and is an update to the Utility's Asset Management Program. The key highlights of the AMWP are as follows:

- The Utility staff and leadership at the City's Public Works Department determined that key business processes related to life-cycle management of assets are important to the sustainability of Master Plan and Utility activities such as planning, design, construction, operations and maintenance (O&M), capital refurbishment, and replacement.
- The Utility's business processes were compared with best practices in each of several business process categories. The cost to close the high priority gap closures is estimated at $170,000 of contractor costs, over the next five years.
- Through several working sessions, the Utility staff and Public Works Department leadership defined, area by area, the level of performance that the Utility should aim to achieve during the next several years. The high-level areas of improvement include; aligning the AMWP with the City goals, clear communication with stakeholders and staff on the AMWP, and more detailed configuration of maintenance strategies and condition assessment efforts to extend asset life and improve asset reliability
- Top management should appoint an Asset Manager with the authority to lead the Asset Management Team (AM Committee) and the resources to develop and sustain the AMWP and Program. This should include schedules and preliminary responsibilities for performance.
- The Utility can benefit from a more robust risk management plan to support operational budget and prioritize capital decision making that aligns the cost of service with level of service. This would include determining criticality for each asset based on reliability and consequence of failure in terms of cost, service delivery risk, environmental risk, etc.
- A staff education program, developed to meet skills needed and enhancing staff growth potential, will be important to support the AMWP plan and sustain the AM Program.

The process for identifying asset management needs and prioritizing actions is shown in Figure E-1.

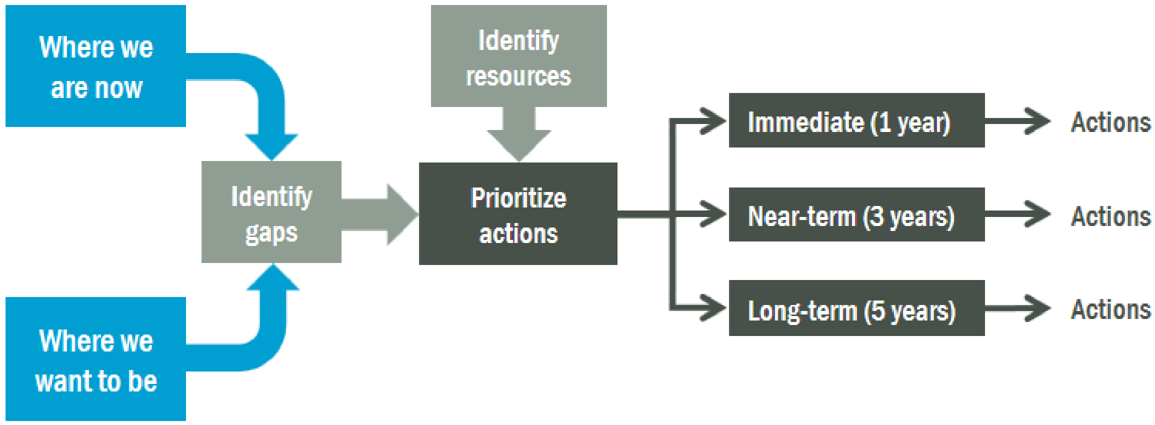

Figure E-1. Development of prioritized actions for AMWP

Table E-1 presents a summary of the estimated implementation costs for immediate, near-term, and long-term asset management needs. Detailed descriptions of the needs and actions for addressing them are provided in subsequent sections of this document. A more detailed breakdown of the cost to close the gaps is provided in Appendix A: *Gap Implementation Cost Estimates*.

Table E-1. Implementation Cost Summary

Personnel	Priorities			Full implementation (total through 5 years)
	Immediate (1 year)	Near-term (3 years)	Long-term (5 years)	
Utility staff	$49,231	$80,090	$62,595	$191,916
Contractor and consultants	$28,025	$59,225	$82,295	$169,545
Total Cost	**$77,256**	**$139,315**	**$144,890**	**$361,461**

It is probable that the Utility will re-prioritize needs, define new goals, revise strategies, and change or add actions over time. These activities will necessitate continual updates to this AMWP, and thus it should be considered an actively managed living document.

Section 1: Introduction

Brown and Caldwell (BC) and FCS Group (FCSG) (Consultant Team) are working with the City of Shoreline (City) to prepare an updated Surface Water Master Plan (Master Plan) for the Surface Water Utility (Utility) that will address drainage and water quality issues associated with growth, increasing regulations, and aging infrastructure. The Master Plan will guide Utility activities for the next 5 to 10 years, and will include recommendations for capital improvement projects, policies, programs, and a financial plan for long-term asset management.

Asset management is a major element of the Master Plan. The City believes that an updated Asset Management Program will improve stewardship of the surface water system infrastructure and assure customers that funds are spent responsibly and effectively. Asset management ultimately ties Utility expenditures to customer service levels, and through increased accountability, aims to ensure that all asset decisions reflect the lowest life-cycle cost needed to meet customer expectations at responsible levels of risk. The primary goal of the Asset Management Program is to provide a structured approach to minimizing asset ownership life-cycle costs, while still meeting required service levels and providing long-term confidence in the condition of system infrastructure. The expected outcomes are lower ownership costs, assets in better condition with longer lives, and more efficient use of the Utility's staff and capital resources.

This Asset Management Work Plan (AMWP) is intended to guide the Utility through the process of updating its Asset Management Program. In preparing the AMWP, the Consultant Team worked with the Utility to complete the following activities:

- Participated in interviews to identify the Utility's strengths and weaknesses as compared to standards for asset management programs
- Analyzed and rated the Utility in 13 business process categories and 89 individual business elements
- Prepared target goals for the Utility Asset Management Program for the next 3 to 5 years
- Performed a gap analysis by comparing current practices with the target goals
- Prioritized needs and developed performance targets for the Asset Management Program
- Reviewed levels of service and related actions that are critical to long-term asset management success

The following sections present the Utility's analysis of its current asset management business processes, its view of improvements needed during the next several years, and a plan for achieving those improvements through implementation of an updated Asset Management Program.

Section 2: Evaluation of Business Practices

The Utility has already completed several fundamental efforts in support of its Asset Management Program, such as defining levels of service and implementing the Cityworks computerized maintenance management system (CMMS). In addition, the Utility has established an Asset Management Committee (AM Committee) to steer and support the asset management planning process. The AM Committee's current focus is to evaluate the strengths and weaknesses of the Utility's Asset Management Program with respect to best practices for similar utilities. To accomplish this, the AM Committee worked with the Consultant Team to evaluate current business practices, identify gaps, and prioritize actions to improve the Asset Management Program (see Figure 1, below).

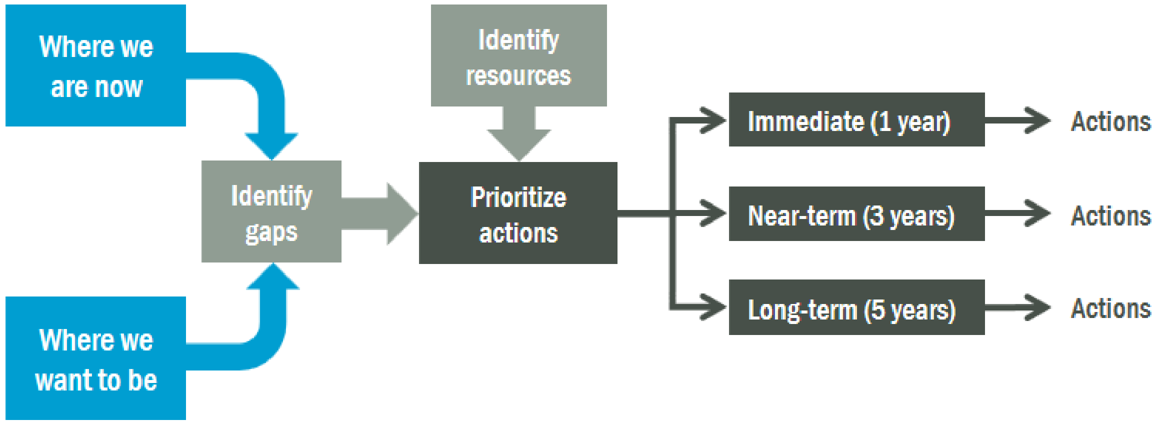

Figure 1. Process for identifying and prioritizing actions for the AMWP

2.1 Gap Analysis

The Consultant Team conducted a series of interviews with Utility staff to evaluate a wide range of business practices using its Utility Business Management Evaluation (UBME) process. The UBME groups the findings into the following major topics or business process categories:

- Management vision and support
- Organization
- Asset management program development
- Asset knowledge
- Asset planning
- Asset management program communication
- Asset development
- Asset operations and maintenance (O&M)
- Asset condition monitoring
- Asset rehabilitation and replacement (R&R)
- Asset financing
- Asset finance reporting
- Asset management systems

The Utility's current business practices were assessed and then compared with known best practices for each business element within the AM categories. The UBME (in Appendix B) provides a gap matrix showing the results of the comparison. Once current practices were evaluated, the Consultant Team worked with the AM Committee to establish a baseline score for each business element. A scoring system in the UBME was developed using five levels of maturity ranking with numeric ranges as defined in Table 1.

Table 1. Gap Scoring System		
Maturity Ranking	Description	Score
Optimizing	Approach is practiced, measured, fully controlled, and has an improvement cycle focused on results	80–100
Managed	Defined documented approach, practiced, and measured—but not controlled	50–70
Defined approach	Defined approach with no controlled documentation and not practiced consistently	30–40
Initial	Aware but no systematic approach	10–20
Unaware	Total unawareness within organization	0–10

The Consultant Team held a workshop with the AM Committee to review the best practices and scores. Once the baseline scores were agreed upon, a second workshop was held to establish the target scores that correlate with desired performance levels to be reached within the next 5 years. A gap analysis was then completed by comparing current baseline scores (i.e., where the Utility is now) with target scores (i.e., where Utility staff would like to be in 5 years) based on what is achievable and consistent with the goals of the City Council (see Table 2). The difference between the target score and the current score is the numeric gap score.

Table 2. 2015–17 Shoreline City Council Goals	
Goal	Description
Goal 1	Strengthen Shoreline's economic base to maintain the public services that the community expects
Goal 2	Improve Shoreline's utility, transportation, and environmental infrastructure
Goal 3	Prepare for 2 Shoreline light rail stations
Goal 4	Enhance openness and opportunities for community engagement
Goal 5	Promote and enhance the City's safe community and neighborhood programs and initiatives

2.2 Prioritization of Needs

The Consultant Team worked with the AM Committee to prioritize each business practice gap. The team used a score of "5" for those areas of the highest criticality and "1" for the lowest criticality. The gap score was multiplied by the criticality rating to calculate a weighted gap score for each business element. For example, a gap score of 30 with a criticality of 5 has a weighted gap score of 150. Weighted gap scores were sorted and used to establish priorities for gap closures as part of a final workshop. The gap closure priorities were divided into three categories as defined in Table 3. Details from the gap analysis, prioritization, and criticality scoring are included in Appendix B.

Table 3. Gap Closure Prioritization Categories and Definitions	
Prioritization category	Definition
Immediate	Key activities to be completed during the next 12 months
Near term	Key activities to be completed during the next 1–2 years
Long term	Key activities to be completed during the next 5 years

The Utility prioritized each business practice and then developed overall priorities for the 13 business process category (see Table 4).

Table 4. Business Process Category Priorities for Action

Business process category	Abbreviation	Priority
Vision and support	VIS	Immediate
Organization	ORG	Immediate
Asset management program development	PRG	Immediate
Asset program communication	COM	Immediate
Asset knowledge	KNO	Near term
Asset operations and maintenance	O&M	Near term
Asset condition monitoring	MON	Near term
Asset management systems	SYS	Near term
Asset planning	PLN	Long term
Asset development	DEV	Long term
Asset rehabilitation and replacement	R&R	Long term
Asset financing	FIN	Long term
Asset financial reporting	REP	Long term

Business process category abbreviations will be used to reference specific goals and actions.

The following sections provide specific recommendations for addressing the asset management needs during the next 5 years. The goals and actions are sequenced as immediate, near-term, and long-term actions to address the priority gaps that have been identified, but also address some of the lower-based priority gaps. The Consultant Team took into consideration the City's desire to expand asset management principles city-wide, and provide a solid foundation as additional services such as wastewater are added to the program.

Section 3: Immediate Actions

The AM Committee realizes that substantial groundwork must be laid within the organization and culture to provide for a sustainable Asset Management Program. To facilitate the development of a robust Asset Management Program, the Consultant Team recommended that the following three areas be adopted first, as immediate actions, to lay that foundation during the next 12 months:

- Vision and support: Setting up and communicating the goals of asset management and communicating to all staff and stakeholders. This includes establishing goals with measurable objectives for communicating with the City Council.
- Organization: Maintaining the AM Committee as a leadership-steering team for the Asset Management Program, and allocating the resources necessary to carry the program forward. Working across the Utility to build stronger asset management principles.
- Asset Management Program development: Creating the AMWP and getting staff involved in the implementation and monitoring of success as a continually improving program.
- Asset Management Program communication: Focusing on the communication and education of staff and the work they perform will link to the services that are provided to customers and stakeholders. Identifying stakeholders and stakeholder groups, defining stakeholder interests, and developing and maintaining communication vehicles to educate stakeholders and keep them informed of progress in asset management.

3.1 Asset Management Vision and Support

An Asset Management Program is a comprehensive and deep effort cutting across many organizational boundaries. One of its aims is to increase accountability in all areas of asset stewardship. In a fundamental sense, it is a new way of doing business.

Programs of this nature require, especially at early stages, clear direction and support from top management. These programs also deserve the early understanding and support of the policy body. Accordingly, the goals, strategies, and actions in the area will aim to obtain active participation of both top management and the City Council in the development of the Asset Management Program.

The City Council holds a strategic planning and goals-setting workshop every year. The Utility plays a vital role in both the planning and execution of the Asset Management Program. It is important for the City Council to understand the objectives of asset management and for the Utility to maintain alignment of the Asset Management Program with City Council goals. Because the Utility's program will ultimately be calibrated based on its customers' required service levels, this area also includes the opening stages of definition and dialog that will lead to an understanding by both customers and the Utility itself of the relationship between the Utility's service levels delivered and the costs of service.

The following three goals have been identified as top priority gap-closure actions for maintaining vision and support of the City Council and top management, and continuing to resource the Asset Management Program.

Goal VIS-01: Obtain understanding and support from the City Council so that it understands the objectives of the Utility Asset Management Program and treats it as a policy priority that leadership can manage through measurable goals.

Discussion. City Council support is limited by its current knowledge of the Utility's Asset Management Program. The City Council has funded the implementation of the Cityworks software application to facilitate asset management, but is not aware of the additional effort that will be needed to build an Asset Management Program which includes policies and goals. Without asset management policies or goals, it is difficult to get support and funding approval from the City Council.

Actions. The following are recommended actions for achieving the stated goal:

- Develop metrics for briefing top management on an annual basis that demonstrates the effectiveness of the asset management program and benefits from improved asset management.
- Prepare a reporting template for use in a PowerPoint presentation to the City Council on the asset management program efforts. Include benefits found from other utilities and how experiences from others might impact the Utility's Asset Management Program.
- Keep top management well informed through a structured communication program (see Section 3.4, below).
- Schedule an annual City Council presentation to show progress on performance and cost of the Asset Management Program.
- Keep the City Council well informed through a structured communication program (see Section 3.4, below).
- Develop an asset management policy with near-, short-, and long-term action items for implementing the policies that are measurable. Leverage the recently developed levels of service and this gap analysis while developing the policy.

Goal VIS-02: Establish the relationship between service levels and costs.

Discussion. Opening a dialog with customers helps them to understand the issues involved, and continues customer participation in the process of defining and updating the levels of service.

Actions. The following are recommended actions for achieving the stated goal:

- Hold a meeting (or meetings) with representative customer groups (e.g., residential and commercial) to introduce the Utility's asset management initiative.
- Create a survey and customer feedback tools to solicit input as to how customers view the Utility's services and how service levels might be defined on an annual basis.
- Develop some indication of the levels of service that customers expect from the Utility, and their views of the values of various levels of service.
- Document how the Utility's overall costs are related to the service levels that are provided in all areas where service levels can be defined (e.g., environmental, satellite capacity, etc.).

Goal VIS-03: Develop a budget for funding and sustaining asset management activities.

Discussion. The Utility should use the near-, short-, and long-term actions recommended in this plan, along with the budget estimates in Appendix A and supporting policies developed by the AM Committee, to develop a funding requirement for asset management activities. Putting a price on activities will allow the Utility to analyze the Asset Management Program on par with other funding requirements, allowing it to better plan for and allocate funds. This is primarily for the software aspects of asset management and not the people or processes that are necessary to support the overall asset management program. Other than considering a new asset manager position, there are currently no specific resources allocated toward the completion of asset management tasks. Part of the purpose of this plan is identify what level of funding is needed.

Actions. The following are recommended actions for achieving the stated goal:

- Summarize near-, short-, and long-term tasks with cost estimates; where applicable, define benefits to compare benefits to costs.
- Utilize these costs to develop a budget for a city-wide Asset Management Program for fiscal year 2018.
- Review the proposed budget at a full meeting of the AM Committee (described below).
- Revise the budget proposal as necessary and submit a supplemental budget request during the 2018 budget process.

3.2 Organization

The Utility staff are taking a leading effort in developing asset management programs within the Public Works Department through the Master Plan update. The Utility's Asset Management Program should be centrally directed and coordinated by a cross-functional and formally recognized AM Committee at the City level. The AM Committee should ideally have senior representation of each department, including at least Administrative Services (Finance); Planning and Community Development; Parks, Recreation and Cultural Services; and all of Public Works. The AM Committee would:

- Continue to develop the Utility's AMWP (i.e., later versions of this document).
- Develop goals and measurable objectives for the program, to be reflected in the AMWP.
- Manage the development of business processes and associated procedures that are required to improve the Utility's asset management practices.
- Continue the work of the Utility staff in identifying and prioritizing areas for improvement.

Goal ORG-01: Formalize the Asset Management Program developed for the Utility as a City-wide program.

Discussion. Management strongly and visibly supports improved asset management, though most of the support thus far has been around Cityworks implementation. There is room for moving management direction beyond Cityworks and toward an enterprise Asset Management Program.

Actions. The following are recommended actions for achieving the stated goal:

- Revise charters for the Cityworks Steering Committee and Executive Team to reflect a broader emphasis on a city-wide Asset Management Program.
- Prepare a short proposal for top management consideration to approve the asset management charter and promulgate the project brief.
- Use the AM Committee to develop the necessary asset management policies and goals as recommended in the “Support from the Policy Body” gap closure goal VIS-01.
- Develop written goals, policies, and responsibilities for the Asset Management Program

Goal ORG-02: Until an asset management position is funded and appointed, it should be the responsibility of the committees to establish asset management priorities and recommend required resources. The committees should work with applicable managers to oversee asset management projects.

Discussion. Asset management responsibility ideally rests with an appointed asset manager, who has the authority and resources to develop and to sustain the Asset Management Program. Top management is refining the responsibilities of an asset manager position and assessing the level of staffing to fulfill those responsibilities. In the interim, the information technology (IT) division manager is acting as the Utility’s asset manager.

Actions. The following are recommended actions for achieving the stated goal:

- Prepare a job description with roles, responsibilities, and criteria for the Asset Manager position.
- Use asset management policies and objectives to determine and allocate the necessary accountability and responsibility to the asset manager position.
- Determine what responsibilities can currently be accomplished through existing management and asset management teams to best leverage existing resources.
- Appoint an asset manager.

3.3 Asset Management Program Development

The following goal was created to address gaps associated with development of the Asset Management Program.

Goal PRG-01: Create a communication plan for presenting the AMWP

Discussion. Further development of the Utility’s Asset Management Program will be the responsibility of a city-wide AM Committee. Some of the work in this area has already been completed; further work of the AM Committee in the immediate future will be aimed at completing the tasks outlined above, implementing the AMWP, and updating and improving the AMWP.

Actions. The following are recommended actions for achieving the stated goal:

- Facilitate a workshop to initiate the AMWP with Utility staff to give them an opportunity to provide feedback on the AMWP and help them understand their role in its success.
- Prepare a schedule for making regular updates to the staff and stakeholders of the Utility

3.4 Asset Management Program Communication

Subsequent to the initial solicitation of top management support for the Utility’s Asset Management Program, Utility staff recognize the need for ongoing communication with stakeholder groups—all of whom will benefit from improved asset management. Candidate groups might include City management, Utility staff in general, the City Council, general public, neighborhood groups, environmental interest groups, and regulatory authorities. Because each group may have interests different from the others, it will be necessary to better understand what these interests are and structure communication programs accordingly.

Goal COM-01: Identify key stakeholder groups and their interests.

Discussion. As the staff identify and communicate with key stakeholder groups, they will develop an understanding of what each stakeholder group sees as the greatest potential benefits from asset management. The goal is to engage in transparent communication through public education and outreach. This also gives staff the opportunity to communicate the issues that are important to the community, and seek its involvement.

Actions. The following are recommended actions for achieving the stated goal:

- Prepare a list of candidate stakeholder groups and an initial priority ranking.
- Create a template for a communication plan
- Maintain a communication plan to inform the community on utility goals and progress
- Discuss and determine the final stakeholder list for communication programs.
- Review and compile results of prior work and compile interest lists for each stakeholder group.
- Review and discuss interest lists at AM Committee meetings, and define communication vehicles, responsibilities, and schedules.
- Create a regular agenda item for the AM Committee to monitor the expectations of key stakeholder groups.

Goal COM-02: Improve staff education with Cityworks training to align with the Asset Management Program goals.

Discussion. Training in asset management has been limited to training in the Cityworks program; there is no formal asset management training program. Most training is done on an as-needed basis to bring an employee up to speed with regard to Cityworks. There is no identification of the required skills per position. Training should be formalized and relate to developed asset management goals. Staff should be aware of not only asset management best practices, but the link between the use of best practices and asset management decisions that impact their responsibilities. Other required training and staff skill development should be identified while developing Asset Management Program goals and tasks.

Actions. The following are recommended actions for achieving the stated goal:

- Formalize Cityworks training.
- Create a prioritized list of staff training requirements as they relate to the Asset Management Program.
- Implement asset management training on a prioritized basis
- Update position descriptions to incorporate possible new knowledge and skills to support the asset management business processes.

Section 4: Near-term Actions

The following near-term actions build on the foundation of the Asset Management Program and focus on sound business practices for developing reliable asset data, sound O&M and condition monitoring procedures, and information systems to help the Utility support those practices. The business process categories in this section should be addressed in the next 1 to 2 years:

- Asset knowledge

- Asset O&M
- Asset condition monitoring
- Asset management systems

4.1 Asset Knowledge

Asset knowledge is defined as quantified asset information that is readily available for asset management purposes. Asset knowledge is critical to achieving good asset management outcomes. The knowledge of operating assets for the Utility should be captured through asset hierarchies and inventories in Cityworks and geographic information system (GIS) software. The use of a system, such as Cityworks, to capture this information allows staff and managers to understand assets from any level and asset performance across multiple systems. Assets should be classified to enable the Utility to compare the performance of assets of similar type. The asset classification process should be well defined and documented (e.g., pump stations could be an asset class, catch basins could be an asset class, pipes by materials could be an asset class, etc.). It will be important to maintain and to build on the current asset knowledge with a disciplined approach to data governance and to make effective use of GIS and Cityworks as more assets and new services are added to the organization. Improving asset knowledge will assist in life-cycle asset management and help the Utility manage long-term costs.

The greatest area for improvement in asset knowledge is in the use of asset criticality, but more asset details could be added to Cityworks when gathering condition assessment information as it relates to analysis of asset reliability and failure data.

Goal KNO-01: Define the minimum level of detail for an asset.

Discussion. It is often difficult to determine the level at which assets should be tracked. Replacement planning, for example, may require a different level of asset detail from maintenance. The normal procedure is to track assets at the lowest level of detail required by any asset management function, but to manage assets at the level of detail appropriate to the purpose. Organizing assets in a hierarchical manner (see below) allows for managing assets at varying levels of detail.

A starting point for determining the appropriate level for tracking assets is to define an asset as a physical object meeting any of the following criteria:

- Cost equal or greater than the capitalization level.
- Defined as an asset by regulations or regulators.
- Requires periodic maintenance.
- Proper functioning important to the provision of service, Utility finances, safety, health, or the environment.

Actions. The following are recommended actions for achieving the stated goal:

- Develop a capital asset policies and procedures manual that establishes policies, guidelines and procedures for the inventory, depreciation, disposal and maintenance of all property and assets owned or leased by the City of Shoreline and defines assets with criteria for dollar threshold and age (such as replacement value greater than $5,000 and estimated useful life of more than one year).
- Based on the initial stakeholder meetings, review the requirements for asset identification to measure service level criteria.
- Prepare a standard that defines the minimum level that an asset will be identified in the fixed asset register to gain alignment with the asset hierarchy, by asset class, in Cityworks.
- Develop and maintain asset performance metrics for each class of asset.

Goal KNO-02: Establish a uniform asset numbering and naming system.

Discussion. The Utility's assets need to be classified in a hierarchical manner both to allow management at different levels and to facilitate the accumulation of costs by asset, basin, facility, infrastructure segment, and so forth. Additionally, assets need to be assigned to asset classes, so that cost and life histories of similar assets can be compared—both to improve life-cycle planning and to facilitate cost savings.

The Cityworks system allows assets to be organized hierarchically and assets are routinely assigned to asset classes for various purposes, including replacement funding analysis. The Utility staff propose that the hierarchical scheme and class assignments be consistent, documented, and inherent in Cityworks, as well as the financial system, fixed asset register, capital improvement plan (CIP) and project management systems, and any other asset management process from design onward. As an example, design engineers should be able to assign asset numbers during the design process and reflect these numbers on drawings. Construction contractors should accumulate costs and provide final billing in the same manner—by asset. This will greatly improve the ability to effectively manage new facilities and accurately report financial results.

Actions. The following are recommended actions for achieving the stated goal:

- Review the Cityworks system for asset hierarchies and develop a city-wide official asset hierarchy with standard asset classes and expected life.
- Review the Cityworks system for asset class definitions.
- Prepare standard nomenclature for the asset classes to be used in the financial system and fixed asset register.
- Establish standard basin, facility, system, and piping hierarchies.
- Develop asset class definitions (will likely be embedded in the hierarchical numbering scheme).
- Prepare standard requirements for design and construction contracts for drawings and billings to conform to the Utility's asset enumeration system.

Goal KNO-03: Identify existing assets and related attributes.

Discussion. Once the appropriate level of detail for asset identification and final hierarchical numbering systems is defined, the Utility should review and update its asset management systems to conform. The primary systems that are affected will be Cityworks, the financial information system (FIS), and GIS, although other systems may be affected as well. In parallel with this effort, the Utility will need to record appropriate asset data if not recorded already. Such asset data will fall into two classes:

- Identifying information, such as serial number, date installed, and original cost.
- Parametric information, such as size, capacity, length, diameter, etc. Required parametric information will need to be defined by asset class.

Actions. The following are recommended actions for achieving the stated goal:

- Review all asset databases for conformity with the defined level of asset detail created in Goal KNO-01, with the hierarchical numbering system and asset class assignments. Re-inventory, re-number, and add/change class assignments as required.
- Investigate and determine which assets should be physically tagged with asset numbers. Define and carry out a program to tag assets.
- Define parametric data required for each asset class. Review databases and add required parametric data where not present.

Goal KNO-04: Establish a risk policy that uses a criticality rating for each asset.

Discussion. Criticality is used to prioritize workload and analysis of the consequences of failure of assets, and is essential to a sound Asset Management Program. Criticality will determine how intensively an asset is managed and how it is managed. Establish indicators of criticality, including:

- Financial consequences of unplanned failure (both internal and community costs).
- Environmental consequences.
- Health and safety consequences.
- Other service level consequences.

Based on the criticality analysis, determine how to calibrate the level of resources that are assigned to assets and systems.

Actions. The following are recommended actions for achieving the stated goal:

- Draft a triple-bottom-line risk policy that defines risk, the level of acceptable risk, consequence, criticality, and how risk is applied to asset management decision making.
- Create a field in Cityworks to track criticality ratings for assets using a 1-5 rating where 5 is a highly critical asset and 1 is a low criticality.
- Perform a risk analysis of facilities and conveyance systems, using a "top down" approach similar to that used in a vulnerability analysis.
- Establish a standardized risk management matrix for Utility assets. The matrix would be a "look-up" table for asset criticality.

Goal KNO-05: Establish asset management strategies based on criticality and risk.

Discussion. Once assets are identified and numbered and criticalities are determined, assets can be assigned to appropriate levels of management (i.e., "regimes"). The intent is to assign the most critical assets to the more intensive management regimes, so that Utility resources can be focused where they will have the greatest effect. Intensity of management will be a continuum with key reference points being:

- Condition-based management*:* Some assets are so critical that unplanned failures will have serious consequences. These assets will be monitored closely and replaced or repaired upon early indication to prevent unplanned failures.
- History-based management: Some assets are less critical in that unplanned failures—while undesirable—can be experienced without serious adverse consequences. These assets will be watched less closely, but will still receive periodic maintenance as applicable. Rehabilitation and replacement (R&R) will largely be based on economic analysis—for example, replacement will be done when the cost is less than the present value of the expected maintenance costs over the current asset's lifecycle if not replaced. Capturing reliable historical maintenance cost information by asset is key to managing assets based on cost.
- Run to failure: Assets with low criticality and no periodic maintenance requirements will simply be used until broken. Analysis may even identify assets with preventive maintenance (PM) requirements where running to failure is cheaper than performing the periodic PMs.

This concept is shown graphically in Figure 2.

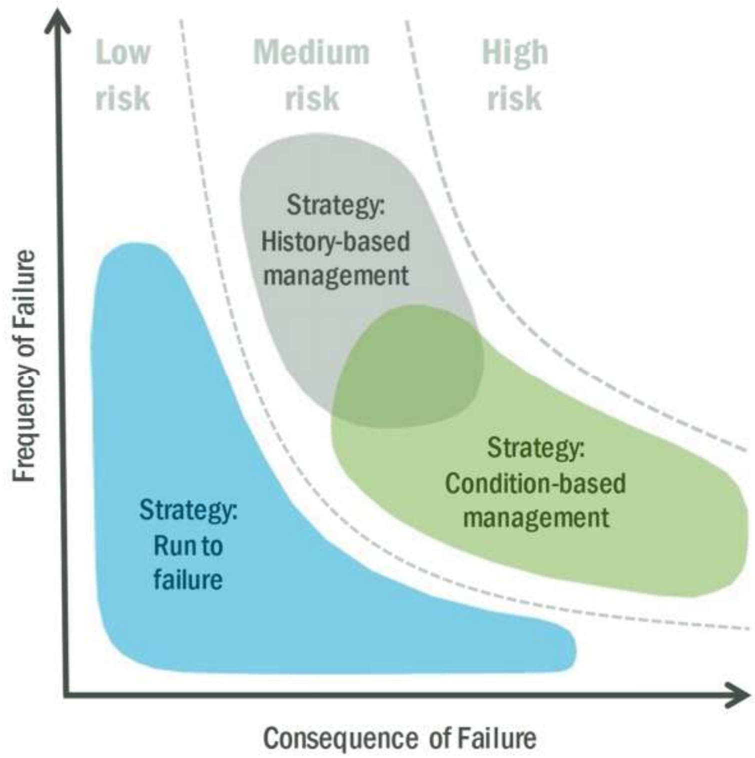

Figure 2. Asset management strategies and asset risk profiles

Assigning assets to the various management regimes in a way that matches customer service requirements helps to ensure that those requirements are met at minimal cost.

Actions. The following are recommended actions for achieving the stated goal:

- Review asset listings and assign preliminary numerical cut-off points for divisions among condition-based management, cost-based management, and run-to-failure management.
- Review results and note assets that should be assigned to different regimes (e.g., higher or lower intensity) or have special requirements (e.g., remote monitoring of condition via PM for cost reasons, even where condition-based monitoring is not indicated by criticality).
- Based on the second review, establish additional management regimes if substantial groups of assets need management methods different from the three regimes discussed above.
- Formalize the reviews by documenting the management regimes that the Utility will use and the criteria that determine to which regime an asset will be assigned.
- Establish procedures to ensure that assets are managed according to the appropriate regimes.

4.2 Asset Operation and Maintenance

The Utility identified several gap closure requirements in O&M in the areas of PM and analysis for updating the asset plans. The operations strategies employed by the Utility should be used to verify that the cost, reliability, and service levels for its assets are met. The strategies employed by the Utility should be developed using the risk profile of each basin, facility, system, asset, piece of equipment, and at every hierarchical level. The operating strategies of the assets should be developed, so the asset reliability is maintained according to the asset risk profile. These strategies should take into account the remote monitoring and control (when available) at each of the assets and the monitoring design versus the actual set points in Cityworks.

A maintenance strategy should be maintained in accordance with the risk profile of a basin, facility, system, or asset. The maintenance options should be categorized as "run-to-failure," "condition-based," or "history-based" maintenance (e.g. PM that is schedule-based or runtime-based) with an analysis of the maintenance costs for all Utility assets performed annually. The cost analysis should be done by analyzing each PM task and observing the frequency and effort required. Each task should be coded by the type of labor needed to perform and complete the task. Changes to the Utility's maintenance program should be redesigned accordingly to improve asset reliability.

The following goals were created to address these gaps and some of the lesser issues.

Goal O&M-01: Define maintenance activities at the appropriate asset level with the minimal number of work order status indicators.

Discussion. Regulatory, reactive, corrective, and PM are the main types of work orders. PM activities should always be defined at the appropriate asset level. In most cases, an inspection is what triggers a corrective work order. PM activities are defined generally by the National Pollutant Discharge Elimination System (NPDES) permit. Other PMs are ad-hoc. There are currently 18 different work order status indicators within Cityworks that can be dramatically reduced.

Because the NPDES permit drives maintenance activity, those assets that are not directly associated with the permit do not necessarily have fully defined PM activities; the Utility should define these activities starting with pump stations. For all maintenance activities, interval and resource information should be defined and tracked in Cityworks. This will enable improved life-cycle cost decision-making and more efficient maintenance planning. Stormwater asset maintenance is generally driven by the NPDES permit and the condition monitoring that comes with the permit requirements. Most maintenance work on assets is currently classified as corrective, as it is driven by required condition assessment and not a set maintenance schedule. PMs, not driven by the NPDES permit, are ad-hoc. PMs listed in Cityworks do not include interval and resource information (e.g., hours, parts lists, etc.). Additionally, there are too many work order status indicators that are used to track maintenance—this makes it more difficult to monitor progress and resource use.

Actions. The following are recommended actions for achieving the stated goal:

- Reduce the number of work order status indicators to four; preventive, corrective, emergency and regulatory.
- Add interval and resource information for all preventive maintenance work.
- Analyze adding PM activities to those assets currently not included. As an example, begin with the pump station assets and determine what activities should be done to improve the life cycle cost of the asset. Schedule those activities as PM work orders.
- Analyze moving some corrective maintenance activities to PM schedules for better resource planning.
- Develop an O&M strategy for all assets and facilities with mechanical and electrical functionality.

Goal O&M-02: Prioritize workload by risk.

Discussion. PM should be defined to mitigate the risk of asset failure. The staff need to have consistency in setting up, scheduling, and performing PM. Work orders should be prioritized based on the risk to system reliability. While such a prioritization can be done automatically if assets have criticality attributes (as recommended above), priorities will need to be manually reviewed.

Actions. The following are recommended actions for achieving the stated goal:

- Prepare procedures for defining maintenance in a proactive plan that includes a schedule and expected costs.
- Specify criticality as the starting point for prioritization with highly critical items getting the highest attention for priority.

Goal O&M-03: Track asset failures consistently.

Discussion. In asset management, most learning comes from asset deterioration and failure. Experience in these areas, if properly recorded and analyzed, helps refine maintenance programs and improves prediction of R&R timing.

Actions. The following are recommended actions for achieving the stated goal:

- Review failure codes in Cityworks and make sure that the codes support failure modes in all significant asset classes (pipes, structures, pumps, etc.). Update as required.
- Educate staff on use of failure codes and failure analysis.
- Prepare procedures to require that root-cause analyses be performed for all assets requiring reactive maintenance or removal from service and require that failure codes be used to record the event in Cityworks. There should also be a requirement to record a brief failure evaluation.

4.3 Asset Condition Monitoring

The Utility should use condition monitoring for assets where it is suitably justified to predict and to intervene before catastrophic failure. Condition monitoring techniques will be employed only where they can be suitably justified (i.e. where the cost of the technique is less than cost of the asset failure). Methods of monitoring asset condition vary according to the asset class. Once the ways in which an asset can fail are defined, monitoring methods can be chosen to predict failures. The condition rating and scoring will reflect the asset condition and allow for comparative analysis and consequence of failure analysis. Condition assessments—and trends in assessments—are normally used to support maintenance scheduling, prediction of R&R timing, and decisions on R&R actions.

The following goals were created to address gaps associated with monitoring the condition of assets.

Goal MON-01: Define condition monitoring methods.

Discussion. Asset condition monitoring was not identified as significant of a weakness as some other business processes. The Utility's review found that the *Western Washington Stormwater Manual* is used as a guide, but there was no specific or systematic approach to performing condition monitoring or determining which assets required such monitoring.

In general, condition monitoring will be used for only the most critical assets because monitoring is often expensive. Thus, the program depends on a sound criticality analysis, as discussed above.

Methods of monitoring asset condition vary according to the asset class. For example, stormwater pipes are usually monitored by closed-circuit television (CCTV) and are easier to access than some other buried assets. Rotating equipment, such as pumps and motors, may be monitored by bearing temperature, oil analysis, vibration analysis, etc. In all cases, the determination of which method to use begins with a root-cause failure analysis. Once the ways in which an asset can fail are defined, monitoring methods can be chosen to predict failures.

Actions. The following are recommended actions for achieving the stated goal:

- Perform a root-cause failure analysis on those asset classes that require monitoring,
- Create a procedure to maintain a condition rating for all assets within the Cityworks records, including those assets that are maintained by contractors.

- Change the condition assessment score to 1 through 5, following a standard similar to the National Association of Sewer Service Companies (NASSCO) or the International Infrastructure Management Manual, where 1 is 'very good condition' and 5 is 'asset unserviceable'.
- Develop a condition assessment protocol for pump stations.
- Based on the failure analysis, define the different kinds of condition monitoring methods and frequencies that will be used to track asset performance and reliability.

Goal MON-02: Define the Condition Monitoring Program.

Discussion. Defining an appropriate Condition Monitoring Program is fundamental to establishing a cost-effective Asset Management Program. Condition monitoring must be used where—and only where—it makes economic sense or protects customer service levels. The assets to be monitored and the frequency of monitoring will be governed by asset criticality and the susceptibility of the asset to predictive assessment. Condition assessments and trends in assessments are normally used to support maintenance scheduling, prediction of R&R timing, and decisions on R&R actions. For condition monitoring to make its best contribution, it needs to be reliably used for these purposes.

Actions. The following are recommended actions for achieving the stated goal:

- Prepare and review an asset listing rank that is ordered by criticality.
- Prepare procedures to implement the program and use the results in normal operations where possible. Based on the results, expand the program over time to all assets qualifying for assessment.
- Prepare procedures to ensure that assessment information, along with criticality, is used to evaluate overall risks and to prioritize corrective maintenance schedules.
- Prepare procedures for using trend analyses of assessed condition, along with criticality and performance measures, to analyze and to forecast R&R needs, timing, and costs.

4.4 Asset Management Systems

The following goal is intended to address gaps associated with asset management systems.

Goal SYS-01: Prepare a system use plan for the Cityworks CMMS.

Discussion. Cityworks is fundamental to the success of the AMWP. Cityworks is used by the Public Works Department for managing assets in the Utility and Operations, Engineering, and Transportation divisions, as well as Fleet and Facilities. The Parks, Recreation, and Cultural Services Department and Ronald Wastewater district are not using Cityworks, but have plans for implementation.

Cityworks is not currently integrated to the City's FIS, so it is not integral to forecasting long-range R&R needs and to providing funding analysis. Planning for that level of integration has not started. A new FIS is being procured and once it is implemented, further evaluation and integration should be considered. There will likely be an interface between GIS and the new FIS. If these systems are integrated, it will not be until 2019 or later.

At this point in time, there is no link between an inventory system and Cityworks. Material costs are tracked within Cityworks, but there is no inventory database. Most of the repair work is contracted and invoiced to the Utility. Material or use of material is included in the contractor cost and not itemized in contractor invoices.

Information systems are planned and budgeted annually with a 3-year forward forecast of needs that are gathered from all departments of the City. The Utility uses some mobile data-collection tools to streamline the process of data input and improve the accuracy of information in the databases—but they are not widely used. At this point, there are no tools for forecasting asset management needs. Tools like RIVA are being considered and the Utility is open to the investigation of similar tools.

Standards and protocols for data usage and asset information systems exist in the form of policy. One reason is enforceability, such as with mobile devices. Employees have access to this policy in the employee handbook, which includes standard operating procedures (SOPs) and workflow diagrams for the use of Cityworks. There was an effort to standardize the data elements in 2015 for all surface water asset information.

Actions. The following are recommended actions for achieving the stated goal:

- Develop a technology roadmap for how Cityworks is going to be maintained, used by the staff, and integrated with other systems.
- Prepare the specifications for a software product that can help the Utility perform trending analysis of assessed condition, criticality and system performance that may also be used to forecast R&R needs, timing, and costs.
- Maintain a configuration management document to track the configuration and system requirements.
- Use Cityworks to track labor, materials, and equipment cost on all work orders.
- Investigate linking Cityworks to the fleet management software system used by Mountlake Terrace.
- Design an inventory management system using Cityworks Storeroom module to track materials by work order or a system that interfaces with Cityworks to track materials by work order.
- Maintain the Cityworks user group and a user log with best practices, common issues, problems, and solutions.

Section 5: Long-term Actions

The following long-term actions focus on improving the Asset Management Program and will take several years to develop. Work on all of these recommendations can begin now, but, in most cases, the Utility will not see the results until the immediate and near-term actions have been initiated.

The long-term business process categories include:

- Asset planning
- Asset R&R
- Asset development
- Asset financing
- Asset financial reporting

5.1 Asset Planning

Asset planning refers to the preparation of the expected life-cycle costs of ownership of an asset. Such costs typically include costs of short-interval activities, such as maintenance, condition assessment, cleaning, calibration, and so forth. These costs are usually reflected in O&M or operating budgets and the plans themselves are reflected in the maintenance job plans in Cityworks. Ownership costs also include the larger expenditures for acquisition, refurbishment, or major repairs and replacement of assets are usually reflected in capital budgets. Asset planning is important for two reasons:

- A key goal of asset management is reducing asset ownership costs. This is accomplished through the classical plan/act/measure/control cycle. Asset management works by preparing plans for assets, carrying out the plans, measuring the results, and updating the plans accordingly.
- Having cost-of-ownership plans for all assets means that the Utility can accurately forecast aggregate ownership costs well into the future, giving a solid foundation for long-range funding plans.

The second item implies that the asset listing must be comprehensive and include all infrastructure assets of value. Asset types may go well beyond those typically found in maintenance management systems, which are primarily concerned with mechanical, rotating, and electrical equipment. Asset management must also consider assets, such as process structures, buildings and roofs, roadways, parking lots, etc. The assets reflected in the City's FIS should align with the same classifications of asset in Cityworks for comparison and annual assessment of total asset valuation.

Asset planning normally starts with generic asset plans developed by asset class. These are then applied to relevant assets and used for planning purposes until better plan information is developed through condition assessment, cost tracking, and so forth.

Asset plans give the Utility a snapshot of important information concerning an asset. The asset plans for the assets owned and operated by Utility should be kept in an electronic database system. The Utility would use asset plans in the building of systems and facilities, such as those produced by business case evaluations (BCE), to provide the basis for more detailed operation and maintenance strategies and R&R plans. Once the systems or facilities are in operation, it will measure and periodically compare actual ownership costs with forecasted costs to improve future forecasts. The Utility can then measure its actual ownership costs for existing systems and facilities and prepare similar asset plans for these new system or facilities. An asset plan is a roadmap to asset ownership costs, expressing best estimates of these costs throughout the entire asset lifecycle. In addition, the asset plan includes operations and maintenance strategies for the asset as well as rehabilitation and refurbishment plans.

Goal PLN-01: Develop clear reporting mechanisms that track program goals so staff can see how asset management impacts them.

Discussion. Asset management understanding exists primarily with Utility staff. If the Asset Management Program were to focus on only the Utility, this would not be adequate because all segments of the City—from Finance to Customer Service—are impacted by asset management policies. Outside the Utility, City staff are generally not aware of how asset management will impact them. The framework for effective communication of asset management throughout the City exists. Tools like SharePoint and the AM Committees can be leveraged to successfully communicate the Asset Management Program.

Actions. The following are recommended actions for achieving the stated goal:

- Leverage the AM Committee to introduce the program to other staff and to ensure that committee membership is representative of staff impacted by asset management.
- Develop report templates that staff can use to track the program.
- Load planned projects into a project layer of GIS, so that future or potential assets can be seen by field staff, planning and engineering.

Goal PLN-02: Establish short-interval portions of asset plans.

Discussion. Aspects of the short-interval portions of asset plans (primarily PM) are not fully defined in Cityworks. These asset plans should be developed to ensure that they are asset-specific, so cost data can be gathered in accordance with the asset hierarchy defined above. Where necessary, additional activities (primarily condition monitoring) can be added and maintained in Cityworks.

Actions. The following are recommended actions for achieving the stated goal:

- Review Cityworks weekly to ensure that all PM activities are represented at the appropriate level and with standard costs.

- Review capability for extracting both plan and historical cost data from the Cityworks database for further analysis. This will be required because Cityworks has only a limited analytical capability for determining asset reliability and asset deterioration.

Goal PLN-03: Establish the long-interval portions of Utility asset plans.

Discussion. Cityworks is not used to maintain plans for long-interval activities, such as R&R, nor does it gather and report costs for these activities. Pending further system review, it is unclear at this time whether these activities can be maintained in Cityworks or whether they should be stored in a separate database and combined with short-interval information via extraction from Cityworks. An example of a long interval activity would be the capital work needed to upgrade or maintain asset reliability over the asset life cycle. For pump stations this might be the scheduling of capital outflow every 8 years to upgrade pumps, maintaining this as a placeholder on a capital plan. For pipes this would be a line item for repairs and improvements that is reevaluated on an annual basis.

Actions. The following are recommended actions for achieving the stated goal:

- Review the used of the Cityworks Contracts module to manage projects associated with long-interval activities that improve asset performance.
- Prepare generic long-interval plans using an asset class-based approach. Enter into the Cityworks (or alternative) database by asset.
- Modify the generic plans where specific timing and/or costs of long-interval activities are known (e.g., planned asset replacements).

Goal PLN-04: Develop procedures to update asset plans by asset class.

Discussion. Asset plans need to be established and updated regularly based on changes in the asset performance and on improved knowledge of costs of ownership, either at the class level or the individual asset level. Improved knowledge will become available through regular reviews of asset condition, criticality, performance, and ownership costs versus plans.

Actions. The following are recommended actions for achieving the stated goal:

- Conduct a review of the current procedures for planning future capital cost on existing asset and methods for tracking cost and performance.
- Prepare procedures to analyze asset histories versus plans, so plans can be updated to reflect the best current knowledge on maintenance frequencies and activities, as well as expected R&R needs.

5.2 Asset Rehabilitation and Replacement

One of the focuses of asset management is the improvement of asset R&R decisions. The focus of R&R goals will vary; in the case of highly critical assets, the goal would be full risk avoidance. In the case of less critical assets, the goal would be to better manage risk. Improved asset knowledge is the key to better R&R decisions—criticality, condition, cost, and performance need to be considered in the analysis.

Improved R&R decisions may go well beyond questions of timing. Where any major re-investment in an asset is required, the entire process for asset creation (e.g., needs analysis, alternatives formulation, etc.) should be revisited. Improved R&R planning arising from asset knowledge greatly improves the quality of capital funding strategies.

Goal R&R-01: Begin using and analyzing failure codes to refine maintenance activities as well as R&R schedules.

Discussion. The maintenance strategy should move past NPDES-driven schedules toward needs based on failure analysis. When an asset fails, information gathered about that failure is useful for determining maintenance and replacement activities for similar assets. Currently, stormwater asset failures are not analyzed using any type of formal process and failure codes are generally not used.

One reason for this is the NPDES permit, not failure analysis, drives maintenance activities. However, the Utility has taken some steps to adjust maintenance schedules for problem assets; certain problem areas (32 known “hot spots” with drainage issues) are identified and PM activities are altered as necessary for these.

Actions. The following are recommended actions for achieving the stated goal:

- Train staff on the use of failure codes and monitor their use for O&M activities.
- Develop SOPs for updating O&M activities based on failure codes.
- Link R&R schedules to failure codes analysis.
- For all of these tasks, start with a few priority asset classes and work through the system until all appropriate assets are covered.

Goal R&R-02: Improve R&R planning.

Discussion. The Utility should link its annual R&R budget more closely with actual asset needs. Some of this need should come through estimated useful life (EUL) and replacement costs as the information becomes available. The Utility does not have to determine this information all at once, but can instead prioritize R&R analysis on critical assets in the short term.

The maintenance of asset plans (see the above section) fulfills this goal. To the extent that the long-range portions of the Utility’s asset plans reflect good asset knowledge, R&R plans for individual assets and for assets in aggregate will be dependable. This will support the maintenance of adequate reserves or other funding mechanisms for upcoming R&R costs.

The Utility retains a set R&R budget for pipes, which is updated annually and based on the prior budget. While this is a positive step in R&R planning, this line item is not linked to asset needs. Data exist to estimate the remaining useful life of assets and improve R&R planning. However, this information is not calculated.

Cityworks is one tool that can help identify asset replacement costs. Currently, there is no consistency in identifying the replacement cost of an asset in Cityworks.

Actions. The following are recommended actions for achieving the stated goal:

- Develop a process for developing and updated the replacement costs for assets, generally included in R&R and other programmatic funding.
- Use condition data and any available estimates of EUL to provide an initial assessment of R&R needs for priority assets and build a system to track these estimates.
- Create a process for how to compare future asset needs to current funding available, and build a business case evaluation approach for appropriate funding levels.

Goal R&R-03: Improve R&R analysis.

Discussion. Proper R&R analysis requires a continual improvement type of process to evaluate performance and ensure that sub-optimal decisions made in the past are not repeated. Asset replacements should be done within well-defined strategies for different asset classes and within different operating risks. Replacements take into account obsolescence and efficiency and be complementary to long range planning efforts. The strategies for routine asset replacements should be translated into decision support models that ensure that decisions are consistent and made in a timely manner. The analysis approach is to identify assets for R&R and look broadly at the performance of the electrical/mechanical/structural asset base and rank assets and equipment according to selected parameters such as rate of failure or reactive maintenance costs. This ranking will generate a prioritized list of assets, which will be subjected to further economic evaluation

Actions. The following are recommended actions for achieving the stated goal:

- Prepare procedures for "first-cause" needs analyses to be performed and documented prior to approving major R&R decisions.
- Prepare procedures for benefit-cost analyses of all reasonable alternatives for meeting the identified needs.
- Establish a process to track capital budgets on a monthly basis that includes R&R expenditures, estimates of capital expenditures, and adjustments.

Goal R&R-04: Ensure that R&R actions are properly reflected for financial reporting.

Discussion. Rehabilitation (and sometimes replacement) actions are often improperly recorded in the fixed asset register used to report asset value and depreciation. The fixed asset register should have a structure that tracks specific asset retirement units such as; concrete pipes, steel pipes, concrete structures, pumping equipment, The Utility's current fixed asset register shows the depreciation of assets as grouped within projects over time and does not always show the depreciation of a specific asset or group of assets by asset class. Common problems with this lack of detail include failure to retire assets that leave service and failure to extend the life of the underlying asset. The effect of errors may be cumulative over time and lead to material misstatements of the financial condition.

The costing of R&R actions should include all appropriate direct and indirect costs of the Utility, as required by Governmental Accounting Standards Board Summary of Statement 34 (GASB 34). The Utility did not specify any required gap closure in the area; however, the AM Committee may determine that some additional action is required in this area in the long term.

Actions. The following are recommended actions for achieving the stated goal:

- Prepare guidelines for classifying R&R transactions for financial reporting purposes.
- Prepare procedures for analyzing and reporting R&R transactions as retirements, replacements, and improvements. In the case of the latter, the procedure should involve increasing the cost basis of the asset rather than adding a new asset.
- For refurbishments that affect the useful life of the underlying asset, procedures should ensure that the fixed asset register is updated to reflect the new remaining useful life that is in Cityworks.
- Prepare procedures for costing R&R actions that ensure appropriate internal Utility costs are included in R&R costs transferred to the fixed asset register. A standard percentage is often used for this purpose.

5.3 Asset Development

The role of asset management in asset creation is to ensure that the Utility optimizes its investment in new infrastructure. That means that the Utility always makes investments that are appropriate, the best alternatives to meeting the identified needs, contribute to meeting required service levels, and have the lowest life-cycle costs for the customer.

Asset creation is a critical role for asset management because the initial choice of an asset is where the greatest opportunity for savings exists.

Goal DEV-01: Formalize the life-cycle costing approach for capital improvement projects to better capture O&M costs over the lifetime of the asset.

Discussion. The Utility can begin tracking the life-cycle costs of new and future assets to better reconcile forecasted and actual costs. The cost to maintain assets can and should be tracked through Cityworks.

There is some effort already under way to capture life-cycle costs for stormwater assets. One effort is in capital improvement planning. Alternative analysis for stormwater assets is done through basin plans; however, life-cycle costs of alternatives are not prepared according to defined formats. Although the Utility is beginning to track O&M costs in overall CIP budgeting and forecasts, reconciliation of these forecasts do not happen after the project is complete.

Life-cycle costs for assets are not well tracked. Although there is a goal to link financial reporting directly with assets, this does not currently occur. It is more common for projects (or the total cost of the contract amount) to be depreciated in the fixed-asset register instead of assets as a retirement unit.

Actions. The following are recommended actions for achieving the stated goal:

- Establish a procedure for conducting an alternative analysis on major (greater than $100,000) projects that looks at the life cycle costs, including the risk and benefits costs, as part of the capital planning procedures.
- Prepare guidelines on how to develop simple life-cycle cost options for major capital improvement projects.
- Conduct an analysis of the life-cycle costing approach for general R&R programs for stormwater to better assess maintenance and capital options for these assets.
- Improve links between financial accounting of fixed assets and assets in Cityworks, so that an asset that can located in the field can be identified in the fixed asset register.

Goal DEV-02: Develop a systematic approach to creating new assets.

Discussion. Utilities adhering to programmatic asset management have developed procedures to ensure that capital investment is minimized and consistent with required service levels. Typically, life-cycle benefit/cost analyses are required for all new projects. While these analyses may not be able to quantify certain benefits, such as regulatory or safety benefits, they can highlight the costs of such benefits and thus facilitate a far more rational approach to capital investment.

Actions. The following are recommended actions for achieving the stated goal:

- Develop an asset onboarding process.
- Prepare procedures for initiating projects and determining the need for new assets or systems. These procedures will govern needs analysis (i.e., problem definition), alternatives formulation and analysis, benefit-cost analysis, and ultimate selection of the preferred alternative.
- Define the life-cycle costing in such a way that life-cycle cost of the preferred alternative becomes the initial asset plan for that alternative.
- Require that consultants, if performing such analyses, follow Utility standards.

Goal DEV-03: Require that enumeration schemes be followed by designers and contractors.

Discussion. The Utility will develop a hierarchical asset enumeration scheme to be shared by all asset-based systems and allow cost analysis by process, facility, infrastructure segment, etc. To save money and time, the Utility's consultants and contractors should use this enumeration scheme through the design and construction cycle.

Actions. The following are recommended actions for achieving the stated goal:

- Add asset enumeration requirements to the standard language for design contracts. Require that all drawings be delivered with assets numbered accordingly.
- Add similar requirements to construction contracts. Require that final pay notices be rendered in detail according to the enumeration scheme. This will ensure that the original cost of each asset is known and can be recorded in the fixed asset reporting system.

Goal DEV-04: Maximize contractor contribution to asset plan development.

Discussion. For new or rehabilitated assets and facilities, contractors can substitute for Utility or consultant labor by providing asset planning and related information. It will be worth the effort to prepare standardized electronic forms for capturing these data, so they can be easily transferred to the Utility's asset-based systems.

Actions. The following are recommended actions for achieving the stated goal:

- Prepare procedures and forms for contractors to submit. All data elements should be organized by asset, numbered per the Utility's asset hierarchy. The data elements required might include:
  - Maintenance information (e.g., activity, frequency, parts and materials) for each PM type.
  - EUL of the asset—note that a legal release might be required to protect the contractor against premature, but out-of-warranty, failure.
  - Cost of the asset.
  - Nameplate information.
  - Attribute information (see discussion regarding asset classes, above).
  - Warranty information.
- Add language to construction contract boilerplate to require contractors provide the information in the defined form.
- Additionally, require that contractors deliver all O&M manuals and similar documentation in hard copy.

5.4 Asset Financing

The Utility's asset financing strategy should include life-cycle planning, decision making, and all necessary financial management components to meet the City's financial reporting requirements. Better knowledge of future capital needs and O&M costs will improve the quality and dependability of the Utility's strategic plan and better document the Utility's future funding needs. It is important for the Utility to understand its costs well enough to make defensible estimates of future costs so proper budgets can be prepared and resources can be properly allocated. Improved cost forecasting allows for improved management of assets through the decision making process. Better forecasting of asset replacement costs over several years will help the Utility to better identify future funding needs and have better control of rates. Policies that balance R&R against new projects and improvements will result in more control of rate fluctuations.

The Utility did not identify any significant gaps in this area, but there is the opportunity for more consistency between Cityworks and the financial system records. The items below are some additional goals for consideration to improve overall Asset Management Program performance.

Goal FIN-01: Improve the use of trending for long-range capital funding plans.

Discussion. Capital funding plans are based on future capital needs, which are made up of two main categories of expenditures: (1) new assets/improvements, and (2) capital reinvestment (or R&R). The Utility determined that knowledge of long-range R&R needs could be improved with better cost trending and better knowledge in this area will improve the quality and dependability of the Utility's funding plans.

Actions. The following are recommended actions for achieving the stated goal:

- Develop systems or software to forecast R&R needs over a longer time frame than is currently the case, typically during the entire economic useful life.
- Incorporate projected R&R needs along with known near-term needs into the Utility's capital funding plans.
- Set up a CIP priority process to select, track, and monitor all capital projects.

- Maintain the long-range plans by re-forecasting R&R needs as asset knowledge improves and update the plans to make the most effective use of available capital.

5.5 Asset Financial Reporting

Financial reporting, especially fixed asset reporting, is an important element of asset management. Given that the Utility intends to comply with the depreciation approach of GASB 34, it is important that representations of asset value and depreciation be accurate and based on best asset knowledge—knowledge that is shared with other functions within the organization. The only significant gap in this area is around consistency in reporting addressed in Goal REP-01. The additional items below are goals for consideration to improve overall asset management performance.

Goal REP-01: Improve consistency of the FIS asset database.

Discussion. The Utility has not taken steps to coordinate its financial reporting database with Cityworks asset records. There should be an annual update procedure to keep the two in synchronization—there are many inconsistencies.

Actions. The following are recommended actions for achieving the stated goal:

- Review the fixed asset list, Cityworks CMMS, GIS system, and financial system (IFAS) databases. Prepare more comprehensive procedures to ensure that they reflect the same asset knowledge at the same level of detail to the asset retirement unit (pipe, instrumentation, structures, electrical etc.).
- Develop reports that assist with production and performance analysis, which include actual versus budgeted/planned work.
- Review fixed asset records and re-define them according to the asset hierarchy; review of GIS records may help with this.
- Allocate acquisition costs of grouped assets as required for specific assets and define useful lives of classes, so depreciation can be calculated based on the new structure.

Goal REP-02: Improve procedures to keep the fixed-asset records up to date.

Discussion. For accurate financial reporting, the fixed asset records must be kept current. This means accurately reflecting all additions, retirements, partial retirements, augmentations, and improvements in the Utility's capital assets in the records. It also means that the fixed asset records must reflect current, best forward-looking asset knowledge.

Actions. The following are recommended actions for achieving the stated goal:

- Review procedures for inter-department communications and creating asset transactions, particularly for retirements, refurbishments, and augmentations. Ensure such activities are known and used to update the fixed asset records and, in the case of augmentations or refurbishments, useful lives as necessary.
- Prepare procedures to ensure that as asset knowledge improves around areas, such as expected replacement years by asset class or for specific assets, fixed asset records are updated accordingly in IFAS.

Section 6: Implementation Costs

The implementation costs in Table 5 below are estimates of the internal Utility costs and potential external costs from contractors and consultants contracted to assist the Utility with developing the Asset Management Program. A more detailed breakdown of the cost to close the gaps is provided in Appendix A: *Gap Implementation Cost Estimates*. The hours are estimates of hours to complete the work for each of the gap areas. A loaded hourly labor rate of $75 was used for the Utility labor cost and $130 per hour was used for the contracted work. The total implementation cost during the next 5 years for all gap closures is expected to be roughly $361,500 (in 2017 dollars).

Table 5. Implementation Cost Summary

Personnel	Priorities			Full implementation (total through 5 years)
	Immediate (1 year)	Near-term (3 years)	Long-term (5 years)	
Utility staff	$49,231	$80,090	$62,595	$191,916
Contractor and consultants	$28,025	$59,225	$82,295	$169,545
Total Cost	**$77,256**	**$139,315**	**$144,890**	**$361,461**

It is probable that the Utility will re-prioritize needs, define new goals, revise strategies, and change or add actions over time. These activities will necessitate continual updates to this AMWP, and thus it should be considered an actively managed living document.

Attachment A: Gap Implementation Cost Estimates

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	AMWP Gap Implementation Costs			Shoreline Staff				Contractor / Consultant Staff			
				Staff Loaded Rate	$75			Cont. Loaded Rate	$130		
	Business Process Area	**Goal**	**Total Cost**	**Staff hours**	**Staff labor costs**	**Staff ODCs**	**Internal total cost**	**Contractor hours**	**Contractor labor**	**Contractor ODCs**	**Contractor Total**
Immediate Actions	Asset Management Vision and Support	VIS-01 Obtain understanding and support from Shoreline's City Council	$5,625	75	$5,625	$0	$5,625	0	$0	$0	$0
		VIS-02 Establish the relationships between service levels and costs.	$11,875	85	$6,375	$0	$6,375	40	$5,200	$300	$5,500
		VIS-03 Develop a budgetfor funding and sustaining asset management activities.	$4,125	55	$4,125	$0	$4,125	0	$0	$0	$0
	Asset Management Organization	ORG-01 Formalize the Asset Management Program developed for the Surface Water Utility as a City-Wide program.	$14,800	65	$4,875	$25	$4,900	70	$9,100	$800	$9,900
		ORG-02 Establish asset management priorities and recommend required resources	$13,526	90	$6,750	$26	$6,776	50	$6,500	$250	$6,750
	AM Program Development	PRG-01 Create a communication plan for presenting the AMWP	$5,245	55	$4,125	$55	$4,180	8	$1,040	$25	$1,065
	AM Program Communication	COM-01 Identify key stakeholder groups and identify their interests.	$4,250	50	$3,750	$500	$4,250	0	$0	$0	$0
		COM-02 Improve staff education with Cityworks training to align with the AM Program Goals.	$17,810	60	$4,500	$8,500	$13,000	32	$4,160	$650	$4,810
		Total for Immediate Actions	**$77,256**				**$49,231**				**$28,025**

	AMWP Gap Implementation Costs			Shoreline Staff				Contractor / Consultant Staff			
				Staff Loaded Rate	$75			Cont. Loaded Rate	$ 130.00		
	Business Process Area	**Goal**	**Total Cost**	**Staff hours**	**Staff labor costs**	**Staff ODCs**	**Internal total cost**	**Contractor hours**	**Contractor labor**	**Contractor ODCs**	**Contractor Total**
Near-Term Actions	Asset Knowledge	KNO-01 Define the minimum level of detail for an asset.	$17,380	160	$12,000	$450	$12,450	36	$4,680	$250	$4,930
		KNO-02 Establish a uniform asset numbering and naming system.	$9,525	75	$5,625	$300	$5,925	26	$3,380	$220	$3,600
		KNO-03 Identify existing assets and related attributes.	$11,910	90	$6,750	$180	$6,930	36	$4,680	$300	$4,980
		KNO-04 Establish a risk policy that uses a criticality ratings for each asset	$10,750	75	$5,625	$225	$5,850	36	$4,680	$220	$4,900
		KNO-05 Establish asset management strategies based on criticality and risk	$11,220	70	$5,250	$260	$5,510	42	$5,460	$250	$5,710
	Asset Operation and Maintenance	O&M-01 Define maintenance activities at the appropriate asset level with the minimal number of works order status indicators.	$11,040	85	$6,375	$100	$6,475	35	$4,550	$15	$4,565
		O&M-02 Prioritize workload by risk	$9,060	55	$4,125	$200	$4,325	36	$4,680	$55	$4,735
		O&M-03: Track asset failures consistently	$11,335	90	$6,750	$200	$6,950	32	$4,160	$225	$4,385
	Asset Condition Monitoring	MON-01 Define condition monitoring methods.	$11,465	85	$6,375	$25	$6,400	36	$4,680	$385	$5,065
		MON-02 Define condition monitoring program	$21,695	170	$12,750	$50	$12,800	68	$8,840	$55	$8,895
	Asset Management Systems	SYS-01 Prepare a system use plan for the Cityworks CMMS	$13,880	85	$6,375	$100	$6,475	55	$7,150	$255	$7,405
		Total for Near-Term Actions	**$139,260**				**$80,090**				**$59,170**

	AMWP Gap Implementation Costs			Shoreline Staff				Contractor / Consultant Staff			
				Staff Loaded Rate		$75		Cont. Loaded Rate		$130	
	Business Process Area	Goal	Total Cost	Staff hours	Staff labor costs	Staff ODCs	Internal total cost	Contractor hours	Contractor labor	Contractor ODCs	Contractor Total
Long-Term Actions	Asset Planning	PLN-01 Develop clear reporting mechanisms that track program goals so staff can see how Asset Management impacts them.	$10,250	35	$2,625	$225	$2,850	50	$6,500	$900	$7,400
		PLN-02 Establish short-interval portions of asset plans	$10,975	40	$3,000	$325	$3,325	55	$7,150	$500	$7,650
		PLN-03 Establish the long-interval portions of Utility asset plans	$11,310	42	$3,150	$100	$3,250	60	$7,800	$260	$8,060
		PLN-04 Develop procedures to update asset plans by asset class	$12,275	65	$4,875	$100	$4,975	55	$7,150	$150	$7,300
	Asset Rehabilitation and Replacement (R&R)	R&R-01 Begin using, and analyzing, failure codes to refine maintenance activities as well as R&R schedules.	$15,250	80	$6,000	$100	$6,100	65	$8,450	$700	$9,150
		R&R-02 Improve R&R planning	$7,315	40	$3,000	$55	$3,055	32	$4,160	$100	$4,260
		R&R-03 Improve R&R analysis	$15,540	120	$9,000	$200	$9,200	48	$6,240	$100	$6,340
		R&R-04 Ensure R&R actions are properly reflected for financial reporting	$11,180	75	$5,625	$255	$5,880	40	$5,200	$100	$5,300
	Asset Development	DEV-01 Formalize the life-cycle costing approach for capital improvement projects to better capture O&M costs over the lifetime of the asset.	$10,230	70	$5,250	$100	$5,350	36	$4,680	$200	$4,880
		DEV-02 Develop a systematic approach to creating new assets	$8,355	40	$3,000	$55	$3,055	40	$5,200	$100	$5,300
		DEV-03 Require enumeration schemes be followed by designers and contractors	$8,295	65	$4,875	$200	$5,075	24	$3,120	$100	$3,220
		DEV-04 Maximize contractor contribution to asset plan development	$8,035	40	$3,000	$255	$3,255	36	$4,680	$100	$4,780
	Asset Financing	FIN-01 Improve use of trending for long-range capital funding plans.	$4,415	36	$2,700	$100	$2,800	12	$1,560	$55	$1,615
	Asset Financial Reporting	REP-01 Improve consistency of the finance system asset database.	$4,790	26	$1,950	$125	$2,075	20	$2,600	$115	$2,715
		REP-02 Improve change management procedures in the fixed asset records.	$6,675	30	$2,250	$100	$2,350	32	$4,160	$165	$4,325
		Total for Long Term Actions	$144,890				$62,595				$82,295
		Grand Totals	$361,406				$191,916				$169,490

Attachment B: UMBE Matrix

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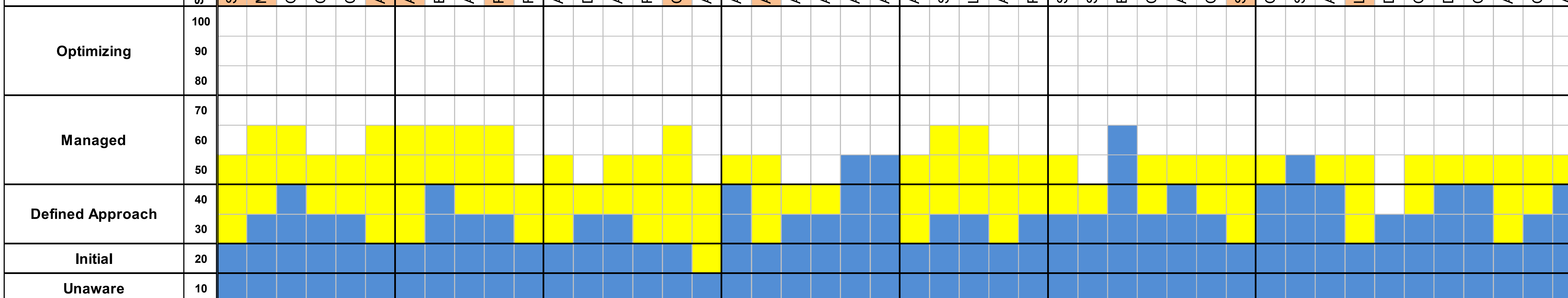

Group	Attribute	Target Practice Score (1)	Current Score (2)	Gap	Criticality (3)	Weighted Gap (Criticality x Gap)	Priority Ranking
Vision and Support	Support From Policy Body	50	20	30	5	150	1
	Management Direction	60	30	30	5	150	1
	Organizational Commitment	60	40	20	5	100	2
	Customer's Perspective	50	30	20	4	80	3
	Corporate AM Goals And Objectives	50	30	20	4	80	3
	Allocation Of Resources	60	20	40	5	200	1
Organization	Asset Manager Responsibility	60	20	40	5	200	1
	Establishment of AM Team	60	40	20	4	80	3
	Asset Management Overview	60	30	30	4	120	2
	Program Development	60	30	30	5	150	1
	Resources and Progress	40	20	20	4	80	3
Program Development	Assessment of Current Practices	50	20	30	4	120	2
	Development of Vision	40	30	10	3	30	3
	Analysis of Gaps	50	30	20	4	80	3
	Preparation of AMWP	50	20	30	4	120	2
	Communication of AMWP	60	20	40	5	200	1
	AM Program Audit	40	10	30	3	90	3
Asset Knowledge	Asset Detail	50	40	10	5	50	3
	Asset Criticality	50	20	30	5	150	1
	Asset Categorization	40	30	10	5	50	3
	Asset Classes	40	30	10	5	50	3
	Asset Hierarchy	50	50	0	5	0	3
	Asset Identification	50	50	0	5	0	3
Asset Planning	Asset Plans	50	20	30	4	120	2
	Short-interval Activities	60	30	30	4	120	2
	Long-interval Activities	60	30	30	4	120	2
	Asset Plan Maintenance	50	20	30	4	120	2
	Project Prioritization	50	30	20	4	80	3
AM Program Communication	Stakeholder Confidence	50	30	20	4	80	3
	Service Demands	40	30	10	3	30	3
	Environmental Compliance Strategy	60	60	0	5	0	3
	Communication Plan	50	30	20	5	100	2
	AM Strategy Awareness	50	40	10	3	30	3
	Continuous Improvement Indicators	50	30	20	3	60	3
	Staff Education	50	20	30	5	150	1
Asset Development	Origination	50	40	10	4	40	3
	Scope for Projects	50	50	0	5	0	3
	Alternatives	50	40	10	5	50	3
	Life-Cycle Costs	50	20	30	5	150	1
	Delivery Methods	30	30	0	1	0	3
	Operability and Maintainability	50	30	20	4	80	3
	Design Requirements	50	40	10	4	40	3
	Construction Requirements	50	40	10	4	40	3
	Asset Reliability and Assessment Updates	50	20	30	4	120	2
	O&M Manuals, Procedures, Guarantees	50	30	20	4	80	3
	Asset Tracking	50	40	10	4	40	3

Notes:

(1) Develop appropriate score with AM Team

(2) Establish current scores based on interviews

(3) Assume criticality weighing between 1 (low) to 5 (high)

Priority	
1	> 150
2	>100, <150
3	< 100

Optimizing	Continual improvement, refinement of processes, standards and procedures
Managed	Quantitative measurements are defined for processes and quality standards
Defined Approach	Defined repeatable approach that is documented and communicated within the organization
Initial	Reactionary and without a systematic approach
Unaware	Total unawareness within organization

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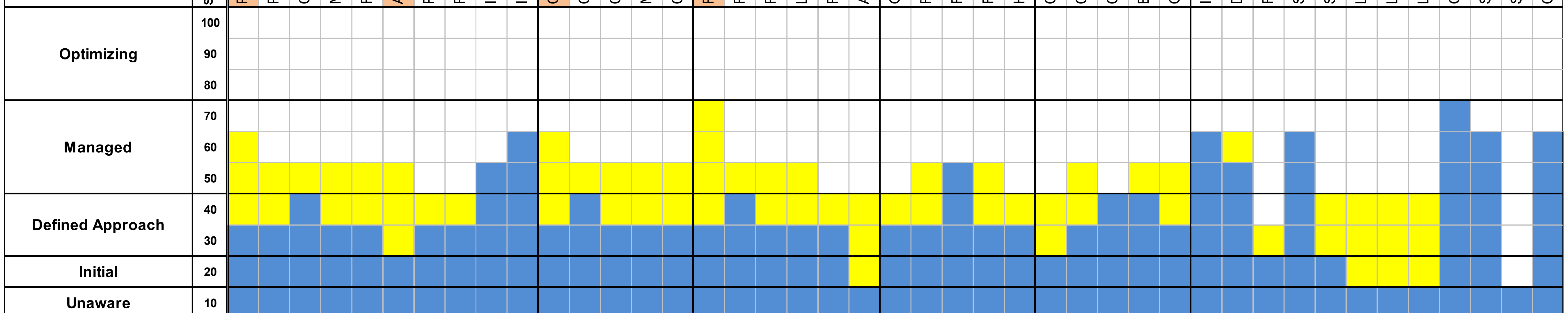

Asset Operation and Maintenance

Attribute	PM Definition	PM Scheduling	Corrective Maintenance	Maintenance Costs	Failure Codes Defined	Analysis Done to update Asset Plans	PM versus CM	Risk and Backlog	Inspection Considerations	Inspections
Target Practice Score (1)	60	50	50	50	50	50	40	40	50	60
Current Score (2)	30	30	40	30	30	20	30	30	50	60
Gap	30	20	10	20	20	30	10	10	0	0
Criticality (3)	5	5	5	5	5	5	4	4	5	5
Weighted Gap (Criticality x Gap)	150	100	50	100	100	150	40	40	0	0
Priority Ranking	1	2	3	2	2	1	3	3	3	3

Asset Condition Monitoring

Attribute	Condition Monitoring Methodology	Condition Rating and Scoring	Condition Tracking	Maintenance Scheduling	Corrective Actions
Target Practice Score (1)	60	50	50	50	50
Current Score (2)	30	40	30	30	30
Gap	30	10	20	20	20
Criticality (3)	5	5	5	5	5
Weighted Gap (Criticality x Gap)	150	50	100	100	100
Priority Ranking	1	3	2	2	2

Asset R&R

Attribute	R&R Planning	R&R Alternatives	R&R Analysis	Life Extensions	R&R Costs	Audit of R&R Practices
Target Practice Score (1)	70	50	50	50	40	40
Current Score (2)	30	40	30	30	30	10
Gap	40	10	20	20	10	30
Criticality (3)	5	3	3	3	4	3
Weighted Gap (Criticality x Gap)	200	30	60	60	40	90
Priority Ranking	1	3	3	3	3	3

Asset Financing

Attribute	Growth Needs	R&R Needs	Funding Plan	Funding Policy	Historical Trending
Target Practice Score (1)	40	50	50	50	40
Current Score (2)	30	30	50	30	30
Gap	10	20	0	20	10
Criticality (3)	4	4	4	4	4
Weighted Gap (Criticality x Gap)	40	80	0	80	40
Priority Ranking	3	3	3	3	3

Asset Financial Reporting

Attribute	Consistency in Reporting	Change Management	Comprehensive Reporting	Budgeting with Objectivity	Cost Forecasting
Target Practice Score (1)	40	50	40	50	50
Current Score (2)	20	30	40	40	30
Gap	20	20	0	10	20
Criticality (3)	5	4	4	4	4
Weighted Gap (Criticality x Gap)	100	80	0	40	80
Priority Ranking	2	3	3	3	3

Asset Management Systems

Attribute	Information System Plan	Data Collection Tools	Forecasting Tools	Standards and Protocols	System Integration Plan	Linked to Inventory /Stores	Linked to Budget/Performance Reporting	Linked to F/A System	GIS Functionality	Supports GASB 34 Depreciation Method	Supports GASB 34 Modified Approach	Change Management Process
Target Practice Score (1)	60	60	30	60	40	40	40	40	70	60	10	60
Current Score (2)	60	50	20	60	20	10	10	10	70	60	10	60
Gap	0	10	10	0	20	30	30	30	0	0	0	0
Criticality (3)	4	4	3	4	4	4	4	4	4	4	1	4
Weighted Gap (Criticality x Gap)	0	40	30	0	80	120	120	120	0	0	0	0
Priority Ranking	3	3	3	3	3	2	2	2	3	3	3	3

Priority	
1	> 150
2	>100, <150
3	< 100

Optimizing	Continual improvement, refinement of processes, standards and procedures
Managed	Quantitative measurements are defined for processes and quality standards
Defined Approach	Defined repeatable approach that is documented and communicated within the organization
Initial	Reactionary and without a systematic approach
Unaware	Total unawareness within organization

Appendix I: Asset Plan Template

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ASSET PLAN TEMPLATE

1. INTRODUCTION AND OVERVIEW

1.1. The classes and sub-classes included in the asset plan

- Drainage Basins
- Open Channels
- Stormwater Drains
- Stormwater Pits
- Best Management Practice

1.2. Quantitative data in respect of the asset classes and sub-classes, as applicable

- Number
- Length
- Area
- Volume
- Size

2. DESCRIPTION OF ASSETS COVERED BY THE PLAN

2.1. Age of stormwater system assets
2.2. Stormwater system asset materials
2.3. Stormwater system asset locations
2.4. Functionality of stormwater asset structures

3. SERVICE LEVELS

3.1. The expected or required service levels for the included assets
3.2. The actual service levels being achieved for the assets
3.3. Regulations and policies

Example – Asset Service Levels

Problem	Intervention Level	Remedy	Response Time
Blocked Drain	flow reduced by ?%	Remove Rubbish	? days
Broken Pit Lid	condition score = ?	Replace Lid	? days
Long grass in open channel	length > ?mm	Cut Grass	? days

Example - Regulations and Policies Affecting the Stormwater System

Regulation/Policy	Description
Regulations: Federal, State of Washington, Regional, and Local	
Clean Water Act	Provides for Water Pollution Control activities, including stormwater.
2013–2018 National Pollutant Discharge Elimination System Western Washington Phase II Municipal Stormwater Permit (NPDES Phase II Permit)	Provides for basic permitting requirements concerning the Phase II NPDES Stormwater Permit. Permit is authorized by the Washington State Department of Ecology.
Policies & Plans	
City of Shoreline Council Adopted Goals	Provides strategies, goals and budgets to achieve effective watershed management and control of stormwater runoff.
Shoreline Environmental Sustainability Strategy	
Shoreline Surface Water Master Plan	Document describing the management of the Surface Water Utility.
Stormwater Management Division – Maintenance Policies Dated 11-20-06	A description of the city urban drainage maintenance responsibilities.
Procedures	
	.

4. FUTURE DEMAND (DERIVED FROM MASTER PLANNING)

4.1. Future requirements associated with Master plans or operational plans
4.2. Known or possible areas for expansion

- Asset classes and potential acquisition dates
- Cost estimates
- Impact on service levels, asset lifecycle and financial considerations

5. LIFECYCLE MANAGEMENT AND FINANCIAL CONSIDERATIONS

5.1. Useful Life

- Estimated length of time during which the asset is likely to be able to deliver a satisfactory level of service.

- May depend on a wide range of environmental factors
- The period over which a depreciable asset is expected to be used, or
- Estimated useful life for each asset class and sub-class
- Annual depreciation expense per asset class & sub-class

Example – Useful Life Table

Asset Sub-class	Useful Life	Average RUL	Annual Depreciation
Drainage Basins	? years	? years	$?
Open Channels	? years	? years	$?
Stormwater Drains	100 years	? years	$?
Stormwater Pits	? years	? years	$?
BMPs	? years	? years	$?

5.2. Valuation of each asset class and sub-class

- Valuation
- Date of valuation and valuation methodology employed

Example – Asset Valuation Table

Asset Sub-class	Replacement Cost	Written Down Replacement Cost
Drainage Basins	$?	$?
Open Channels	$?	$?
Stormwater Drains	$?	$?
Stormwater Pits	$?	$?
BMPs	$?	$?

5.3. Operation and Maintenance Activities

- Operational activities
- Maintenance activities
- Description of program
- Timing of program
- Maintenance expense per asset class and sub-class

Example – Maintenance Expense Table

Asset Sub-class	Annual Maintenance Expenditure
Drainage Basins	$?
Open Channels	$?
Stormwater Drains	$?
Stormwater Pits	$?
BMPs	$?

5.4. Condition Assessment and Monitoring Activities

5.5. Renewal/Replacement Plan

- Rehabilitation and replacement cycles and costs
- Capital Improvement Project (CIP) Planning
- Renewals capital expenditure

Example - Projected Stormwater Drainage Renewal Expenditure

Asset Sub-class	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Drainage Basins	$?	$?	$?	$?	$?	$?	$?	$?	$?	$?
Open Channels	$?	$?	$?	$?	$?	$?	$?	$?	$?	$?
Stormwater Drains	$?	$?	$?	$?	$?	$?	$?	$?	$?	$?
Stormwater Pits	$?	$?	$?	$?	$?	$?	$?	$?	$?	$?
BMPs	$?	$?	$?	$?	$?	$?	$?	$?	$?	$?

5.6. Acquisition

- New or upgrade capital expenditure

Example - Projected Stormwater Drainage New and Upgrade Capital Expenditure

Asset Sub-class	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Drainage Basins	$?	$?	$?	$?	$?	$?	$?	$?	$?	$?
Open Channels	$?	$?	$?	$?	$?	$?	$?	$?	$?	$?
Stormwater Drains	$?	$?	$?	$?	$?	$?	$?	$?	$?	$?

5.7. Disposal

- Proposed timing of asset retirement or disposal
- Estimated residual values at retirement or disposal

Example - Projected residual value of future stormwater drainage retirements & disposals

Asset Sub-class	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Drainage Basins	$?	$?	$?	$?	$?	$?	$?	$?	$?	$?
Open Channels	$?	$?	$?	$?	$?	$?	$?	$?	$?	$?
Stormwater Drains	$?	$?	$?	$?	$?	$?	$?	$?	$?	$?
Stormwater Pits	$?	$?	$?	$?	$?	$?	$?	$?	$?	$?
BMPs	$?	$?	$?	$?	$?	$?	$?	$?	$?	$?

5.8. Risk Management

- Identification of risks
- Identification of risk mitigation strategies
- Stormwater system asset criticality matrix

5.9. Data Requirements and Tools

- Data requirements
- Document management
- Tools

6. ACTION PLAN

Appendix J: Asset Management Processes

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Prepared for: City of Shoreline

Project title: Shoreline Surface Water Master Plan

Project no.: 149479

Deliverable D13

To: Uki Dele **Date:** April 28, 2017

From: Scott Bash, FCS GROUP

CC: Nathan Foged, Brown and Caldwell

RE Asset Management Process and Framework

The intent of this memorandum is to provide guidance on how the Surface Water Utility may govern the asset management program and to recommend a framework for effective asset management.

ASSET MANAGEMENT FRAMEWORK

INTRODUCTION

Asset management (AM) is a structured approach to optimizing the life-cycle cost of asset ownership and focuses on providing reliable and dependable Surface Water Utility (Utility) service to customers of the City of Shoreline. The goal of an AM program is to meet customer needs and expected levels of service through sound fiscal planning and improved infrastructure management across the enterprise.

An enterprise AM program helps the Utility maintain its mission of protecting public health and the environment by improving the knowledge and management of assets. Two basic concepts of asset management are to maximize the useful life of assets and to reduce life-cycle costs. Measurement of asset performance and processes are key to sustaining the AM program. The cost of asset ownership must be well understood for informed decision making and all staff should be aligned with the best practices related to effective service delivery and meeting the desired business outcomes.

The Utility makes use of asset management, the supporting information technology, and financial performance data to manage the surface water assets and improve the organization's performance and costs. One of the goals of the AM program is to design and deliver practical programs that manage the life-cycle cost of asset ownership while improving asset reliability. The AM program requires an ongoing collaboration among the engineering, operations, maintenance, finance, and information

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technology groups. Such a broad and coordinated program requires top management commitment, a cross-functional team approach, and an AM framework.

Figure 1 outlines the various elements of the framework in support of an enterprise AM program.

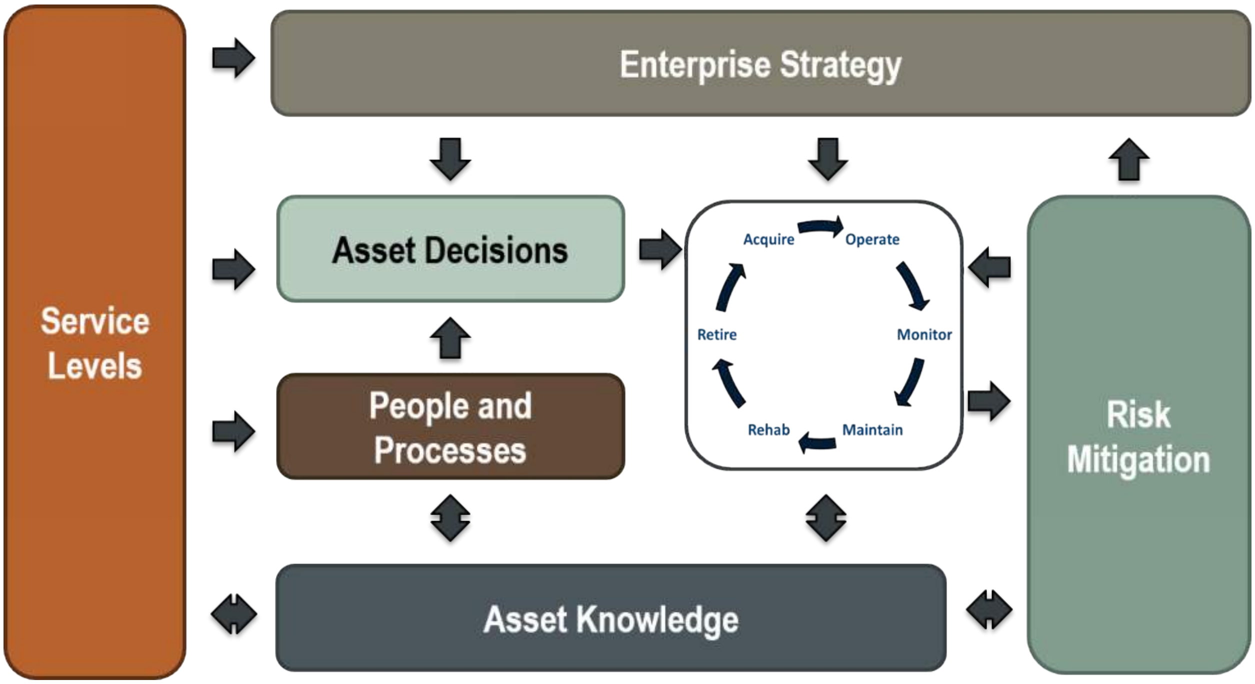

Figure 1: AM Framework

SERVICE LEVELS

Levels of service are the starting point for assessing the Utility's AM program. A customer service level is any utility service that a customer perceives as valuable that can be defined and measured. The strategy for developing levels of service is to clearly identify the current levels of service and come to an understanding with regulators, customers, and other stakeholders as to which service levels are prime obligations and which are targets to be met on a best-efforts basis. These service levels need to be updated as required so that they reflect the long-term interests of stakeholders.

Stakeholders should be kept informed of the performance of the Utility against its service levels and long-term cost targets. This ensures the ongoing reputation of the Utility and allows the Utility greater influence over its levels of service to its customers and the environment in the future.

A communications strategy is important for conveying service levels. The Utility should maintain a comprehensive communications strategy to keep its various stakeholders informed about meeting its service levels and long-term cost targets. Communication should be open and frequent. Special communication initiatives need to be devised on a proactive basis for special issues involving regulatory matters or changes in service levels.

ENTERPRISE STRATEGY

The Enterprise Strategy identifies the goals of the Utility and the approach for reaching those goals. It is a combination of strategies, each with an objective or set of objectives with specific measurable actions. These strategies should be with respect to the management of assets necessary to meet the level of service targets. The Enterprise Strategy is documented to explain how the individual strategies are implemented and managed. The Utility should develop a process of continual monitoring to allow for strategic plan updates as changes in the organization and environment occur.

Managing the regulatory environment is an important element of the Enterprise Strategy. The Utility works with regulators to achieve sound social, environmental, and economic outcomes for its communities. A regulatory management strategy should be developed for engaging with regulators and lawmakers on matters involving regulatory change. Whenever a rule or regulation is in development, it goes out for comment. The Utility should engage in the regulatory debate on federal matters mainly through its involvement in industry associations and comment directly on certain matters. The Utility should follow similar active engagement processes in dealing with proposed changes to state laws and the rules that affect them.

RISK MITIGATION

Risk mitigation is the process of developing options and actions to enhance opportunities and reduce threats to asset performance and enterprise strategy objectives. The idea of evaluating risk in asset management is to ensure that failure modes can be identified, acceptable levels of risk can be evaluated, critical assets and business processes are identified, consequences or failures are known, and risks are avoided or reduced.

For risk management of assets it is necessary to establish goals, objectives and strategies, and the scope of the risk assessment and management process. Without establishing goals and objectives, it will be difficult for the Utility to evaluate acceptable levels of risk. The Utility should develop a risk policy with a risk and criticality assessment related to assets being a part of the Operations and Maintenance (O&M) Strategies. The policy should break risk down into risk identification, risk analysis, and risk mitigation.

The Utility should maintain risk management policies, procedures, and practices by which assets and asset systems are identified and ranked according to their level of criticality. If the asset were to fail to fulfill its function, the worst-case credible scenario should be used to establish this risk ranking.

Based on the criticality ranking, the appropriate risk management methodology should be applied in order to determine the risk score of the asset or asset system, based on consequence and likelihood of a loss event. This risk score should be set up such that it can be expressed in a current measurable risk exposure. The organization should be able to aggregate the risk exposure at various levels or across various dimensions of the asset source of record.

Based on asset risk score, the organization should apply the appropriate risk assessment and treatment methodology to determine the appropriate level of risk mitigation. This typically involves understanding the possible failures and potential for degradation of assets in enough detail to determine the measure of exposure to a probabilistic loss event. Mitigating actions and events are then prescribed in order to arrive at a treatment plan that measurably reduces risk. This process should also track the cost of these actions and events so that life-cycle cost estimates can be analyzed. The Utility can then use the cost to reduce risk exposure to calculate a risk return on investment.

A risk mitigation evaluation should include exception criteria. These help detect deviations in expected performance metrics. In addition, it is important to have performance analysis in place. Performance analysis is used to monitor compliance to prescribed risk mitigation actions and events. Performance analysis should also include condition assessments done in order to monitor for changes in asset health. Finally, exception criteria should also consider performance requirements of the asset in terms of units of production, availability, or utilization.

ASSET DECISIONS

Asset decisions should be documented and follow a repeatable process. A decision-making process is developed and accepted at the Utility and should outline the threshold for which asset decisions require a business case evaluation (BCE) in order to obtain approval, the process for approval of asset decisions below the threshold, and the process for approvals within the BCE process. The BCE process is implemented at the Utility so that all capital and operating decisions are made in a documented and structured way. The BCE process should be well documented, and the process participants should have training in the use of the process. Roles and responsibilities for decision making should be documented so that all Utility staff are aware of the steps in obtaining approval for capital and operating decisions regarding assets.

Asset Plans

An asset plan is a road map to asset ownership costs, expressing best estimates of these costs throughout the entire asset life cycle. In addition, the asset plan includes O&M strategies for the asset as well as rehabilitation and replacement (R&R) plans. Asset plans should be used to give the Utility a snapshot of important information concerning an asset. The asset plans for the assets owned and operated by the Utility should be kept in an electronic database system. The asset plans should be kept up to date using electronic systems, and the plans should be produced in hard copy for workers unable to access a computer. The Utility should use asset plans in the building of facilities, such as those produced by BCE, to provide the basis for more detailed O&M strategies and R&R plans. Once facilities are in operation, it should measure and periodically compare actual ownership costs with forecasted costs to improve future forecasts. The Utility should measure its actual ownership costs for existing facilities and prepare similar asset plans for these facilities.

Asset Financing

The Utility’s asset financing strategy includes life-cycle planning, decision making, and financial management components. Better knowledge of future capital needs and future O&M costs will improve the quality and dependability of the Utility’s business plan and better document the Utility’s future funding needs. It is important for the Utility to understand its costs well enough to make defensible estimates of future costs so that proper budgets can be prepared and resources can be properly allocated. Improved cost forecasting allows for improved management of assets through the decision-making process. Better forecasting of asset replacement costs over several years will help the Utility better identify future funding needs and better control rates. Policies that balance R&R against new projects and improvements will result in more control over rate fluctuations.

ASSET LIFE CYCLE

This section summarizes key milestones in the asset life cycle, including acquire, operate, monitor, maintain, rehabilitate, and retire.

Acquire

The new asset development strategies employed by the Utility should be used to gain the best cost and project outcomes. The project outcomes are measured by project cost and project timelines. Projects should be bundled to get cost and contracting advantages, when practical. The new asset acquisition strategies for routine asset replacements should be well developed for different asset/equipment types, taking into account the project risk profile.

Operate

The operations strategies employed by the Utility should be used to ensure that the cost, reliability, and service levels for the Utility assets are met. The strategies employed should be developed using the risk profile of each facility and piece of equipment, and every hierarchical level in between. The operating strategies of the assets should be developed so that the asset reliability is maintained according to the asset's risk profile. These strategies take into account the remote monitoring and control available at each of the assets and consider the monitoring design versus the actual set points.

Monitor

The Utility should use condition monitoring for assets to predict failure and intervene before catastrophic failure. Condition monitoring techniques should be employed only where it can be suitably justified; i.e., where the cost of the technique is less than the cost of the asset failure. Methods of monitoring asset condition vary according to the asset class. Once the ways in which an asset can fail are defined, monitoring methods can be chosen to predict failures. The scoring system should reflect the asset condition and allow for comparative analysis and consequence-of-failure analysis. Condition assessments and trends in assessments are normally used to support maintenance scheduling, prediction of R&R timing, and decisions on R&R actions.

Maintain

A maintenance strategy should be developed after understanding the risk profile of a facility or piece of equipment. The maintenance options should be categorized as run to failure, condition-based maintenance, or preventive maintenance (PM) (calendar-based or run-based) with an analysis of the maintenance costs for all Utility assets performed annually. The cost analysis should be done by analyzing each PM task and by looking at the frequency and effort required. Each task should be coded by the type of labor needed to carry out the task. Changes to the operator's or maintainer's maintenance program should be redesigned accordingly to improve asset reliability.

Rehabilitate

Asset replacements should be done within well-defined strategies for different asset classes and within different operating risks. Replacements should take into account obsolescence and efficiency and be complementary to long-range planning efforts. The strategies for routine asset replacements should be translated into decision support models that ensure that decisions are consistent and made in a timely manner. The approach taken to identify assets for R&R is to look broadly at the performance of the electrical/mechanical asset base and rank equipment according to selected parameters such as rate of failure or reactive maintenance costs. This ranking will generate a prioritized list of equipment, which should be subjected to further economic evaluation.

Retire

The Utility should itemize its assets in accordance with the established hierarchy and at a level of detail that supports its normal business processes. When assets are retired because they are either disposed of or no longer in use, all databases and necessary journal entries to remove the asset's financial information should be updated. The retirement should be part of the asset plan and a record for each asset should be maintained, as necessary, for asset planning and for making asset decisions such as determining optimal maintenance intervals and actions, timing and types of capital refurbishments, and timing of retirements/replacements. The Utility should review and document its processes for informing Administrative Services of asset retirements or replacements. These processes should be strengthened, if necessary, with the advice of the finance section. Criteria for capitalization and retirement review as well as how the review conduct should be conducted.

PEOPLE AND PROCESSES

The Utility should develop a systematic approach for educating and motivating the workforce to generate both direct and indirect value for the AM program. The objective of an education strategy is to encourage innovation, problem solving, and skills improvements at all levels of the Utility. Skilled and knowledgeable staff require an investment in training. This investment leads to improvement in service, which leads to public trust. Trust leads to better relationships with customers and stakeholders, which will be necessary to support the goals of the Utility. The education and development program for all staff involved in the AM program should be based on their specific roles and responsibilities.

Continuous Improvement

Continuous improvement should include quality assurance (QA) plans and procedures and will provide the framework for ensuring that all AM processes and procedures implemented at the Utility are monitored for improvement. The Utility should annually audit its AM program in an effort to ensure continual improvement and provide quality assurance that procedures and processes are implemented. A program should be developed that defines the Utility audit procedure for the AM program. The program will allow for reviews of the quality procedures in place at the Utility, define roles and responsibilities, and define the corrective action process.

Knowledge Sharing

Knowledge sharing supports the strategic framework of the AM program and involves the information systems, data, and manner in which staff uses information and coordinates activities. The Utility should develop a knowledge-sharing program as an essential part of measuring organizational success. The knowledge-sharing strategy is a combination of data, processes, and software technology strategies. Data are used to support the management of organizational goals, business processes, business interactions, and the workflow of individual performers. Hardware and software technology will vary based on application needs to meet the strategic goals. Standards should be maintained at all times to document user needs and integration requirements.

ASSET KNOWLEDGE

Asset knowledge is critical to achieving good AM outcomes. Knowledge of the operating assets of the Utility is captured through asset hierarchies and asset inventories in the Cityworks computerized maintenance management system (CMMS) and geographic information system (GIS). The use of CMMS and GIS to capture this information allows asset managers to understand their assets from any level and equipment performance across multiple installations. Assets should be classified to enable the Utility to compare the performance of assets of similar types. The asset classification process should be well defined and documented (for example, bioretention facilities could be an asset class, pumps could be an asset class, stormwater pipes by materials could be an asset class, etc.).

The Utility should understand its assets' costs and reliability through data access and knowledge sharing. All assets should be given a minimum performance limit and targeted for a desired level of performance. Failure codes are used to help measure an asset's reliability and are useful in the analysis of data. The tendency is to grow the selection of available codes with unique identifiers to cover each specific instance of failure, which makes analysis very difficult. The number of available codes in the list should be limited as much as possible.

PERFORMANCE MEASURES

The effectiveness of the AM program can be measured in the following three major ways:

1) The degree to which the required cash flows identified in the Surface Water Master Plan are incorporated into the City Council's long-term financial plan
2) The degree to which 1- to 6-year detailed capital works programs, budgets, business plans, and organizational structures take into account the AM work plan
3) Measure of key performance indicators (KPIs) that track the level-of-service targets

The levels of service and KPIs are the primary measures of performance. KPIs are used to drive business improvements and will ultimately lead to changes in the AM program. For purposes of continual improvement, the AM program should be refined with improvements to standards and procedures as deemed necessary to improve and to meet program goals.

Each of the defined service levels should have KPIs or metrics in order to determine if each service level was met. These metrics should be coordinated with other Utility programs and City Council goals. The Utility should continually update and document both external and internal service levels. For each of these service levels, a KPI or similar metric can be assigned in order to measure the performance of the service level. On an annual basis, an audit should be conducted to determine if these KPIs were achieved during the year. Corrective action plans can then be developed as a result of this audit, if KPIs were not achieved for the service levels.

GLOSSARY

Term	Definition
Asset	A physical component of a facility that has value, enables services to be provided, and has an economic life of greater than 12 months. Dynamic assets have some moving parts, while passive assets have none.
Asset class	A set of assets with similar characteristics that can be treated similarly when estimating R&R requirements.
Asset hierarchy	A framework for segmenting an asset base into appropriate classifications. The asset hierarchy can be based on asset function, asset type, or a combination of the two.
Asset management (AM)	A program to minimize costs of asset ownership while managing risks and meeting required service levels.
Asset plan	A road map to asset ownership costs, expressing best estimates of these costs throughout the entire asset life cycle.
Asset management program manager	The person appointed by an organization to ensure that corporate AM goals, objectives, and legal obligations are met. The AM program manager may also be required to lead the AM team.
Asset management information system	An AM system is a combination of processes, data, and software applied to provide the essential outputs for effective AM such as reduced risk and optimum infrastructure investment. A computerized maintenance management system (CMMS) is an example of an asset management information system.
Asset management strategy	A strategy for asset management covering the development and implementation of plans and programs for asset creation, operation, maintenance, R&R, disposal, and performance monitoring to ensure that the desired levels of service and other operational objectives are achieved at optimum cost.
Asset management team	The team appointed by an organization to review and monitor the corporate AM improvement program and ensure the development of integrated AM systems and plans consistent with organizational goals and objectives.
Asset register	A record of asset information considered worthy of separate identification including inventory, historical, financial, condition, construction, technical, and financial information about each.
Business case evaluation (BCE)	A process to determine the need for and best configuration of a capital project in terms of service levels, economics, and risk.
Business plan	A plan produced by an organization (or business units within it) that translates the objectives contained in an annual plan into detailed work plans for a particular, or range of, business activities. Activities may include marketing, development, operations, management, personnel, technology, and financial planning.
Capital expenditure	Expenditure used to create new assets or to increase the capacity of existing assets beyond their original design capacity or service potential. Capital expenditure increases the value of asset stock.
Component	A specific part of an asset having an independent physical or functional identity and having specific attributes such as different life expectancy, maintenance regimes, risk, or criticality.
Condition assessment	The process of evaluating an asset to estimate its remaining useful life, or probability of failure. Assessments are tied to asset failure modes and are usually expressed numerically.
Condition-based maintenance	Maintenance initiated as a result of knowledge of an item’s condition from routine or continuous monitoring.
Condition monitoring	Continuous or periodic inspection, assessment, measurement, and interpretation of the resultant data, to indicate the condition of a specific component so as to determine the need for some preventive or remedial action.
Corrective maintenance	The remedial actions performed as a result of failure, to restore an item to a specified condition. Corrective maintenance may or may not be scheduled.
Critical asset	An asset for which the financial, business, or service level consequences of failure are sufficiently severe to justify proactive inspection and rehabilitation. Critical assets have a lower threshold for action than non-critical assets.

Term	Definition
Criticality	A numerical measure of the potential consequences of an asset's unexpected failure in terms of service levels, community cost, safety, etc.
Data warehouse	A system that is used to centralize a group of disparate databases in an organization to facilitate access into each of those databases.
Depreciation	The wearing out, consumption, or other loss of value of an asset whether arising from use, passing of time, or obsolescence through technological or market changes. It is accounted for by the allocation of the cost (or revalued amount) of the asset less its residual value over its useful life.
Disposal	The sale or other ultimate disposition of an asset that has been demolished or replaced. Also includes the activities necessary to dispose of decommissioned assets.
Economic life	The period from the acquisition of the asset to the time when the asset, while physically able to provide a service, ceases to be the lowest-cost alternative to satisfy a particular level of service. Economic life is at a maximum when equal to the physical life; however, obsolescence will often ensure that economic life is less than physical life.
Facility	A complex comprising many assets (e.g., a hospital, water treatment plant, recreation complex, etc.) that represents a single management unit for financial, operational, maintenance, or other purposes.
Failure modes, effects, and criticality analysis	A technique for analyzing and evaluating a design to ensure that the application has the desired reliability characteristics by preventing those critical failure modes through employment of redundancy, providing alternate modes of operation, de-rating, or any other means.
Gap analysis	A method of assessing the gap between a business's current AM practices and the future desirable AM practices. Also called needs analysis or improvement planning.
Geographic information system (GIS)	Software that provides a means of spatially viewing, searching, manipulating, and analyzing an electronic database.
Key performance indicator (KPI)	A qualitative or quantitative measure of a service or activity used to compare actual performance against a standard or other target. KPIs commonly relate to statutory limits, safety, responsiveness, cost, comfort, asset performance, reliability, efficiency, environmental protection, and customer satisfaction.
Level of service	The defined service quality for a particular activity or service area against which service performance may be measured. Levels of service usually relate to quality, quantity, reliability, responsiveness, environmental acceptability, and cost.
Life	A measure of the anticipated life of an asset or component, such as time, number of cycles, distance intervals, etc.
Life cycle	The cycle of activities that an asset (or facility) goes through while it retains an identity as a particular asset; i.e., from planning and design to decommissioning or disposal.
Life-cycle cost	The total cost of owning an asset over its useful or economic life including planning, design, acquisition, O&M, periodic reinvestments, condition monitoring, etc. The life-cycle cost can be expressed as a single cost in today's dollars using present value. The total cost of an asset through its life including planning, design, construction, acquisition, operation, maintenance, rehabilitation, and disposal costs.
Life-cycle cost analysis	Any technique that allows assessment of a given solution, or choice from among alternative solutions, based on all relevant economic consequences over the service life of the asset.
Maintainability	A characteristic of the design of an installation, usually identified by the required amount of time of an effort to retain an asset as near as practicable to its new or desired condition within a given period.
Maintenance	All actions necessary for retaining an asset as near as practicable to its original condition, but excluding rehabilitation or replacement. Fixed-interval maintenance is used to express the maximum interval between maintenance tasks.
Maintenance strategy	Collated information, policies, and procedures for the optimum maintenance of an asset or group of assets.
Maintenance standards	The standards set for maintenance service, usually contained in preventive maintenance schedules, operations and maintenance manuals, codes of practice, estimating criteria, statutory regulations, and mandatory requirements, in accordance with maintenance quality objectives.

Term	Definition
Net present value	The value of an asset to the organization, derived from the continued use and subsequent disposal in present monetary values. It is the net amount of discounted total cash inflows arising from the continued use and subsequent disposal of the asset after deducting the value of the discounted total cash outflows.
Operation	The active process of utilizing an asset that will consume resources such as manpower, energy, chemicals, and materials. Operation costs are part of the life-cycle costs of an asset.
Operations and maintenance (O&M)	The normal day-to-day activities to operate, maintain, and repair an infrastructure system. O&M activities are usually funded from the operating budget and treated as current-period expenses in financial reporting.
Performance monitoring	Continuous or periodic quantitative and qualitative assessments of the actual performance compared with specific objectives, targets, or standards.
Planned maintenance	Planned maintenance activities fall into three categories: 1. Periodic: necessary to ensure the reliability or to sustain the design life of an asset 2. Predictive: condition monitoring activities used to predict failure 3. Preventive: maintenance that can be initiated without routine or continuous checking (e.g., using information contained in maintenance manuals or manufacturers' recommendations)—not condition-based
Present value (PV)	The time-adjusted value of a series of cash flows, expressed as a single number in today's dollars. The discount rate is used for the time adjustment.
Preventive maintenance (PM)	An asset intervention that sustains the condition and functionality of an asset on a short-interval basis, as distinct from repair (see following). PM is an O&M activity (see previous).
R&R	Rehabilitation and replacement (see following).
Rehabilitation	Works to rebuild or replace parts or components of an asset, to restore it to a required functional condition and extend its life, which may incorporate some modification. Rehabilitation generally involves repairing the asset to deliver its original level of service without resorting to significant upgrading or renewal, using available techniques and standards.
Reliability-centered maintenance	A process for optimizing maintenance based on the reliability characteristics of the asset.
Remaining economic life	The time remaining until an asset ceases to provide the required service level or economic usefulness.
Repair	An action to restore an item to its previous condition after failure or damage.
Replacement	The removal from service of an asset and substitution with a new asset of the same asset class. The complete replacement of an asset that has reached the end of its life to provide a similar, or agreed alternative, level of service.
Replacement cost	The cost, actual or expected, of an asset replacement. The cost of replacing an existing asset with a substantially identical new asset.
Retirement	The physical removal of an asset from service.
Risk cost	A fundamental cost of asset ownership, normally expressed in dollars per year. It is the product of the direct and community cost of unexpected asset failure and the probability of failure per year. The assessed annual cost or benefit relating to the consequence of an event. Risk cost equals the costs relating to the event multiplied by the probability of the event occurring.
Risk management	The application of a formal process to the range of possible values relating to key factors associated with a risk to determine the resultant ranges of outcomes and their probability of occurrence.
Routine maintenance	Day-to-day operational activities to keep an asset operating (replacement of light bulbs, cleaning of drains, repairing leaks, etc.) and that, for part of the annual operating budget, include preventive maintenance.
Service level	Any utility service that a customer perceives as valuable, as defined and measured. A mature AM organization understands the service levels its customers (or the environment) require and manages itself to meet those service levels at the lowest cost.

Term	Definition
Strategic plan	A plan containing the long-term goals and strategies of an organization. Strategic plans have a strong external focus; cover major portions of the organization; and identify major targets, actions, and resource allocations relating to the long-term survival, value, and growth of the organization.
Useful life	The interval between the time an asset is placed in service and the expected date of replacement. The total useful life of an asset in service may increase over time because of standard mortality considerations, although remaining useful life may continue to decline. May be expressed as either: (1) the period over which a depreciable asset is expected to be used, or (2) the number of production or similar units (i.e., intervals, cycles) that is expected to be obtained from the asset.

Appendix K: Utility Billing

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FCS GROUP
Solutions-Oriented Consulting

Memorandum

Prepared for: City of Shoreline

Project title: Shoreline Surface Water Master Plan

Project no.: 149479

Deliverable D13

To: Uki Dele, City of Shoreline **Date:** April 28, 2017

From: John Ghilarducci, David Gordon, FCS GROUP

CC: Margaret Ales, Nathan Foged, Brown and Caldwell

RE Stormwater Utility Billing System Audit

SUMMARY

Brown and Caldwell and FCS Group (Consultant Team) are working with the City of Shoreline (City) to prepare an updated Surface Water Master Plan (Master Plan) for the Surface Water Utility (Utility). This memorandum summarizes the results of Task 8.1: Audit Utility Billing System of the Master Plan, which is an audit of King County's (County's) surface water management utility billing system, used by the City to charge City stormwater rates.

We compared data used by the County to determine and charge surface water fees with City geographic information system (GIS) data on chargeable area. We discovered few major differences between the two data sets and have calculated the potential revenue impact from comparable data as less than 2 percent of total annual expected revenues (with the County data currently resulting in higher revenues).

We also analyzed the processes for updating surface water data. This process reveals gaps in the City's methods for updating impervious-surface information. Currently, updated impervious-surface data are received only for new commercial and residential parcels. Currently (and historically), changes in impervious-surface information due to development have not been recorded. This raises the need to determine a path forward for assessing the accuracy and completeness of historical data as well as to change data-recording procedures to collect and distribute new impervious-surface information.

INTRODUCTION

The purpose of this task is to review the accuracy and completeness of the County's billing of City surface water rates. The County uses spatial and tax parcel data to calculate and bill Shoreline residents and businesses appropriate stormwater fees. The City provides the County with updated parcel information via the City Planning and Community Development Department (PCD). The County also requests parcel updates from the City prior to billing customers.

Although successful information sharing between the County and City already exists, it is important to audit the current billing information to ensure accuracy, identify problems, and ensure that processes going forward guarantee the correct billing of City stormwater utility customers.

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METHODOLOGY

We performed this audit of County surface water billing by comparing existing City GIS data with the most recent customer billing information provided by the County. When comparing data sets, we searched for the following information:

- **Parcel matches:** This checks to see if parcels in the City data set are in the County data set and highlights if and where data may be missing from either data set.
- **Parcel classifications:** This determines if the data sets share accurate information on the type of parcel and its account status.
- **Impervious surface:** Except for residential-classified parcels, impervious surface is extremely important in determining the correct service charge. We compare impervious-surface data by tax identifier (ID) for both data sets.
- **Billing:** Using the prior data checks, we can compare expected and actual bill amounts and determine if and how data differences influence revenue.

In addition to comparing the data sets, we researched how the County and City update important parcel information. This information is vital in determining how data inaccuracies may be reconciled in future processes.

The City's goal is to make this audit repeatable by City staff in the future. Toward that effort, our analysis uses set equations in Excel to compare and analyze data sets. The City can use this Excel file, with updated information, to perform future audits of the billing data. This file is submitted separately and is titled, "Combined Data 20170428.xlsx".

ANALYSIS

Comparisons of the City's and County's surface water data reveal differences that are largely explainable and, based on the current rate structure, of minimal impact to potential revenues.

PARCEL MATCHES

There is a strong correlation between parcels in the County data set and those in the City's data set. Table 1 compares the account status for City and County data sets.

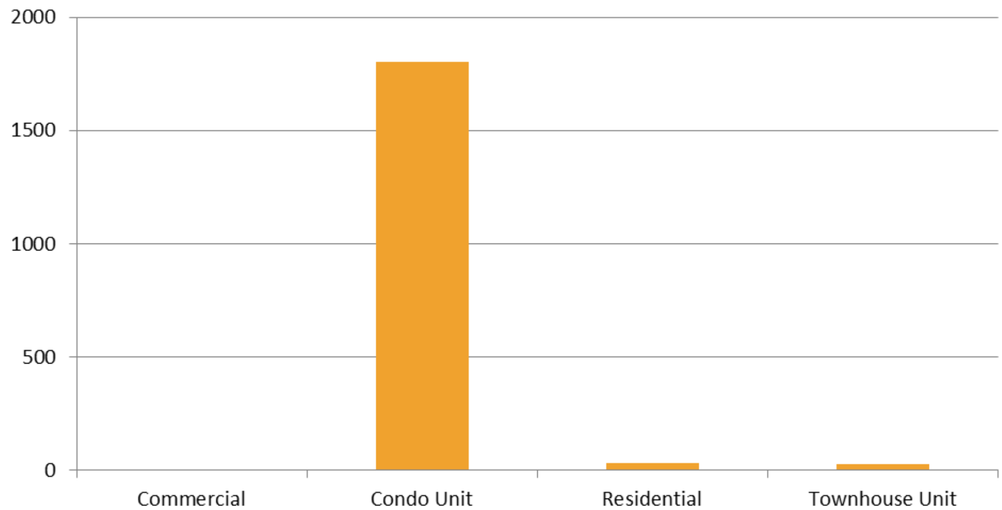
Table 1: Account Status by Data Source

County Account Status	City GIS Account Status		
	Active	Suspended	Not in City
Active	17,034		1,865
Suspended		121	2
Undeveloped	1		
Not in County	398	6	

About 10 percent of all parcels listed in both data sets do not match. This means that a parcel in one data set does not exist in another.

The great majority of these unmatched parcels exist in the County's data set and not in the City's. These unmatched parcels are almost entirely condo units. Each unit is billed separately by dividing the complex's total bill (based on size and impervious surface) by the number of units in that complex. See Figure 1.

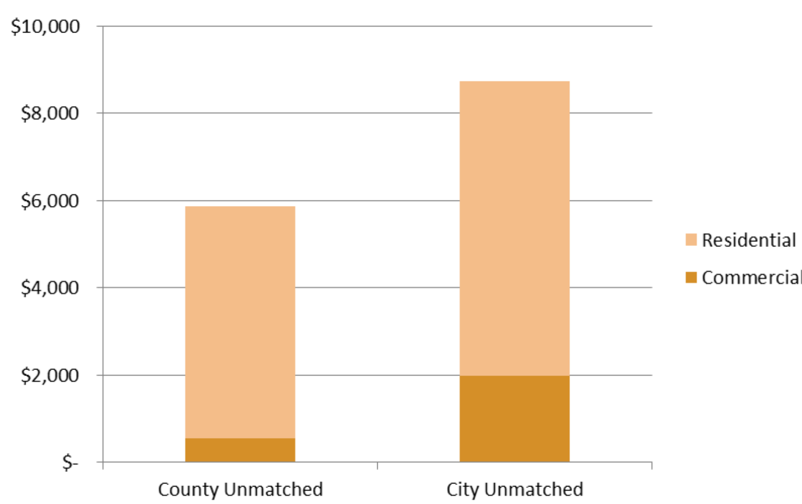
Figure 1: County Unmatched Parcels by Account Type



Of the 400 parcels that exist in the City's data set and not in the County's, the majority are of an unknown category. These are difficult to decipher, but reflect the condo and townhouse complexes expressed as units in the County data.

Residential and commercial properties make up the remainder of unmatched parcels. Analyzing only these parcels by the expected annual fees they should produce shows that the County data may be missing approximately $3,000 in annual fees. This is shown in Figure 2.

Figure 2: Unmatched Parcels by Fee Total



Because the impact of known mismatched parcels is low, there are no significant findings when considering unmatched parcels.

PARCEL CLASSIFICATIONS

Now considering only matched parcels, those that do appear in both data sets, it is important to determine if the parcel rate classes are similar. Different rate classes have significant impacts on expected revenue. Under the current fee structure, there are seven rate categories. The first category is for single-family residential parcels. These parcels are charged a flat fee. The remaining rate categories are distinguished by percent impervious surface. Variations in parcel classifications could lead to significant differences in expected revenue.

We completed this analysis by comparing the rate class already listed in the County's data with a calculated rate class from the City that was based on calculated impervious-surface percentages and residential classifications.

Table 2: Parcel Classification Match

City Calc. Rate Class	County Rate Class						
	Residential	**Very Light**	**Light**	**Moderate**	**Moderately Heavy**	**Heavy**	**Very Heavy**
Residential	94.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Very light	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%
Light	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%
Moderate	0.0%	0.0%	0.0%	0.3%	0.1%	0.1%	0.0%
Moderately heavy	0.0%	0.0%	0.0%	0.1%	0.5%	0.3%	0.2%
Heavy	0.0%	0.0%	0.0%	0.1%	0.2%	0.6%	0.8%
Very heavy	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	1.1%

The green highlighted cells in Table 2 show where parcel classifications match. Matches occur for 97.5 percent of data and almost all residential classifications. Classification differences that do exist are a result of different calculated impervious-surface percentages for both data sets.

IMPERVIOUS SURFACE

Although rate classes largely match for both data sets, it is important to analyze impervious-surface data. If the City were to calculate surface water fees using more detailed impervious-surface data, instead of the current bucketed approach, these differences could lead to significant revenue differences. We performed this analysis using both total impervious acreage and percent impervious surface.

Figure 3: Impervious-Surface Analysis

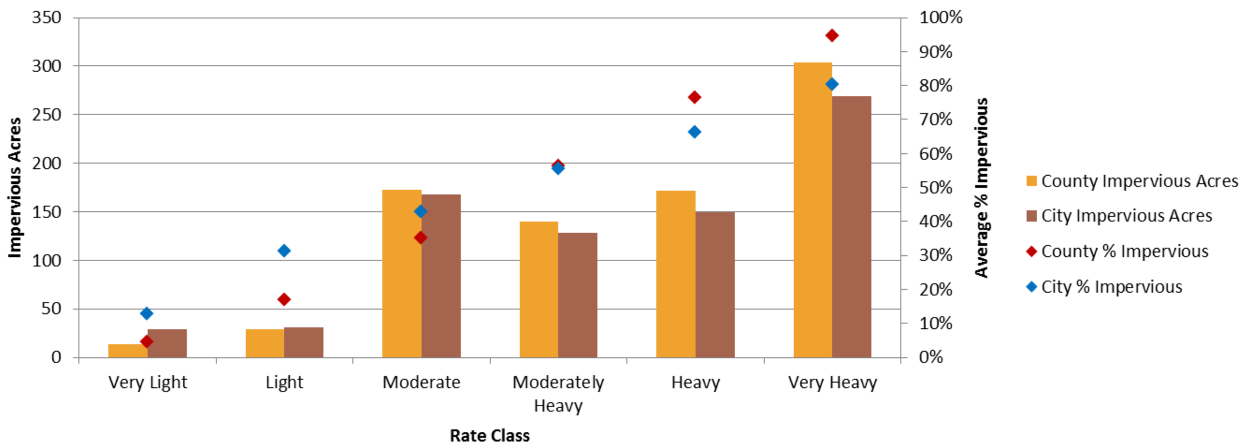


Figure 3 shows the results of this analysis. At the lowest levels of impervious-surface coverage, City data skew slightly higher in both total acreage and average impervious-surface coverage. At higher tiers, this trend flips and the County's data show both higher overall impervious-surface coverage and average rate of impervious-surface coverage. Such a unique trend in the data may mean that the method or data source for initially calculating impervious-surface coverage is different between the two data sets.

Despite these differences, the data remain close. It is currently not possible to monetarily quantify the impact of these differences unless the City adopts a different rate structure outside of the current tiered system used by the County. If the City were to consider a system that uses precise impervious-surface data to calculate a fee (instead of using data to place properties in buckets), these differences could be quantified monetarily.

BILLING

Under the current tiered fee structure, we can compare the calculated rates for both data sets and determine the fiscal impact of one data set over the other.

The challenge in this comparison is that the billing data provided by the County incorporate discounts without expressly naming these discounts. A first glance at the data appears to show that the County undercharges for services. However, removing these discounts and calculating the fee separately for both data sets shows highly similar annual revenue expectations.

Figure 4: Comparing Billing Data

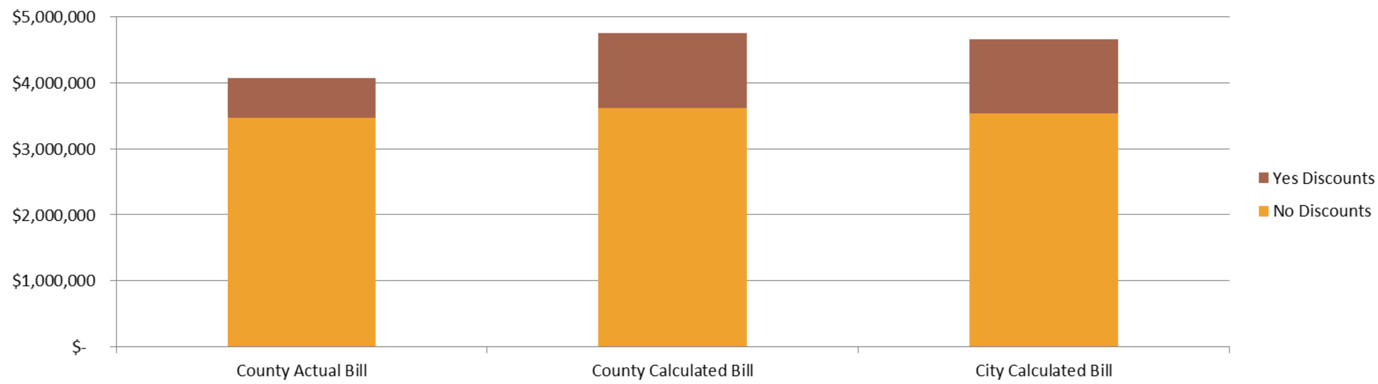


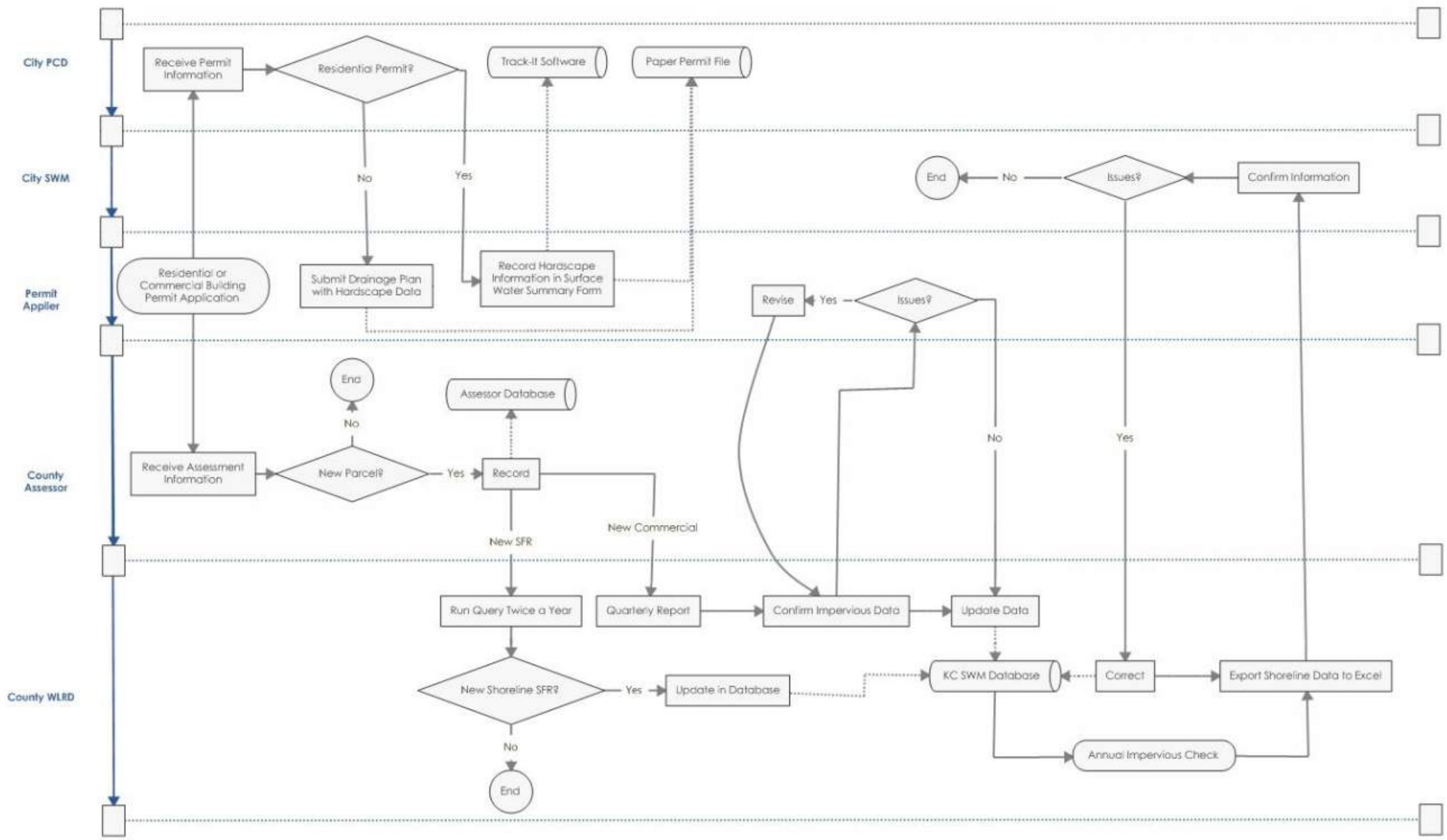
Figure 4 shows three columns. The column on the left shows the actual billed fee revenue as recorded by the County. The other two columns show calculated fees using rate classes for County-only data and City-only data. This figure compares only matching parcel data. Each column comprises billing data with and without discounts.

Differentiating the discounted and non-discounted parcels in the billing data shown in Figure 4 helps to reveal very similar revenue expectations for both data sets. The calculated County annual revenue is approximately $80,000 higher than the City's calculated revenue. This represents approximately 2 percent of total expected revenue.

DATA FLOW

The City and County rely on each other to ensure that surface water data are appropriately updated prior to each billing cycle. Our analysis shows that while there is ample opportunity to share and record updated impervious-surface information, this generally does not occur. Figure 5 shows the current process flow for impervious-surface information for Residential and Commercial building permits.

Figure 5: Impervious-Surface Data Process Flow



PROCESS DESCRIPTION

Updates to hardscape information for a parcel occur when an individual applies for a permit that requires hardscape data inputs. PCD requires hardscape, not impervious-surface, information.

This process generally occurs for a Residential Building or Commercial/Multi-Family Building permit. The individual provides the hardscape data via the permit application. For Residential Building permits, this occurs within the Medium Impact or Small Impact surface water summary forms. For Commercial/Multi-Family Building permits, hardscape data can be found in the individual drainage engineering plans.

The City then records this information via a paper filing system as well as the Track-It software[1]. These data are not subsequently sent to the Surface Water Management group, nor are they sent to the County.

If the permit has relevance to the County Assessor's office, the applier will also send information there. No impervious-surface data are shared through this process. If the permit involves a new parcel (commercial or residential), this information is recorded and eventually sent to the County's Water and Land Resources Division (WLRD).

For new commercial parcels, the WLRD will use existing submitted permit information to confirm impervious surfaces. This information is checked with the applier and corrections are made as necessary. Once confirmed, the information is added to the billing database. For new single-family residential parcels, the WLRD updates its billing database to ensure that these parcels are recorded so they can be billed.

Before billing surface water customers, the WLRD checks with the City to ensure that all impervious-surface and parcel data are correct. Information is submitted via an Excel spreadsheet to the City. The City then has the opportunity to correct any issues it finds. Historically, the City has not used this opportunity to update impervious-surface data.

ISSUES IDENTIFIED FROM PROCESS ANALYSIS

Although there is ample opportunity to collect and share information, impervious-surface data are not currently being updated via information provided to the City. The only form of impervious-surface data updates comes from new parcel information provided by the County. Particular process issues include:

[1] The Track-It software is new and its relationship with hardscape information generally applies to Residential Building permits only. There is a line in the Residential Building permit to include hardscape information. Previously the City used Hansen. Hardscape data were not individually recorded here.

- **Currently collected permit data not used by City:** Although the County requests parcel updates from the City prior to billing, the City does not provide any updates on impervious-surface data.
- **Data gathering does not lend itself to queries:** Even though the City has important information within permits and plans, the information is not currently gathered in a way that would lend itself to simple queries. This is because Commercial/Multi-Family Building permits do not have a field for recording hardscape data within Track-It.
- **Historical data are unused and not readily accessible:** The County updates impervious-surface data for new commercial parcels. Unless construction involves a new parcel, revised impervious-surface data will not have been incorporated into surface water billing. These data may be accessible in physical plans within permits, but this cannot be easily queried.

FINDINGS AND RECOMMENDATIONS

Our analysis of available County and City data reveals no significant differences that would necessarily merit further investigation into missing or inaccurate data. The current level of data discrepancies shows that, at some level, the data sets are different. However, these are predominantly minor and largely explainable.

Further inquiry into detailed impervious-surface data may be warranted if the City decides to change its fee structure in a way that would use the accuracy of impervious-surface coverage information. However, our analysis of available data shows that the City should not expect large differences between the County and City data.

Of greater importance is the ability of the City to check the accuracy of its own data and communicate data updates to the County. There may be a high correlation between County and City data, but this does not mean that the data are accurate.

Improving the internal accuracy of data requires the following two actions:

- **Emphasize stormwater data needs in PCD**: The City should work with PCD to ensure that impervious-surface data needed for billing are collected in a manner that is accurate and easily queried. This requires two steps: (1) ensuring that the appropriate "impervious-surface" data are collected, not just hardscape data, and (2) the City must record updated impervious-surface data within the Track-It system for applicable permits by adding a field in the software as well as implementing a new process so planners know to input this information.
- **Review the accuracy of historical information to perform a business case on further data collection:** Improved planning data help data accuracy only for new projects. Historical inaccuracies may or may not be an issue for the City. Depending on the scale of the issue, and the rate structure ultimately used by the City, the level of effort for correcting historical data may vary. The City should analyze if historical data are at a level of imprecision to warrant new or different historical data collection. This will likely require a high level of effort as historical data for commercial and multi-family residential properties are located within plans, not within Track-It or the prior system, Hansen.

Appendix L: Financial Planning

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City of Shoreline

Surface Water Utility

Financial Analysis for 2018 Master Plan

FINAL REPORT

November 2017

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TABLE OF CONTENTS

Section I. INTRODUCTION

This financial plan is intended to ensure the viability of the surface water management program during the six-year planning period (2018 to 2023). It considers the historical financial condition, current and identified future financial and policy obligations, operations and maintenance needs, and the capital projects identified in the updated Surface Water Master Plan. **Appendix A** presents backup documentation related to this financial plan.

The City's Surface Water Utility (Utility) is responsible for funding all of its costs. The primary source of funding is a surface water fee that is billed on the County property tax statement. Nominal additional revenues are generated through interest earned on reserves. The City controls the level of user charges and, subject to City Council approval, can adjust user charges as needed to meet financial objectives.

The financial plan considers both operating and capital requirements to assess total system cost. This is accomplished through two elements:

- **Capital Funding Analysis**. Identifies the total capital improvement plan (CIP) obligations of the planning period. The plan defines a strategy for funding the CIP including an analysis of available resources from rate revenues, existing reserves, debt financing, and any special resources that may be available (e.g. grants, developer contributions, etc.). The capital funding plan impacts the financial plan through the use of the assumed rate revenue available for capital funding.
- **Financial Forecast**. Identifies future annual non-capital costs associated with the operating, maintenance and administration of the surface water system. Included in the financial plan is a reserve analysis that forecasts cash flow and fund balance activity along with testing for satisfaction of actual or recommended minimum fund balance policies. The financial plan ultimately evaluates the sufficiency of utility revenues in meeting all obligations, including cash uses such as operating expenses, capital outlays, and reserve contributions. The plan also identifies the future adjustments required to fully fund all utility obligations in the projection period.

Section II. Available Capital Funding Assistance and Financing Resources

Long-term capital funding strategies must be defined to ensure that adequate resources are available to fund the CIP identified in this Master Plan. In addition to City resources, capital needs can be met from outside sources such as grants, low-interest loans, and bond financing. The following summarizes internal and external resources available for meeting funding requirements.

CITY RESOURCES

Resources appropriate and available to the City for funding capital needs are limited to rate revenues and accumulated cash (through rates and interest) beyond what is required by the minimum reserve requirements set forth in fiscal policies. The City does not maintain specific capital-related charges such as a General Facilities Charge (GFC) that would provide additional capital resources.

OUTSIDE RESOURCES

Although the City does not have additional internal funding sources, there are grant, loan, and bond opportunities available to fund the CIP identified.

Grants and Low Cost Loans

Historically, Federal and State grant programs assist local utilities for funding capital projects. However, these assistance programs have been mostly eliminated, reduced, or replaced by loan programs. Remaining miscellaneous grant programs are generally lightly funding and heavily subscribed. Major funding sources include:

Department of Ecology Grants and Loans

The Washington Department of Ecology (Ecology) administers an integrated funding program for projects that improve and protect water quality throughout the State. The combined funding cycle generally begins September 1, and applicants must submit the final application by the first week of November. Ecology rates and ranks applications based on the highest-priority needs. Projects include stormwater control and treatment, nonpoint pollution abatement and stream restoration activities, and water quality education and outreach. The amount of available grant and loan funding varies from year to year based on the state's biennial budget appropriation process and the annual congressional federal budget. The sources of funding for water quality projects include:

- Centennial Clean Water Fund State Grant Program
- Clean Water Act Section 319 Federal Grant Program
- Clean Water State Revolving Fund (CWSRF) Loan Program
- Stormwater Financial Assistance Program (SFAP)

Further detail is available at http://www.ecy.wa.gov. The City has received SFAP funding in the past and anticipates further funds from this program in 2018.

King County Flood Reduction Grant[1]

King County's Flood Reduction Grants assist local flood reduction projects. Eligible applicants include cities within King County. Applications are generally due in May there is no cap on the award amount. Total available funding for 2017 was slightly over $3 million.

For more information see http://www.kingcountyfloodcontrol.org/default.aspx?ID=62.

Public Works Trust Fund (PWTF)

Cities, counties, special purpose districts, public utility districts, and quasi-municipal governments are eligible to receive loans from the PWTF. Eligible projects include repair, replacement, and construction of infrastructure for domestic water, sanitary sewer, stormwater, solid waste, road, and bridge projects that improve public health and safety, respond to environmental issues, promote economic development, or upgrade system performance. As of August 2017, the PWTF is not funded through 2019 and is not accepting funding requests.

Further detail is available at http://www.pwb.wa.gov.

Bond Financing

General Obligation Bonds

General Obligation (G.O.) bonds are bonds secured by the full faith and credit of the issuing agency, committing all available tax and revenue resources to debt repayment. With this high level of commitment, G.O. bonds have relatively low interest rates and few financial restrictions. However, the authority to issue G.O. bonds is restricted in terms of the amount and use of the funds, as defined

[1] For more information see http://www.kingcountyfloodcontrol.org/default.aspx?ID=62

by Washington constitution and statute. Specifically, the amount of debt that can be issued is linked to assessed valuation.

RCW 39.36.020 states:

> *"(ii) Counties, cities, and towns are limited to an indebtedness amount not exceeding one and one-half percent of the value of the taxable property in such counties, cities, or towns without the assent of three-fifths of the voters therein voting at an election held for that purpose.*
>
> *(b) In cases requiring such assent counties, cities, towns, and public hospital districts are limited to a total indebtedness of two and one-half percent of the value of the taxable property therein."*

While bonding capacity can limit availability of G.O. bonds for utility purposes, these can sometimes play a valuable role in project financing. A rate savings may be realized through two avenues: the lower interest rate and related bond costs; and the extension of repayment obligation to all tax-paying properties (not just developed properties) through the ad valorem property tax.

It is also possible to use rate revenues to repay G.O. bonds, while retaining the security of the City's taxing power. This practice would still consume statutory G.O. debt capacity. The current financial forecast does not anticipate issuing G.O. bonds.

Revenue Bonds

Revenue bonds are commonly used to fund utility capital improvements. The debt is secured by the revenues of the issuing utility. With this limited commitment, revenue bonds typically bear higher interest rates than G.O. bonds and also require security conditions related to the maintenance of dedicated reserves (a bond reserve) and financial performance (added bond debt service coverage). The City agrees to satisfy these requirements by resolution as a condition of bond sale.

Revenue bonds can be issued in Washington without a public vote. The current financial forecast anticipates issuing revenue bonds to help fund capital projects starting in 2018.

Section III. FINANCIAL FORECAST

The financial forecast, or revenue requirement analysis, forecasts the amount of annual revenue that needs to be generated by user rates to meet the obligations of the Utility. The analysis incorporates operating revenues, operations and maintenance (O&M) expenses, debt service payments, rate-funded capital needs, and any other identified revenues or expenses related to surface water management.

The objective of the financial forecast is to evaluate the sufficiency of the current level of rates. In addition to annual operating costs, the analysis needs to also include any applicable debt covenant requirements and specific fiscal policies and financial goals of the City.

The resulting findings determine the amount of revenue needed in a given year to meet that year's expected financial obligations. For this analysis, two revenue sufficiency tests have been developed to reflect the financial goals and constraints of the City: cash needs and debt coverage. In order to operate successfully with respect to these goals, both tests of revenue sufficiency must be met.

Cash Test

The cash flow test identifies all known cash requirements for the City in each year of the planning period. Typically these include O&M expenses, debt service payments, depreciation funding or directly funded capital outlays, and any additions to specified reserve balances. The total annual cash needs of the City are then compared to projected cash revenues using the current rate structure. Any projected revenue shortfalls are identified and the rate increases necessary to make up the shortfalls are established.

Coverage Test

The coverage test is based on a commitment made by the City when issuing revenue bonds or certain other forms of long-term debt. Debt service coverage is expressed as a multiplier of the annual revenue bond debt service payment. For example, a 1.0 coverage factor would imply that no additional cushion is required. A 1.25 coverage factor means revenue must be sufficient to pay O&M expenses, annual revenue bond debt service, plus an additional 25 percent of that annual revenue bond debt service. The excess cash flow derived from the added coverage, if any, can be used for any purpose, including funding capital projects. Targeting a higher coverage factor can help the City achieve a better credit rating and provide lower interest rates for future debt issues.

In determining the annual revenue requirement, both the cash and coverage sufficiency test must be met and the test with the greatest deficiency drives the level of needed rate increase in any given year.

CURRENT FINANCIAL STRUCTURE

The City maintains a fund structure and implements financial policies that target management of a financially viable and fiscally responsible stormwater system.

Fiscal Policies

Operating Reserves

Operating reserves are designed to provide a liquidity cushion to ensure that adequate cash working capital will be maintained to deal with significant cash balance fluctuations such as unanticipated cash expenses.

The City's current policy is to maintain a minimum balance of 20% of O&M revenues.

We recommend and the study reflects an O&M reserve minimum balance of 120 days. This higher level of reserves is consistent with the risk maintained by the City from receiving surface water fees twice a year coinciding with the payment of property taxes. If the City were to move to a monthly billing system this reserve target could be reduced.

Capital Reserves

A capital contingency reserve is an amount of cash set aside in case of an emergency should the utility have to make an unexpected capital investment. The reserve also is available for other unanticipated capital needs such as cost overruns. Capital reserves are usually calculated as a percentage of fixed asset cost with industry best practice set at around 1 or 2 percent.

We recommend and the study reflects a capital contingency reserve minimum balance of at least 2% of assets, or approximately $450,000. The City has not maintained a separate balance for this purpose.

System Reinvestment

System reinvestment funding promotes system integrity through reinvestment in the system. Target system reinvestment funding levels are commonly linked to annual depreciation expense as a measure of the decline in asset value associated with routine use of the system. The specific benchmark used to set system reinvestment funding targets is a matter of policy that must balance various objectives including managing rate impacts, keeping long-term costs down, and promoting "generational equity" (i.e. not excessively burdening current customers with paying for facilities that will serve a larger group of customers in the future).

Due to the levels of planned capital improvements over the next six years, this study does not separately consider the need for additional, dedicated, system reinvestment.

Capital Funding

The City will use a combination of debt proceeds and rate revenue to fund prioritized capital projects. More specifically, the following funding resources are identified as part of the capital funding strategy:

- Accumulated cash reserves over minimum fund balances
- Annual cash from rates available for rate funded capital
- Interest earned from the available fund balance and other miscellaneous capital resources
- Revenue bond proceeds (as necessary)

Debt Management

Policies related to debt management are important as part of a broader utility financial policy structure. The City already successfully utilizes and manages revenue bonds. This financial analysis models a minimum bonded debt coverage test of 1.5.

Financial Assumptions

The financial forecast is developed from 2017 and 2018 budget documents. This forecast is supported by key factors and assumptions used to develop a complete portrayal of the Utility's annual financial obligations. The following is a list of the key revenue and expense factors and assumptions used to develop the baseline financial forecast:

- **Revenue** - Revenue is broken down in to two sources: revenue from surface water fees (rate revenue) and miscellaneous (non-rate) revenue. Rate revenues can be adjusted to meet annual revenue requirements. Non-rate revenues are not assumed to escalate as they generally comprise of set grants.
- **Growth** - Rate revenue is escalated based on a 0.1 percent customer growth rate. This is based on actual revenue growth seen by the Utility and consistent with the built out nature of the City.
- **Expenses** - O&M expenses are projected based on the 2017 and 2018 budget documents. Expenses are forecasted to increase by factors relevant to their category including labor cost, benefit costs, general costs, and construction cost. One-time expenses are not escalated and other expenses are manually edited based on improved planning data.

  Tax expenses are calculated based on forecasted revenue and prevailing tax rates including the State B&O tax and the City's Utility Tax. Expenses also vary by the management strategies discussed in the next section.
- **Existing Debt** - The City's Surface Water Utility has two sources of existing debt. The first source is a Public Works Trust Fund (PWTF) loan set to be paid in full in 2021. The second is a revenue bond for stormwater pipe replacement set to be completed in 2031.

- **Future Debt** - The capital funding strategy developed for this plan utilizes new revenue bonds to help fund capital needs.
- **Rate Funded Capital** - Funds above the minimum reserve requirements are projected for use in funding capital programs.

Section IV. Management Matrix Analysis

The City considered three management strategies in the financial analysis; minimum, proactive, and optimum. Each management strategy reflects a different suite of programs and projects that allow the City to provide varying levels of service to its customers[2]. These varying programs and projects impact forecasted operating and capital costs and thus necessary rate increases.

It is important to note that these three strategies are a change from Utility's current operating scenario. The three management strategies all account for additional operational and capital expenditures that help better align the Utility to its levels of service.

Utilizing management strategies in the financial analysis allows the City to determine the rate impacts of different service levels. Through discussion with City Council, City staff, and community residents, the Proactive strategy was chosen as the recommended management strategy.

MANAGEMENT STRATEGY OPTIONS

Management strategies differ on two levels:

- **Programs** - Programs are operations and maintenance activities meant to enhance or maintain surface water services. The Minimum strategy utilizes the fewest number of programs and the Optimum strategy the most. Each strategy builds on the next so there are no programs in the minimum strategy that are not also in the Proactive strategy and there are no programs in the Proactive strategy missing from the Optimum strategy.
- **Projects** - Projects are capital investments meant to enhance or maintain surface water services. The three management strategies differ in the number of projects that are assumed to take place in the six year planning horizon. Projects not planned in the six year planning period are assumed to occur between 2024 and 2036.

[2] All management strategies considered allow the City to comply with regulatory requirements

Minimum

The Minimum management strategy is a combination of projects and programs meant to meet the minimum in existing system needs and anticipated new regulatory requirements.

Proactive

The Proactive management strategy adds new high-priority projects and enhanced programs that address high priority long-term needs as well as anticipated new regulatory requirements.

Optimum

The Optimum management strategy adds additional priority projects and programs that focus on enhancements to water quality and aquatic habitat.

MANAGEMENT STRATEGY RESULTS AND SUMMARY

The following table summarizes the annual revenue requirements based on the forecast of revenues, expenditures, fund balances, and fiscal policies for each management strategy.

Table IV-1: Management Strategy Summary

Management Strategy Rate Impact Summary	2017	2018	2019	2020	2021	2022	2023
Minimum							
Proposed Increase	N/A	20.00%	5.00%	5.00%	4.00%	3.00%	3.00%
Resulting Revenue	$4,488,372	$ 5,391,433	$ 5,666,666	$ 5,955,949	$ 6,200,381	$ 6,392,779	$ 6,591,147
Proactive							
Proposed Increase	N/A	27.00%	15.00%	10.00%	10.00%	5.00%	5.00%
Resulting Revenue	$4,488,372	$ 5,705,933	$ 6,568,35	$ 7,232,449	$ 7,963,649	$ 8,370,193	$ 8,797,492
Optimum							
Proposed Increase	N/A	42.00%	20.00%	10.00%	8.00%	5.00%	5.00%
Resulting Revenue	$4,488,372	$ 6,379,862	$ 7,663,490	$ 8,438,269	$ 9,122,444	$ 9,588,145	$ 10,077,620

With the greatest number of programs and projects, the Optimum strategy has the highest annual revenue requirements and thus the largest rate adjustment of the three scenarios. However, all scenarios require increases in annual revenue to meet new, required, expenses as they relate to meeting regulatory requirements and appropriately managing the system.

In all three scenarios, an initial, larger, revenue increase is required in 2018 followed by subsequent smaller increases over the next five years. This is due to increases in operations and maintenance expenses to meet regulatory and basic management requirements for operating the Utility.

These expenses cannot be funded through debt and thus the rate impact cannot be spread out over time. The project team has taken effort to spread costs and delay projects where possible to mitigate initial rate impacts and this is reflected in the above results.

Staff recommends the Proactive management strategy. This strategy allows the City to not only be compliant with permit requirements but also attend to pressing investment needs. The next section goes into detail regarding the recommended funding plan for the Proactive strategy.

Section V. RECOMMENDED FUNDING PLAN (PROACTIVE)

PLAN SUMMARY

The Proactive management strategy includes program and project investments to meet regulatory requirements and address high priority long-term needs of the Utility. There are over $19.5 million in identified capital project costs (in unescalated 2017 dollars) over the six year planning horizon. Projects and costs include:

Table V-1: CIP Cost Summary for Proactive Management Strategy

Project Name	Total CIP Cost from 2018 – 2023 (in 2017 $)
Annual CIP Expenses and Programs	
Surface Water Capital Engineering	$ 1,146,600
Cost Allocation Charges	$ 1,199,754
Stormwater Pipe Replacement Program (Enhanced)	$ 3,814,495
Surface Water Small Projects (Enhanced)	$ 2,400,000
Capacity	
25th Avenue NE Flood Reduction and NE 195th Street Culvert Replacement Design	$ 2,674,000
Springdale Ct. NW and Ridgefield Rd. Drainage Improvements	$ 545,000
10th Ave NE Stormwater Improvements	$ 1,788,000
Heron Creek Culvert Crossing at Springdale Ct. NW	$ 226,000
25th Ave NE Ditch Improvements Between NE 177th and 178th Street	$ 141,000
6th Ave NE and NE 200th St Flood Reduction Project	$ 22,000
NE 148th Street Infiltration Facilities	$ 393,000
Stormwater Upgrades NW 196th Street	(delayed past 2023)
NW 195th Place and Richmond Beach Drive Flooding	$ 747,000
Stabilize NW 16th Place Storm Drainage in Reserve M	$ 28,000
Flood Reduction in Linden Avenue Neighborhood	(delayed past 2023)
Culvert Improvements Near 14849 12th Avenue NE	(delayed past 2023)
18th Avenue NW and NW 204th Drainage System Connection	$ 15,000
NW 197th Pl and 15th Ave NW Flooding	$ 7,000

Project Name	Total CIP Cost from 2018 – 2023 (in 2017 $)
Lack of System and Ponding on 20th Avenue NW	$ 81,000
26th Avenue NE Flooding and Lack of System Study	(delayed past 2023)
NE 192nd St Ditch Modifications	(delayed past 2023)
NW 194th Place and 25th Ave NW Ditch Erosion	(delayed past 2023)
Repair and Replacement	
Hidden Lake Dam Removal	$ 2,097,000
Pump Station 26 Improvements	$ 320,000
Pump Station 30 Upgrades	$ 90,000
Pump Station Misc Improvements	$ 732,000
NW 196th Place and 21st Avenue NW Infrastructure Improvements	$ 83,000
NE 177th Street Drainage Improvements	$ 9,000
NW 180th and 8th Avenue Ditch with Unknown Connection	(delayed past 2023)
Other	
Master Plan Update	$ 500,000
Boeing Creek Regional Stormwater Facility	$ 83,000
System Capacity Modeling Study	$ 300,000
Storm Creek Erosion Management Study	$ 80,000
Climate Impacts and Resiliency Study	$ 80,000
Convert Stormwater Conveyance Ditches to Bio-infiltration Facilities	(delayed past 2023)
Boeing Creek Restoration Pre-design Feasibility Study	$ 50,000
Echo Lake Biofiltration Swale	(delayed past 2023)
12th Ave NE Infiltration Pond Retrofits	$ 38,000
Bioretention at N 199th St and Wallingford Avenue NE	(delayed past 2023)
Bioretention at NE 192nd St and Burke Ave NE	(delayed past 2023)
Hamlin Creek Daylighting	(delayed past 2023)
Thornton Creek Course-Grained Sediment Improvements	(delayed past 2023)
Enhance Ronald Bog Wetland Fringe Areas	(delayed past 2023)
Westminster Triangle Bioinfiltration Facility	(delayed past 2023)
Total for 2018 – 2023	**$ 19,689,849**

The costs from **Table V-1** shows unescalated project costs. All costs are escalated to the projected year of construction in the analysis. Four projects are delayed past the planning period but may occur sometime after 2023. “CIP Related Expenses” reflect general costs to providing the CIP program and include ongoing system investment such as the “Stormwater Pipe Replacement Program”. “Current Improvement Projects” are projects already listed in prior versions of the City’s CIP. “New Improvement Projects” reflect work identified as part of the updated master planning process.

These total costs are spread over each year depending on the size of the project and the project phase. The below table shows total CIP costs by year in 2017 and inflated values.

Table V-2: Capital Costs by Year

Year	2017 $	Inflated $
2018	$ 1,575,518	$ 1,622,784
2019	2,521,323	2,674,872
2020	3,096,062	3,383,150
2021	3,170,456	3,568,377
2022	2,853,565	3,308,064
2023	6,472,925	7,729,011
Subtotal	**$ 19,689,849**	**$ 22,286,257**
2024 – 2036	58,616,342	86,134,881
Total 2018 – 2036	**$ 78,306,191**	**$ 108,421,138**

In addition to updated CIP costs, the Proactive management strategy contains a number of programs that impact operating costs.

Table V-3: Additional Programmatic Operational Costs for Proactive Management Strategy

Proactive Management Strategy (Escalated Program Costs)	2018	2019	2020	2021	2022	2023
Aquatic Habitat Studies (Not Funded)						
Catch Basin Repair and Replacement	$ 354,100	$ 54,100	$ 354,100	$ 354,100	$ 354,100	$ 354,100
Pump Station Maintenance	63,600	63,600	63,600	63,600	63,600	63,600
LID Maintenance	53,732	53,732	53,732	53,732	53,732	53,732
Utility Crossing Removal	18,400	18,400	18,400	18,400	18,400	18,400
Improper Connection Repair (Not Funded)						
Pipe Condition Assessment Program	160,340	160,340	160,340	160,340	160,340	160,340
Asset Management Program (Enhanced)	69,200	69,200	69,200	69,200	69,200	69,200
Private Facility Inspection and Maintenance (Enhanced)	62,192	62,192	57,341	52,868	48,745	44,943
System Inspection (Enhanced)	47,021	47,021	47,021	47,021	47,021	47,021
Drainage Assessment (Enhanced)	175,640	175,640	175,640	175,640	175,640	175,640
Stormwater Permit	47,840	47,840	47,840	47,840	47,840	47,840
NPDES Compliance (Enhanced)			32,480	32,480	32,480	32,480
Thornton Creek Stewardship (Not Funded)						
Business Inspection Source Control			86,780	86,780	86,780	86,780
Water Quality Monitoring (Enhanced)	85,470	85,470	85,470	85,470	85,470	85,470
O&M for Proactive CIP	33,867	33,867	33,867	33,867	33,867	33,867
Total Unescalated Program Expenditures:	**1,171,402**	**1,171,402**	**1,285,811**	**1,281,338**	**1,277,215**	**1,273,412**
Total Escalated Program Expenditures	*1,200,687*	*1,230,704*	*1,384,678*	*1,414,358*	*1,445,051*	*1,476,768*
Total Escalated Remaining O&M Expenses	*3,579,659*	*3,661,954*	*3,742,840*	*4,023,316*	*4,115,923*	*4,211,053*
Total O&M Expenditures (Escalated)	**$4,780,346**	**$4,892,658**	**$5,127,517**	**$5,437,674**	**$5,560,974**	**$5,687,821**

These programs, as identified in **Table V-3**, are in addition to existing O&M expenses that increase over time at varying rates. The Proactive management strategy's programs initially add over 30% to baseline O&M costs. These additional programs cannot be financed through debt, increasing initial rate adjustment requirements.

CAPITAL FINANCING STRATEGY

The capital costs described in **Table V-2** are funded via a mix of fund balances (above minimum requirements), debt, and approved grants. Since it costs the City money and time to issue debt, a debt issuance strategy of only issuing debt once every three years (as necessary) is used. This is a more realistic methodology than issuing debt every year. Grant funding is not assumed unless it is already approved. Thus, grant funding plays a small role in overall capital financing though it may have a larger role if future grants are received.

Table V-4: Capital Financing Summary

Capital Fund Summary	2018	2019	2020	2021	2022	2023
Funds Available for Capital	**$ 1,207,123**	**$ 4,821,000**	**$2,486,142**	**$ 584,362**	**$ 9,323,518**	**$ 7,163,005**
Capital Revenues:						
Operating Surplus	-	315,909	1,468,939	454,610	1,100,934	1,376,809
Grants / Outside Sources	530,625	-	-	-	-	-
Net Debt Proceeds Available	4,700,000	-	-	11,850,000	-	-
Interest Earnings	6,036	24,105	12,431	2,922	46,618	35,815
Total Capital Revenues and Available Funds	**$ 6,443,784**	**$ 5,161,014**	**$ 3,967,512**	**$ 12,891,894**	**$ 10,471,070**	**$ 8,575,629**
Capital Project Expenditures	*$ (1,622,784)*	*$ (2,674,872)*	*$(3,383,150)*	*$(3,568,377)*	*$(3,308,064)*	*$(7,729,011)*
Ending Capital Balance	**$ 4,821,000**	**$ 2,486,142**	**$ 584,362**	**$ 9,323,518**	**$ 7,163,005**	**$ 846,618**
Minimum Target	*$ 463,258*	*$ 516,755*	*$ 584,418*	*$ 655,786*	*$ 721,947*	*$ 876,264*

Table V-4 shows the balance between grants, funds, and debt for financing capital projects. Since the City does not have separate funds for Capital and Operating expenses, the “Funds Available for Capital” at the top of the table is not reflective of the total fund balance available to the City. Rather, it is reflective of the available Capital funds after appropriate operations reserves are taken out.

The “Minimum Target” at the bottom of the table reflects the capital reserve target discussed earlier of 2% of assets. Debt issuances and the use of fund balances reflects a strategy to smooth rate increases, reduce the number of debt issuances, and balance the use of debt and rate funding for capital projects.

The capital financing strategy shows two necessary debt issuances; one in 2018 of $4.7 million and one in 2021 of $11 million. After these debt issuances, there is an influx of available funds for use in capital projects. These funds are reduced until the next debt issuance. By the end of the planning period (2023), remaining balances are approximately equal to the minimum target of 2% asset value.

FUNDS AND RESERVES

The issuance of additional debt in 2018 and 2021 increases annual debt service payments. It also adds a reserve funding requirement for the new debt. Increased rate revenue to cover new and increasing operational and capital expenditures increases the tax burden on the Utility. As shown in **Table V-5**, this leads to an overall operational cash requirement (outside of Capital requirements) that begins at $5.8 million in 2018 and grows to over $9.3 million in 2023.

Table V-5: Funds and Reserves Analysis

Total Expenses and Transfers	2018	2019	2020	2021	2022	2023
Cash Operating Expenses	$4,780,346	$4,892,658	$5,127,517	$5,437,674	$5,560,974	$5,687,821
Existing Debt Service	491,355	489,724	488,091	486,459	158,351	158,351
New Debt Service	377,376	377,376	377,376	1,328,845	1,328,845	1,328,845
Additional Taxes After Rate Increase	90,980	155,327	204,795	259,297	289,450	321,159
Transfer of Surplus to Capital	-	315,909	1,468,939	454,610	1,100,934	1,376,809
Total Cash Requirement	**$5,740,058**	**$6,230,994**	**$7,666,719**	**$7,966,886**	**$8,438,555**	**$8,872,985**

The additional operational costs and capital investments also increase the relative reserve requirements for the Utility. These are shown in **Table V-6** alongside the ending fund balance for each year. Fund balances increase with the issuance of debt (years 2018 and 2021) but fall towards minimum balances as funds are used for capital projects.

Table V-6: Fund Balance Analysis

	2018	2019	2020	2021	2022	2023
Operating Reserve (120 – 150 Days O&M)	$1,571,621	$1,638,457	$1,736,826	$1,855,058	$1,913,514	$1,965,130
Capital Reserve (2% Asset Value)	463,258	516,755	584,418	661,571	724,753	876,264
New Debt Reserve Requirement	377,376	377,376	377,376	1,328,845	1,328,845	1,328,845
Total Fund Balance Requirement	$2,412,255	$2,532,588	$2,698,620	$3,845,474	$3,967,112	$4,170,239
Beginning Fund Balance	$3,090,142	$6,788,321	$4,911,589	$3,650,033	$12,507,421	$10,405,365
Operating Revenues	5,824,359	6,689,119	7,355,474	8,085,118	8,497,011	8,924,602
Cap. Rev. (Grants, New Debt, Interest)	5,236,661	24,105	12,431	11,852,922	46,618	35,815
Less Operating Expenditures	*(5,740,058)*	*(5,915,085)*	*(6,197,779)*	*(7,512,275)*	*(7,337,621)*	*(7,496,177)*
Less Capital Expenditures	*(1,622,784)*	*(2,674,872)*	*(3,383,150)*	*(3,568,377)*	*(3,308,064)*	*(7,729,011)*
Available Ending Fund Balance	**$6,788,321**	**$4,911,589**	**$2,698,564**	**$12,507,421**	**$10,405,365**	**$4,140,593**

Section VI. CURRENT AND PROJECTED RATES

Analysis shows the need for rate increases in the Proactive management strategy as follows.

Table VI-1: Projected Percentage Rate Increases

Rate Increase Summary	2017	2018	2019	2020	2021	2022	2023
Annual Rate Increases		27.0%	15.0%	10.0%	10.0%	5.0%	5.0%
Cumulative Rate Increases		27.0%	46.1%	60.7%	76.7%	85.6%	94.8%
Single Family Annual Bill	$ 168.81	$ 214.38	$246.54	$ 271.19	$ 298.31	$ 313.23	$ 328.89
Increase over prior year		$ 45.58	$ 32.16	$ 24.65	$ 27.12	$ 14.92	$ 15.66

Table VI-1 reflects the need for the highest increase in 2018 with gradually smaller increases in later years. For single family residences, this reflects an increase in the annual surface water charge from $168.81 in 2017 to $347.95 by 2023.

The complete, updated, rate schedule by year reflects the same percentage increases for every customer type.

Table VI-2: Recommended Rate Schedule

Recommended Rate Schedule		Existing w/ Tax						
		2017	2018	2019	2020	2021	2022	2023
Service Charge:	Unit							-
Single Family Residential	Parcel	$168.81	$214.38	$246.54	$271.19	$298.31	$313.23	$328.89
Very Light	Parcel	168.81	214.38	246.54	271.19	298.31	313.23	328.89
Light	Acre	392.06	497.92	572.61	629.87	692.85	727.50	763.87
Moderate	Acre	809.98	1,028.67	1,182.97	1,301.27	1,431.40	1,502.97	1,578.11
Moderately Heavy	Acre	1,570.94	1,995.10	2,294.36	2,523.80	2,776.18	2,914.98	3,060.73
Heavy	Acre	1,990.22	2,527.58	2,906.72	3,197.39	3,517.13	3,692.99	3,877.64
Very Heavy	Acre	2,606.90	3,310.76	3,807.38	4,188.12	4,606.93	4,837.27	5,079.14
Minimum Rate	n/a	168.81	214.38	246.54	271.19	298.31	313.23	328.89

VI.A. 2024 – 2036 REVENUE REQUIREMENT DISCUSSION

Capital Improvement estimates show a sustained increase in capital investments from 2024 through 2036. This increase currently results in an average of over $3 million annually in additional capital expenditures as compared to the current six-year spending average.

If cost estimates remain unchanged, the City may require higher rate increases in 2024 and 2025 (12% and 9% respectively) before gradually reducing back to inflationary increases. These increases are contingent on the capital costs and schedules remaining as currently estimated.

Section VII. Conclusion

The City examined three management strategies in the financial analysis. Each analysis considered all funding resource options, the Utility's financial policies and targets, and current operating needs. All strategies were developed such that they comply with permit obligations.

The Proactive strategy adds new, high-priority, projects and programs and is the recommended management strategy.

All management strategies require rate increases; in particular a higher increase in 2018 followed by smaller increases through 2023. These increases are related to higher O&M obligations of new programs. The Proactive management strategy is recommended because it meets permit obligations and funds many high-priority needs but does not require the same level of investment as the Optimum strategy.

It is important that the City revisit the proposed rates annually to ensure that the rate projections developed remain adequate. Any significant changes should be incorporated into the financial plan and future rates should be adjusted as needed.

The City should take extra consideration of improved capital cost estimates and scheduling in the 2024 – 2036 planning period. While the current rate forecast plans for an increase in capital expenditures through this period, changes to costs and schedules will be important to incorporate.

RECOMMENDATIONS

- Adopt rate structure presented for the Proactive management strategy
- Revise City "CIP Model" to include updated reserve requirements including:
  - 120 days of O&M expenses minimum operating reserve balance
  - 2% of assets minimum capital reserve balance
- Review rates and current operational and capital needs annually
  - This is especially important due to the planned implementation of asset management strategies that may lower operating costs
- Conduct new financial analysis in five years to assure projected rates are in line with Utility expenses

Section VIII. Appendix A: Rate Model Results

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City of Shoreline

Utility Rate Study: Stormwater

Summary - Draft Results (showing Proactive Management Strategy)

High Level Summary	2017	2018	2019	2020	2021	2022	2023
Annual Rate Increases	0.00%	27.00%	15.00%	10.00%	10.00%	5.00%	5.00%
Operating Fund							
Beginning Balance	$ 1,200,000	$ 1,505,644	$ 1,589,945	$ 2,048,071	$ 1,736,826	$ 1,855,058	$ 1,913,514
Total Operating Revenues	4,655,270	5,824,359	6,689,119	7,355,474	8,085,118	8,497,011	8,924,602
Total Operating Expenditures & System Reinvestn	(4,156,721)	(5,740,058)	(5,915,085)	(6,197,779)	(7,512,275)	(7,337,621)	(7,496,177)
Operating Surplus: Transfers to Capital Fund	(192,906)	-	(315,909)	(1,468,939)	(454,610)	(1,100,934)	(1,376,809)
Cash Surplus / (Deficiency)	305,644	84,302	458,125	(311,245)	118,233	58,456	51,616
Ending Fund Balance	**$ 1,505,644**	**$ 1,589,945**	**$ 2,048,071**	**$ 1,736,826**	**$ 1,855,058**	**$ 1,913,514**	**$ 1,965,130**
Capital Fund							
Beginning Balance	$ 2,280,660	$ 1,207,123	$ 4,821,000	$ 2,486,142	$ 584,362	$ 9,323,518	$ 7,163,005
Total Capital Inflows	686,309	5,236,661	340,014	1,481,370	12,307,532	1,147,552	1,412,624
Total Capital Expenditures	(1,759,846)	(1,622,784)	(2,674,872)	(3,383,150)	(3,568,377)	(3,308,064)	(7,729,011)
Cash Surplus / (Deficiency)	(1,073,537)	3,613,877	(2,334,858)	(1,901,780)	8,739,155	(2,160,512)	(6,316,387)
Ending Fund Balance	**$ 1,207,123**	**$ 4,821,000**	**$ 2,486,142**	**$ 584,362**	**$ 9,323,518**	**$ 7,163,005**	**$ 846,618**
	-	-	-	-	-	-	-
	-	-	-	-	-	-	-

City of Shoreline

Utility Rate Study: Stormwater

Summary - Draft Results (showing Proactive Management Strategy)

Operating Fund Summary	2017	2018	2019	2020	2021	2022	2023
Summary of Existing Operations Before Rate Increases							
Rate Revenues Under Existing Rates	$ 4,488,372	$ 4,492,861	$ 4,497,354	$ 4,501,851	$ 4,506,353	$ 4,510,859	$ 4,515,370
Non-Rate Revenues	166,898	118,426	120,735	123,025	121,469	126,818	127,110
Total Revenues	4,655,270	4,611,287	4,618,088	4,624,876	4,627,822	4,637,677	4,642,480
Total Expenditures	(4,156,721)	(5,649,077)	(5,759,758)	(5,992,985)	(7,252,978)	(7,048,171)	(7,175,017)
Cash Surplus / (Deficiency)	**$ 498,549**	**$ (1,037,790)**	**$ (1,141,670)**	**$ (1,368,108)**	**$ (2,625,156)**	**$ (2,410,494)**	**$ (2,532,538)**
Revenues After Rate Increases							
Rate Revenues (Before Rate Increases)	$ 4,488,372	$ 4,492,861	$ 4,497,354	$ 4,501,851	$ 4,506,353	$ 4,510,859	$ 4,515,370
Additional Revenue from Rate Increases	-	1,213,072	2,071,031	2,730,598	3,457,296	3,859,334	4,282,122
Other Revenues & Interest	166,898	118,426	120,735	123,025	121,469	126,818	127,110
Total Revenues With Rate Increases	$ 4,655,270	$ 5,824,359	$ 6,689,119	$ 7,355,474	$ 8,085,118	$ 8,497,011	$ 8,924,602
Expenses & Transfers							
Cash Operating Expenses	$ 3,663,733	$ 4,780,346	$ 4,892,658	$ 5,127,517	$ 5,437,674	$ 5,560,974	$ 5,687,821
Existing Debt Service	492,988	491,355	489,724	488,091	486,459	158,351	158,351
New Debt Service	-	377,376	377,376	377,376	1,328,845	1,328,845	1,328,845
Additional Taxes After Rate Increase	-	90,980	155,327	204,795	259,297	289,450	321,159
Transfer of Surplus to Capital	192,906	-	315,909	1,468,939	454,610	1,100,934	1,376,809
Total Expenses	$ 4,349,627	$ 5,740,058	$ 6,230,994	$ 7,666,719	$ 7,966,886	$ 8,438,555	$ 8,872,985
Additions / (Subtractions) to Operating Fund Bal	**305,644**	**84,302**	**458,125**	**(311,245)**	**118,233**	**58,456**	**51,616**
Impacts to Operating Fund Balance							
Beginning Operating Balance	$ 1,200,000	$ 1,505,644	$ 1,589,945	$ 2,048,071	$ 1,736,826	$ 1,855,058	$ 1,913,514
Net Cash Flow After Transfers to Capital	305,644	84,302	458,125	(311,245)	118,233	58,456	51,616
Ending Operating Balance	$ 1,505,644	$ 1,589,945	$ 2,048,071	$ 1,736,826	$ 1,855,058	$ 1,913,514	$ 1,965,130
Minimum Operating Balance Target	*$ 1,204,515*	*$ 1,571,621*	*$ 1,638,457*	*$ 1,736,826*	*$ 1,855,058*	*$ 1,913,514*	*$ 1,965,130*
Net Cash Flow After Rate Increase	**498,549**	**84,302**	**774,034**	**1,157,694**	**572,843**	**1,159,390**	**1,428,425**
Coverage After Rate Increase: Bonded Debt	**6.33**	**1.79**	**3.11**	**3.80**	**1.61**	**1.81**	**1.98**
Coverage After Rate Increase: Total Debt	**2.03**	**1.10**	**1.92**	**2.35**	**1.32**	**1.81**	**1.98**
Sample Residential Monthly Bill [a]	**$168.81**	**$ 227.25**	**$ 261.33**	**$ 287.47**	**$ 316.21**	**$ 332.02**	**$ 348.62**
[a] Including City Utility Tax							
	-	-	-	-	-	-	-

City of Shoreline

Utility Rate Study: Stormwater

Summary - Draft Results (showing Proactive Management Strategy)

Capital Fund Summary	2017	2018	2019	2020	2021	2022	2023
Beginning Capital Balance	**$ 2,280,660**	**$ 1,207,123**	**$ 4,821,000**	**$ 2,486,142**	**$ 584,362**	**$ 9,323,518**	**$ 7,163,005**
Capital Revenues:							
Rate Funded System Reinvestment							
Minimum Policy	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Operating Surplus	192,906	-	315,909	1,468,939	454,610	1,100,934	1,376,809
Total	$ 192,906	$ -	$ 315,909	$ 1,468,939	$ 454,610	$ 1,100,934	$ 1,376,809
Grants / Outside Sources	482,000	530,625	-	-	-	-	-
Net Debt Proceeds Available for Projects	-	4,700,000	-	-	11,850,000	-	-
Interest Earnings	11,403	6,036	24,105	12,431	2,922	46,618	35,815
Total Capital Revenues and Beginning Fund Bal	$ 2,966,969	$ 6,443,784	$ 5,161,014	$ 3,967,512	$ 12,891,894	$ 10,471,070	$ 8,575,629
Capital Project Expenditures	$ (1,759,846)	$ (1,622,784)	$ (2,674,872)	$ (3,383,150)	$ (3,568,377)	$ (3,308,064)	$ (7,729,011)
Ending Capital Balance	**$ 1,207,123**	**$ 4,821,000**	**$ 2,486,142**	**$ 584,362**	**$ 9,323,518**	**$ 7,163,005**	**$ 846,618**
Minimum Target	*$ 430,802*	*$ 463,258*	*$ 516,755*	*$ 584,418*	*$ 655,786*	*$ 721,947*	*$ 876,527*
	-	-	-	-	-	-	-

Ending Fund Balances	2017	2018	2019	2020	2021	2022	2023
Operating Fund	$ 1,505,644	$ 1,589,945	$ 2,048,071	$ 1,736,826	$ 1,855,058	$ 1,913,514	$ 1,965,130
Capital Fund	1,207,123	4,821,000	2,486,142	584,362	9,323,518	7,163,005	846,618
Debt Reserve Fund	-	377,376	377,376	377,376	1,328,845	1,328,845	1,328,845
	$ 2,712,766	**$ 6,788,321**	**$ 4,911,589**	**$ 2,698,564**	**$ 12,507,421**	**$ 10,405,365**	**$ 4,140,593**
Operating Reserve: Minimum Days of O&M	*120 days*	*120 days*	*120 days*	*120 days*	*120 days*	*120 days*	*120 days*
Operating Reserve: Actual Days of O&M	*150 days*	*119 days*	*148 days*	*119 days*	*119 days*	*119 days*	*119 days*
Capital Fund Minimum Target	$ 430,802	$ 463,258	$ 516,755	$ 584,418	$ 655,786	$ 721,947	$ 876,527

City of Shoreline

Utility Rate Study: Stormwater

Summary - Draft Results (showing Proactive Management Strategy)

Debt Management	2017	2018	2019	2020	2021	2022	2023
Debt Service Coverage							
Bonded Debt	6.33	1.79	3.11	3.80	1.61	1.81	1.98
All Debt	2.03	1.10	1.92	2.35	1.32	1.81	1.98
Debt Service ÷ Rate Revenues	11%	15%	13%	12%	23%	18%	17%
Debt to Fixed Assets	20%	41%	33%	27%	64%	56%	43%
Formula: Outstanding Debt Principal ÷ Book Value of Plant-in-Service (Original Cost - Accumulated Depreciation)							
Outstanding Debt Principal							
Existing Debt Balance	$ 3,958,848	$ 3,518,746	$ 7,603,756	$ 6,979,284	$ 6,344,996	$ 17,116,308	$ 16,336,207
plus: New Debt Issued	-	4,700,000	-	-	11,850,000	-	-
less Debt Principal Paid Off	$ (440,103)	$ (614,989)	$ (624,472)	$ (634,288)	$ (1,078,688)	$ (780,102)	$ (809,057)
Total Outstanding Debt Principal	$ 3,518,746	$ 7,603,756	$ 6,979,284	$ 6,344,996	$ 17,116,308	$ 16,336,207	$ 15,527,149
Book Value							
Book Value	n/a	$ 17,540,583	$ 18,681,531	$ 20,842,348	$ 23,658,192	$ 26,591,851	$ 29,194,264
Original Cost Plant in Service	19,780,260						
Accumulated Depreciation	(3,552,730)						
plus: Capital from CIP	1,759,846	1,622,784	2,674,872	3,383,150	3,568,377	3,308,064	7,729,011
less: Annual depreciation	(446,793)	(481,836)	(514,054)	(567,306)	(634,717)	(705,652)	(771,367)
Original Asset Cost Net of Depreciation	$ 17,540,583	$ 18,681,531	$ 20,842,348	$ 23,658,192	$ 26,591,851	$ 29,194,264	$ 36,151,907

Rate Increase Summary	2017	2018	2019	2020	2021	2022	2023
Annual Rate Increases		27.0%	15.0%	10.0%	10.0%	5.0%	5.0%
Cumulative Rate Increases		27.0%	46.1%	60.7%	76.7%	85.6%	94.8%
Single Family Annual Bill	$ 168.81	$214.38	$246.54	$271.19	$298.31	$313.23	$328.89
		$45.58	$32.16	$24.65	$27.12	$14.92	$15.66

The City of Shoreline Civic Center, which includes the City Hall building at 17500 Midvale Avenue N, provides approximately 66,400 square feet of office space where governmental services are available. These services include, but are not limited to, customer response, administration, permitting, environmental and human services, road and park maintenance, and neighborhood coordination. The campus also includes a 21,000 square foot auditorium, a 75 car elevated parking structure, and a one-acre public park and plaza.

In addition, the City owns and maintains approximately 28,765 square feet of facilities to support the park system, including the Spartan Recreation Center, the Shoreline Pool, the Richmond Highlands Recreation Center, Kruckeberg Botanic Garden, the Richmond Beach Saltwater Park Pedestrian Bridge, numerous park shelters, and outdoor restrooms.

The City operates a maintenance facility at Hamlin Park, located at 16006 15th Avenue NE. This location serves as a storage yard for various City vehicles, including a street sweeper and road maintenance equipment, as well as offices for street and park maintenance crews. The City is evaluating the relocation and expansion of this facility as part of possible utility acquisitions.

Stormwater Facilities

The Surface Water Master Plan, adopted in 2018 ~~2011~~, provides a detailed discussion of the stormwater facilities in Shoreline. The plan responds to both state and federal requirements for managing surface water in the city. The plan reviews current and anticipated regulatory requirements, discusses current stormwater management initiatives, identifies flooding and water quality programs, and discusses the resources needed for the City to fully implement the plan. Management of surface waters in the city is funded through the City's Surface Water Utility. The plan also provides a detailed inventory of the existing stormwater facilities and necessary capital facility upgrades.

Transportation Facilities

The Transportation Master Plan, adopted in 2011, and Transportation Element of this Plan provide a detailed discussion of the transportation facilities in Shoreline. The City prepares and adopts a six-year Transportation Improvement Plan (TIP) each year. The TIP lists street and non-motorized projects, and can include both funded and unfunded projects. It is prepared for transportation project scheduling, prioritization, and grant eligibility purposes.

Parks and Recreation Facilities

There are a number of public parks and recreation facilities within the community. These facilities are discussed in more detail in the 2011-2017 Parks, Recreation, and Open Space Plan and Parks, Recreation, and Open Space Element of this Plan.

Current Police Facilities

The Police Station was built in 1956 and purchased by the City shortly after incorporation in 1995. The Station is located at 1206 N 185th Street. The building is 5,481 square feet, and is constructed of unreinforced masonry that has not been retrofitted to earthquake standards. In 2012, the City initiated a facility feasibility study to analyze potential locations of a new facility. This need was identified during the City's 2009 Hazard Mitigation Planning effort.