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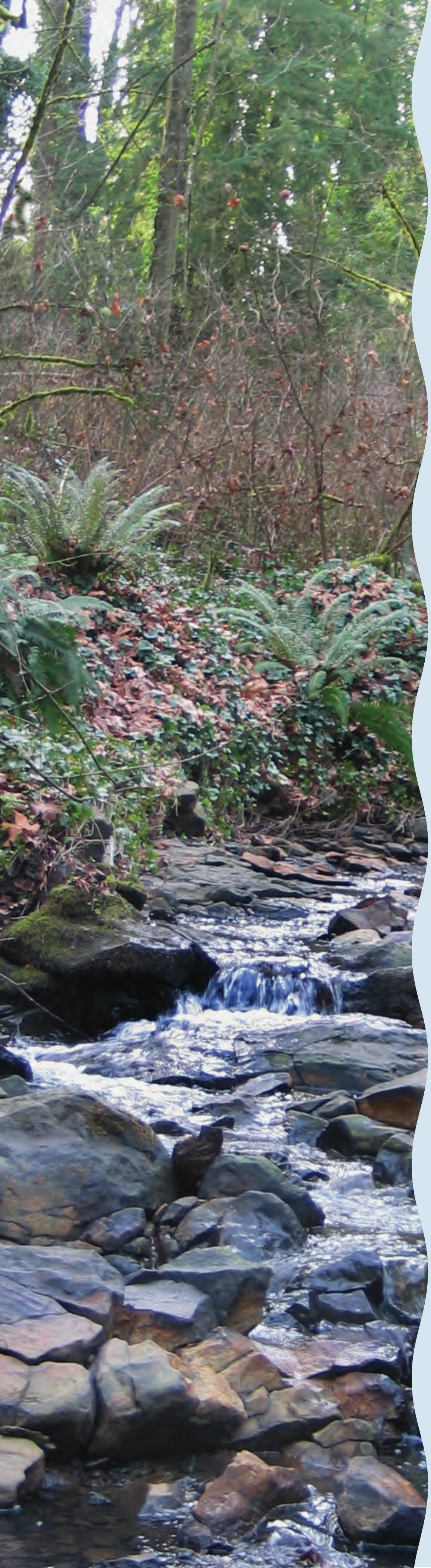

Stephens Creek Stormwater System Plan

January 2013

ENVIRONMENTAL SERVICES
CITY OF PORTLAND
working for clean rivers

DAN SALTZMAN, COMMISSIONER • DEAN MARRIOTT, DIRECTOR

CITY OF PORTLAND
ENVIRONMENTAL SERVICES
1120 SW Fifth Avenue, Room 1000, Portland, Oregon 97204 ▪ Dan Saltzman, Commissioner ▪ Dean Marriott, Director

January 2013

RE: Stephens Creek Stormwater System Plan

Dear Readers,

The Bureau of Environmental Services is pleased to publish the Stephens Creek Stormwater System Plan. It is the result of a multi-year pilot to analyze and put forth recommendations to improve both stormwater infrastructure and watershed health conditions in the Stephens Creek watershed. We are excited to report that the exercise was successful and that the lessons learned will inform the citywide approach to stormwater system planning.

While Portland emphasizes managing stormwater at the source, Stephens Creek and conditions in southwest Portland challenge this approach. A system perspective is necessary to characterize overall condition and performance in order to tailor stormwater improvements and requirements to meet system needs. This approach will apply to other parts of the city where different challenges exist, and it will inform the next Stormwater Management Manual update.

Understanding that the health and growth of our community depends on infrastructure, our charge is to find ways stormwater infrastructure can serve multiple functions and benefits. Infrastructure that filters, collects, conveys, and discharges stormwater is a visible part of our community, and its appearance contributes to the character of an area. Rather than burying stormwater and sending the problems downstream, we benefit by exposing it to air and plants, allowing it to recharge groundwater, and create spaces that support parks, transportation and other community needs.

Broad and complex interests have a stake in the stormwater system. This is reflected in the wide array of professionals who made this plan possible, as well as the number of partners needed to implement the recommendations. It is ultimately shaped by decisions regarding how we best use and maintain our land. A long-term commitment to coordination and collaboration are keys to success, with public agencies and private property owners working side by side.

Building on a rich and successful history, the Stephens Creek Stormwater System Plan is one step in an exciting journey. Looking forward, I invite you to stay involved and help define the next generation of innovative, cost-effective solutions. If you have questions or need more information, please call me at 503-823-0050 or email me at dawn.uchiyama@portlandoregon.gov.

Sincerely,

Dawn Uchiyama, Landscape Architect
Stormwater System Program Manager

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Stephens Creek
Stormwater System Plan

FINAL REPORT

JANUARY 2013

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Acronyms and Abbreviations

BDS	Bureau of Development Services
BEHI	bank erosion hazard index
BES	Bureau of Environmental Services
cfs	cubic feet per second
CIP	capital improvement program
CSO	combined sewer overflow
DEQ	Oregon Department of Environmental Quality
FY	Fiscal Year
GIS	geographical information system
LID	local improvement district
LOS	levels of service
MS4	Municipal Separate Storm Sewer System
NPDES	National Pollutant Discharge Elimination System
NPW	net present worth
O&M	operation and maintenance
ODFW	Oregon Department of Fish and Wildlife
ODOT	Oregon Department of Transportation
PAWMAP	Portland Area Watershed Monitoring and Assessment Program
PBOT	Portland Bureau of Transportation
PP&R	Portland Parks and Recreation
PWMP	Portland Watershed Management Plan
PWQI	Portland Water Quality Index
SCSWSP	Stephens Creek Stormwater System Plan
SWMM	Stormwater Management Manual
UIC	Underground Injection Control

Key Terms and Definitions

Asset Management: The combination of management, financial, economic, engineering, and other practices applied to physical assets with the objective of providing required levels of service in the most cost-effective manner. It includes the management of the whole life cycle (design, construction, commissioning, operating, maintaining, repairing, modifying, and decommissioning) of physical and infrastructure assets.

Drainageway: A drainageway is an open linear depression, whether constructed or natural, that functions for the collection and drainage of surface water. It may be permanently or temporarily inundated, act as a headwater or tributary to a larger drainage system, and may be present as a distinct channel tributary. Natural seeps, springs, or wetlands where subsurface waters come to the surface are not considered drainageways unless they are part of a conveyance carrying waters across a property.

Drainage Reserve: A drainage reserve is a portion of property set aside to protect the functional flow values of a drainageway. This reserve is identified during the development review process and is legally reserved as a no-build area on the building permit or application. Previous rules and City Code called this a drainageway easement.

Fragipan: A subsurface soil layer that restricts water flow and root penetration. Infiltration rates are generally very low in areas where fragipan layers exist, as is the case in most of the Stephens Creek watershed.

HEC-20: A qualitative geomorphic analysis described in the Federal Highway Administration HEC-20 document (Stream Stability at Highway Structures).

High Pulse Count: Number of times in a year that the daily time step hydrograph rises above 2 times the annual mean flow

High Pulse Range: The range in days within a water year between the start of the first high flow pulse and the end of the last high flow pulse.

Local Improvement District: A method by which a group of property owners can share in the cost of infrastructure improvements. Most LIDs involve improving a street, building sidewalks, and installing a stormwater management system.

Neighborhood Facility: A stormwater management facility that serves multiple properties and/or blocks of right-of-way. It is smaller than a typical end-of-pipe regional stormwater facility, yet larger than a typical single-lot or green street facility. Neighborhood facilities can be located in the right-of-way, but due to their larger size will more often be located on a parcel of land. The term “parcel-based” facility is sometimes used instead of neighborhood facilities.

Seven-day Annual Minima: Seven-day average minimum flow rate for each calendar year, as the percent of the predeveloped flow rate.

Shared Facility: A detention and/or pollution reduction facility of any size that mingles stormwater from multiple private and/or public properties.

Stormwater Retrofit: Construction or expansion of a stormwater management facility to provide stormwater detention and/or pollution reduction from existing impervious surface.

Stormwater System: The network of built and natural assets which convey concentrated stormwater through a watershed. This includes pipes, gutters, ditches, drainageways, and natural channels. The stormwater system includes assets owned by the Bureau of Environmental Services, and also assets on private property or owned by other agencies.

Street by Street Initiative (also known as Performance Based Streets and Up Out of the Mud): A Portland Bureau of Transportation program which will modify street standards for some undeveloped streets with low traffic counts. The intent is to provide lower cost street designs appropriate for low traffic streets with narrow rights-of-way.

Acknowledgments

This plan acknowledges the hard work and commitment of countless people who have contributed to the City of Portland's innovative stormwater programs and policies over the past two decades. Without their efforts this plan would not be possible. A special thanks to Virgil Adderley, Asset System Management Division Manager and Lana Danaher, System Development Division Manager for their constant support and guidance throughout the development and implementation of this plan.

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Executive Summary

This report presents the analyses and recommendations of the Stephens Creek Stormwater System Plan. The purpose of the plan is to articulate a strategic approach to address stormwater system needs in the Stephens Creek watershed and to serve as a basis for future stormwater system planning, especially on Portland's westside. This plan presents an integrated approach to stormwater management that prioritizes projects and activities to protect, improve, and maintain stormwater infrastructure and watershed health conditions as measured by established levels of service.

The stormwater system relies on both natural and engineered infrastructure, and affects the interests of a wide range of stakeholders. Most stormwater infrastructure in place today was built before there were clear standards for protecting public health and safety or watershed health. Now, stormwater planning and management must comply with local building codes and state and federal regulations including the National Pollutant Discharge Elimination System Municipal Separate Storm Sewer System Discharge Permit, the Water Pollution Control Facility Underground Injection Control Permit, and the Endangered Species Act. In addition, because stormwater management facilities are generally visible in the landscape, their design can influence the way the city looks, and, if well done, can provide benefits beyond stormwater management and significantly contribute to community livability.

Portland is a recognized leader for on-site stormwater management policies and practices; however, much of Portland's westside challenges this approach. In many areas, infiltration is limited, site conditions are constrained, and public stormwater infrastructure is substandard. In many cases, natural and private drainageways serve as the infrastructure to convey stormwater to streams and other surface waterbodies. These circumstances, combined with significant impacts from urban development, alter the hydrology, water quality, habitat, and biological communities of these natural systems.

The conditions in the Stephens Creek watershed clearly illustrate the challenges. Infiltration is not a viable stormwater management approach in roughly two-thirds of the basin. Nearly five miles of unimproved right-of-way and over five hundred properties do not have an approvable stormwater discharge point for new or redevelopment. Water quality, as measured by Portland Water Quality Index, is poor due to E. coli concentrations and runoff from I-5 and other high volume transportation corridors. Bank stability is a concern for protection of a sanitary sewer trunk line which runs parallel to the creek. Many outfalls that discharge directly to the stream lack adequate energy dissipation. Stream hydrology is altered, as characterized by high pulse counts and high pulse ranges, which are now more frequent and extend well into the summer season. These flow pulses wash out insects and other biological communities, conditions confirmed by scores that rate the stream's biotic integrity as poor. Fish surveys have not located any resident fish populations in Stephens Creek or its tributaries; however, the confluence with the Willamette River is an important refuge for juvenile salmon migrating through the Portland urban area. The confluence provides important habitat, and upper stream conditions shape the conditions there. In-stream, near-bank, and riparian habitat conditions range from optimal to poor with upper reaches of the stream ranked mostly poor,. Most riparian areas in the watershed are severely impacted by non-native and invasive plants.

Within these complex conditions, existing development is underserved, and new development is delayed or halted, due to lack of an approvable stormwater discharge point or an affordable path forward. The bottom line is that stormwater system needs on Portland's westside are many, but resources are limited. This situation calls for innovative solutions and a clear investment strategy to make incremental improvements over time.

This plan puts forth an integrated funding strategy that phases and prioritizes both capital and operating investments to address infrastructure needs and restore impaired watershed assets. Operating investments include certain policy, program, and operating activities that, combined with capital investments, address unmet system needs. Capital investments include shared public and private neighborhood-scale stormwater management facilities and more context-sensitive, affordable stormwater conveyance improvements in the right-of-way, as well as select habitat enhancement projects.

Specifically, improvements are recommended in three phases and a set of early actions. Early actions include the development of a centralized database to house stormwater related complaints, additional E. coli investigations, and programmatic efforts to build institutional and private partnerships.

Phase 1 (fiscal year [FY] 2014–2018) is to: repair and enhance select city-owned stormwater outfalls on tributaries of Stephens Creek; construct three regional detention and pollution reduction facilities in the headwaters of the watershed; and retrofit several public right-of-way stormwater management facilities to address high-priority system needs. The total estimated cost for Phase 1 is $3,960,000.

Phase 2 (FY 2015–2019) is to: partner with Oregon Department of Transportation to build shared detention and pollution reduction facilities; restore habitat on Stephens Creek tributaries in areas where opportunities have been identified; and implement projects to mitigate stormwater runoff from existing impervious surfaces on private property. The total estimated cost for Phase 2 is $4,100,000.

Phase 3 (FY 2018–2022) is to enhance and potentially daylight headwater streams and replace the Macadam Avenue culvert. The total estimated cost for Phase 3 is $6,400,000.

This plan relies on integrating the values and principles of engineering and watershed science and proposes a new program to support and expand this integration. Moving forward, the Stormwater System Program will serve as a nucleus for stormwater policy and strategic direction, and will support and maintain the shared and distributed ownership of stormwater work throughout the Bureau of Environmental Services. It will apply asset management principles to identify and manage the greatest stormwater system risks, focus on facilitating transparent and collaborative decision making, and will contribute to ensuring compliance with federal and state regulations.

Finally, perhaps one of the most important outcomes of this effort is to acknowledge the roles of private and institutional properties in the stormwater system. The Bureau of Environmental Services does not own the stormwater system in its entirety and must rely on successful partnerships to build and maintain a functioning system. This plan proposes to strengthen relations with partners like the Oregon Department of Transportation, the Portland Bureau of Transportation, and Portland Parks and Recreation in order to jointly assess system needs and opportunities. It also recommends a focused public outreach effort that addresses the role of private property in the conveyance network and in meeting other system needs.

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CHAPTER 1

Introduction

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1 Introduction

This chapter describes the scope and structure of the SCSWSP pilot project and outlines the relationship of the project to broader city planning efforts.

1.1 Purpose of Plan

This report summarizes the conditions, analysis, and recommendations for the Stephens Creek Stormwater System Plan (SCSWSP) pilot project. Its purpose is to characterize conditions and prioritize recommended City of Portland Bureau of Environmental Services (BES) projects and activities that will protect, improve, and maintain stormwater infrastructure and watershed conditions associated with stormwater management so that established levels of service (LOS) are met.

This SCSWSP final report articulates a strategic approach to stormwater infrastructure planning in the Stephens Creek watershed and suggests an approach that may be appropriate for many areas on the westside of Portland where infiltration is limited and site conditions are constrained. It emphasizes increased cohesion and coordination between work groups and applies asset management principles to mitigate risk and support transparent decision making.

The following program goals established at the outset of the SCSWSP informed the project approach:

- Develop an overall strategic approach to stormwater infrastructure planning that can be applied in southwest and, as feasible, citywide.
- Integrate goals of the Portland Watershed Management Plan (BES, 2012a) into stormwater infrastructure planning.
- Coordinate across all affected work groups within BES as well as across bureaus, especially Portland Bureau of Transportation (PBOT) and Portland Parks and Recreation (PP&R).
- Apply asset management principles.
- Address LOS criteria and unmet system needs in the plan area.
- Create a usable plan that identifies and prioritizes stormwater projects in the Stephens Creek watershed and provides the basis for related budget requests, both operating and capital.
- Comply with all stormwater regulations, especially the National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) Discharge Permit and the Water Pollution Control Facility Underground Injection Control (UIC) permit.

1.2 Project Context

The SCSWSP is part of a broader suite of BES planning activities. The relationship of the SCSWSP to other planning activities is described here.

1.2.1 System Planning

The BES System Plan identifies and prioritizes investments needed to improve and maintain its wastewater and stormwater infrastructure for the purposes of protecting and improving human and environmental health and meeting regulatory requirements. It consists of several individual components, including the Combined Sewer System Plan, the Sanitary Sewer System Plan, the Sewer Rehabilitation Plan, and the Stormwater System Plan.

Related to the System Plan is the BES Public Facility Plan (PFP), which includes major capital investment recommendations for both sanitary and stormwater infrastructure. The PFP is a component of the City of Portland's state-mandated Comprehensive Plan and was last updated in 1999. The PFP is currently being updated in conjunction with the Comprehensive Plan update and it will also inform future stormwater system planning work.

To date, system planning has focused on the needs of the combined and sanitary sewer system. With major combined sewer overflow (CSO) milestones met, BES is prepared to address other infrastructure needs.

BES is a recognized national leader in stormwater management, and, over the past two decades, stormwater facility planning has successfully responded to an array of regulatory requirements including but not limited to flooding, reducing CSOs, and protecting surface water and groundwater.

BES plans to create a citywide Stormwater System Plan to coordinate and prioritize stormwater infrastructure work based upon LOS, develop more integrated responses to regulatory requirements, and describe system conditions more completely in a variety of city planning and investment efforts. The SCSWSP pilot project is the first step in development of the citywide Stormwater System Plan.

Because stormwater management relies on both natural and engineered systems, responsibility spans many work groups. Stormwater management is important to both watershed and infrastructure planning efforts and therefore it is necessary to describe the relationship of the stormwater system planning to watershed planning.

1.2.2 Watershed Planning

Watershed planning occurs at a range of scales. The Portland Watershed Management Plan (adopted in 2005, updated in 2012) is a citywide policy document that defines watershed goals and overarching strategies to improve environmental health. The first strategy is stormwater management. The Portland Watershed Management Plan acknowledges that stormwater is fundamental to improving hydrologic function and watershed health. It recommends that stormwater management approaches focus on achieving increased infiltration, retention and detention, treating stormwater pollutants and separating stormwater flows from the combined sewer system.

Watershed planning also occurs at the basin scale. BES has four Watershed Management Teams (Willamette, Johnson Creek, Columbia Slough and Tryon/Fanno) that have created individual watershed plans with detailed basin characterizations and project-specific recommendations to improve watershed health. Many of the recommendations involve stormwater management and mitigation.

The Willamette Watershed team prepared the *Stephens Creek Subwatershed Improvement Strategies Report* in 2009 (BES, 2009a). It included a characterization, geographical information system (GIS) analysis and field assessments that identified and prioritized project-specific opportunities to improve watershed conditions.

1.3 Project Overview

The SCSWSP includes relevant stormwater information from the *Stephens Creek Subwatershed Improvement Strategies Report*, but adds more in-depth characterization of the stormwater system. It focuses on customer service needs and utilizes more detailed modeling and analysis tools for the basin characterization. Alternative solutions were developed and evaluated to address deficiencies of the system. Alternative evaluation prioritized projects and programs based on LOS that mitigate the highest risk in the system.

The Stephens Creek watershed (Figure 1-1) has a separated storm sewer system that drains to Stephens Creek. It was selected as a pilot because there are a number of BES projects and studies in the basin, relating to stormwater, sanitary sewer and watershed health in general. Many opportunities and constraints found in Stephens Creek are also found in other Portland watersheds. Some identified opportunities and constraints include:

- Managing stormwater from existing development, especially from public right-of-way
- Inadequate service (lack of an approvable discharge point) for some new development and redevelopment sites
- Poorly infiltrating soils
- Seasonally high groundwater
- Streets and private property subject to landslide and flooding risks
- Streams, drainages, and riparian land located on private property
- Pipeline capacity, deficiencies and structural failure risk
- Sensitive receiving waters and biotic communities
- Modified sediment transport and delivery processes relative to pre-developed conditions, included a changed balance of degradation and aggradation
- Opportunities for beneficial groundwater recharge
- An on-going need to protect and maintain city investments in infrastructure and natural area restoration
- Future monitoring and reporting requirements to gauge the impact of actions taken as result of the plan

This pilot aids in developing a larger stormwater strategy that can be applied to much of the west side and other parts of the city as appropriate.

The following goals informed SCSWSP recommendations and were used to structure the alternatives evaluation process:

- Goal 1: Stormwater is managed to minimize risk to stream corridors, habitat, biological communities, and human health.
- Goal 2: Stormwater is managed to minimize risks to property and infrastructure.
- Goal 3: Stormwater is managed to minimize risks to community safety and livability.

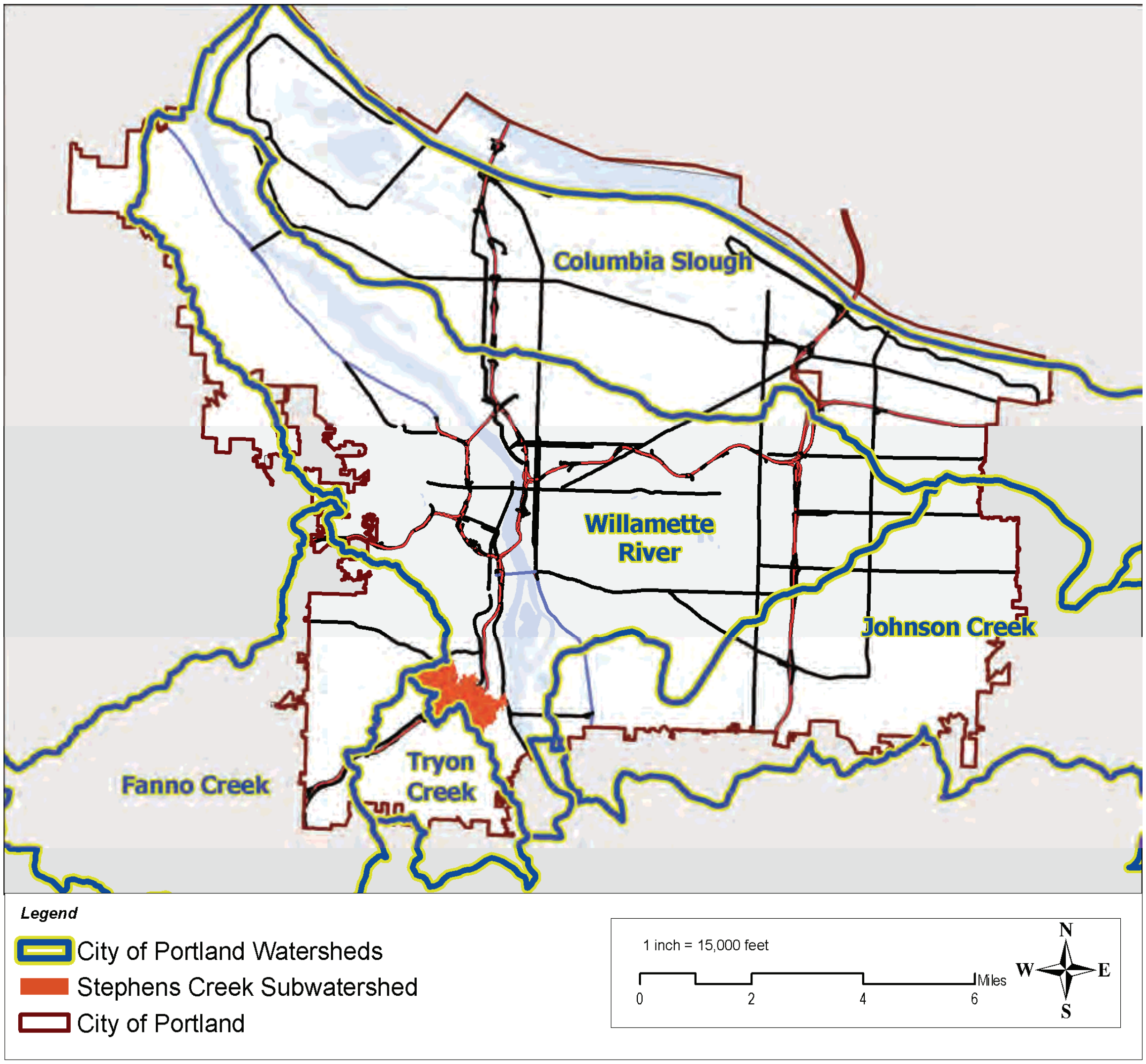

Figure 1-1
Location Map

1.3.1 Levels of Service

In order to establish the scope and priorities of this pilot project, LOS were developed for the Stephens Creek stormwater system. LOS is an asset management term that is commonly defined as an agreement between a utility and its customers based on the type and quality of service it will provide. Where possible, LOS are presented as specific, measurable actions to be achieved either now or at some date in the future.

Project staff across BES contributed to the development of the Stephens Creek LOS, including Asset Systems Management, Watershed Services, Grey to Green Program, Portland Harbor, Engineering Services, Maintenance Engineering, and Materials Testing Lab. This ensured that a comprehensive view was taken of the stormwater system services, that BES goals for providing these services were included and documented, and that the end-product was in line with the BES mission and strategic plan.

The Stephens Creek LOS were structured to highlight fundamental services provided by the stormwater system. For the purposes of this SCSWSP, a fundamental service is defined as "a publicly desired function performed by the city, which has a consequence on assets, either owned or stewarded." Functions were identified for each fundamental service. These functions were related to the watershed goals adopted in the 2005 Portland Watershed Management Plan—hydrology, physical habitat, water quality, and biological communities.

Table 1-1 lists the sixteen fundamental LOS developed for the Stephens Creek stormwater system. Draft performance measures and targets were also developed for each LOS (see *TM 2.3 Levels of Service for Stephens Creek* for more detail). The LOS were central to implementation of the pilot project because they organized the content of basin characterization (see Chapter 2), directed alternative development, and served as the basis for development of objectives to evaluate alternatives and help formulate the preferred alternative (see Chapter 3).

Table 1-1
Stephens Creek Stormwater System Plan Level of Service

Identification Number*	Title	Description
Hydrology and Hydraulics		
A1	Provide Stormwater Infrastructure	Provide adequate infrastructure for stormwater runoff for existing development with no current stormwater system, as well as new development and redevelopment, both public and private
A2	Conveyance System Capacity	Manage ditches, stormwater pipes, and publicly managed culverts (road drainage only—not streams) to convey the design storm as per the *Sewer and Drainage Facilities Design Manual* (BES, 2011a)
A4	Outfall Energy Dissipation	Adequate energy dissipation occurs at outfalls
B1	Hydrologic Indicators of Stream Health	Discharges to natural streams are managed to support healthy streams
G1	Prevent Flood Hazards	Prevent property damage within flood hazard areas up to the base flood elevation plus 2 feet of freeboard as per City Code Chapter 24.50
G2	Protect Public Infrastructure	Protect public infrastructure along stream corridors during flow events up to the 100-year storm
Water Quality		
E2	Total Maximum Daily Load	Meet U.S. Environmental Protection Agency (EPA) approved Total Maximum Daily Load (TMDL) Load Allocations (LAs) and Waste Load Allocations (WLAs)
E4	Portland Water Quality Index	Stormwater runoff is managed to meet the targeted Portland Water Quality Index (PWQI) score (or Oregon Water Quality index, if PWQI is unavailable)
F1	Temperature Water Quality Standard	Water temperature in natural channel streams meets applicable standards for salmon and trout spawning, rearing and migration
Stream Condition, Habitat, and Biological Communities		
B5	Wetland Function	Maintain or improve hydrologic connectivity, floodplain function, and nutrient cycling functions of existing wetlands

Table 1-1
Stephens Creek Stormwater System Plan Level of Service

Identification Number*	Title	Description
F2	Native Fish and Macroinvertebrates	Support the persistence and potential population productivity of native fish and aquatic wildlife associated with X stream; use in conjunction with F3
F3	In-stream Habitat Conditions	Provide desired in-stream habitat conditions established individually for each basin and each habitat element; use in conjunction with F2
F6	Riparian Vegetation	Reduce occurrence of non-native plants that are known to have a detrimental effect on hydrology, water quality, stream and riparian habitats
F7	Off-Channel Connectivity	Provide hydraulic connectivity, flood storage opportunities, and off-channel habitat in floodplain areas associated with Stephens Creek where appropriate or applicable within the system
F8	Sediment Delivery	Protect or restore natural sediment delivery processes that are supportive of system appropriate stream channel conditions for biological communities
F10	Hydraulic Conditions Support Fish Passage	Meet the necessary hydraulic conditions to assure the potential for fish-passage for determined species and life stages at culverts located in identified fish bearing reaches of streams, for a range of low to high flows during fish bearing seasons; subject to the natural constraints of the system

*Identification numbers established during development of the Stephens Creek Pilot Project LOS are provided for cross reference with supporting technical memoranda, corresponding basin condition assessments described in Chapter 2, and the development of SCSWSP objectives explained in Chapter 3.

The foundation for the LOS work was a literature review, the results of which are described in TM 2.1 Literature Review Results (BES, 2010). For more detail on the process used to develop the LOS see TM 2.2a Levels of Service (BES, 2010). For more detail on specific levels of service, refer to *TM 2.3 Levels of Service for Stephens Creek Subwatershed* (BES, 2011b).

1.3.2 Scope of Work

The Stephens Creek Pilot Project was launched November 2009. The scope established that the project would integrate watershed health goals into stormwater infrastructure planning (BES, 2009b). In the spring of 2011, after developing draft stormwater LOS and preparing to begin characterization work, a course correction was adopted to clarify the project scope and revise the structure to ensure successful integration between work groups (BES, 2011c). A project charter was adopted (BES, 2011d) and the project was restructured according to the following tasks:

- Task 1 Project Management
- Task 2 Asset Management
- Task 3 Data Management
- Task 4 Characterization
- Task 5 Alternative Development
- Task 6 Alternative Evaluation
- Task 7 Recommended Plan

Work plans were created for Tasks 2, 4, 5, and 6 (BES, 2011e; BES, 2011f; BES, 2012b; BES, 2012c), which when combined with the previous documents referenced above defined the complete scope of work for the project.

Planning Approach

In order to inform the project work plan and meet the project schedule, the project team incorporated the following planning cycle business processes, with limitations as noted.

- **Planning Level Analysis**: The pilot developed planning level recommendations that will included feasibility screening. The pilot did not complete the level of analysis necessary for a BES predesign, such as constructability, utility conflicts or permitting obligations.
- **Project Alternatives**: All alternatives developed in this pilot addressed each LOS to some degree. As a baseline, each alternative provided a plan to provide adequate infrastructure for stormwater runoff from existing development with no current stormwater system, as well as from new development and redevelopment, both public and private.
- **Asset Management and Decision Making Process**: A long-term goal of stormwater system planning is to apply asset management principles to assess business risk . Although BES completed a risk assessment in the late 1990s that focused on the consequence of failure related to stormwater maintenance activities, a complete risk analysis for the stormwater system has not yet been completed. In the absence of a risk analysis, the SCSWSP used relative ranking (multi-attribute utility analysis) and other tools to evaluate and select alternatives. The task of assessing and putting a dollar value on risk in the stormwater system will be pursued on a parallel track with the intention of integrating these ideas into future stormwater system planning work.
- **Capital Improvement Program (CIP) Requirements:** Although the SCSWSP also included operating project recommendations, capital project recommendations will be informed by the BES Implementation Procedures for Capital Projects.
- **Public Involvement**: Because this was an internal pilot project, no formal public involvement was included in the scope of this project. At the request of a few neighborhood transportation committees, the project manager did provide project updates with the commitment to return to report on the pilot results and establish a more formalized public involvement process for future stormwater system planning projects.

1.3.3 Team Structure and Decision Making

The SCSWSP project was assigned to the Asset System Management (ASM) Division with the ultimate responsibility assigned to the ASM Division Manager, Virgil Adderley. The project was managed by a Core Team with task lead assignments distributed across several work groups as shown in Table 1-2.

Table 1-2
Core Team

Task	Task Lead, Work Group
Task 1 Project Management	Dawn Uchiyama, System Development
Task 2 Asset Management	Alicia Lanier, ASM
Task 3 Data Management	Arnel Mandilag, ASM

Table 1-2
Core Team

Task	Task Lead, Work Group
Task 4 Characterization	Naomi Tsurumi, Watershed Services
Task 5 Alternative Development	John Burns, ASM
Task 6 Alternative Evaluation	Kristen Acock, Watershed Services
Task 7 Recommended Plan	Dawn Uchiyama, System Development

Core Team members were responsible for project management and leading their assigned tasks with support from the Technical Task Team. In addition to the Core Team and Technical Task Team, critical resources and additional areas of expertise were needed to successfully execute the project (see Table 1-3). With this wider range of professional disciplines and skill sets, the project more accurately defined level of service deficiencies and developed a broad range of integrated solutions.

Table 1-3
Project Teams

Team	Responsibilities	Resources
Technical Task Teams	Research, propose and execute task assignments. Support task leads. Meet regularly.	Mary Bushman, Dave Whitaker, Binhong Wu, Marc Peters, Greg Savage, Dan Ashney, and others as needed
ASM and WS Program Managers	Manage staff resources assigned to project and attend Advisory Team meetings	Ning Mao, Paul Ketcham
Advisory Team	Track project progress and provide project guidance from BES/citywide stormwater perspective. Meet regularly.	Tim Kurtz, Frank Wildensee, Dawn Sanders, Lester Lee, Elisabeth Reese Cadigan, Andi Gresh, Dan Layden, Dan Vizzini, Amber Clayton, Ericka Koss, Ning Mao, Paul Ketcham
Management Team	Provide management oversight and project sponsorship. Meet monthly.	Jane Bacchieri, Mike Rosen, Linda Dobson, Bill Ryan, Virgil Adderley, Gary Irwin

The project structure provides decision making authority to resolve technical issues at the team level. Table 1-4 outlines the types of decisions anticipated in this project and assigns responsibility. The most frequent decisions are made at the task level. These decisions are made by the task teams with direction from the task lead. If a decision impacted more than one task, it was made by consensus with the project manager and Core Team members.

Direction from the Advisory Team was necessary when decisions affected existing BES programs or policies. Other topics were brought before the Advisory Team for guidance based on consultation with the Project Manager. Direction from the Management Team was necessary when policy decisions were needed, or when the Advisory Team or Core Team could not reach consensus. Other topics were brought to the Management Team for decision based on consultation with the Project Manager.

If necessary, the Management Team deferred decisions to BES's Bureau Leadership Team (BLT). The decision-making process did not always follow the process specified in Table 1-4. However, every effort was made to make decisions at the appropriate level.

Table 1-4
Decision Making Authority

Project Entity	Decision Authority
Management Team	Decisions affecting direction of project
Advisory Team	Decisions affecting existing programs and policies
Project Manger/Core Team	Decisions affecting multiple tasks
Technical Task Teams	Technical or task-level decisions

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CHAPTER 2

Stephens Creek Watershed Characterization

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2 Stephens Creek Watershed Characterization

This chapter provides an overview of relevant information about the Stephens Creek watershed study area and summarizes the characterization of basin conditions as they pertain to the SCSWSP LOS outlined in Table 1-1. Characterization results were evaluated to identify stormwater system deficiencies and establish guidance for focused development of viable alternatives that address stormwater issues in the study area, as discussed in the conclusion to this chapter.

2.1 Overview

A summary of existing conditions within the watershed and creek is presented here.

2.1.1 Study Area Definition

Stephens Creek begins at a steep ridge south of the Hillsdale Neighborhood center and flows about 2 miles to the Willamette River just north of the Sellwood Bridge. Its drainage area, the Stephens Creek watershed, includes 754 acres (approximately 1 square mile) of southwest Portland. The watershed is mostly residential neighborhoods but also includes the commercial areas around the Burlingame Fred Meyer store, part of the Interstate 5 (I-5) corridor, and the SW Taylors Ferry Road canyon (Figure 2-1).

2.1.2 Land Use

Residentially zoned land comprises nearly two-thirds of the watershed (68%). Lands zoned as open space and for a variety of commercial uses make up the remaining portion of the watershed (21% and 11%, respectively). Open space is primarily located in the southern portion of the watershed, mostly south of SW Taylors Ferry Road. Smaller areas of open space occur around I-5 and in the northwestern portion of the watershed. Residential land use is distributed throughout the watershed. Commercial areas are concentrated near I-5 and SW Barbur Boulevard.

2.1.3 Topography

The terrain throughout the basin ranges from moderately sloped to steep. The average ground slope for the entire basin is about 11% and ranges from 1% to 53%. The average stream centerline slope for Stephens Creek mainstem is about 5% and ranges from about 0.5% to 25%.

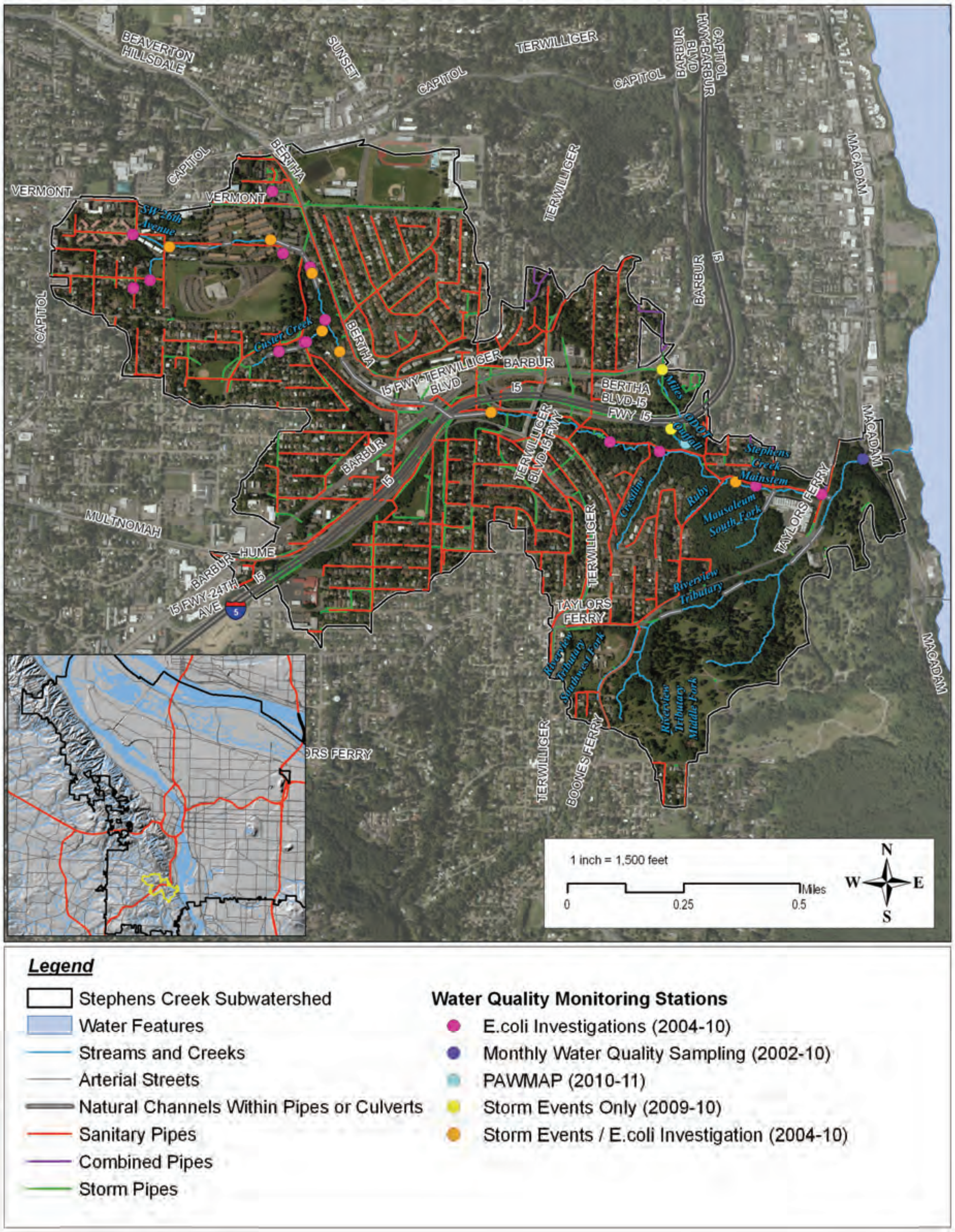

Figure 2-1
Stephens Creek Watershed Overview

A typical description of a Stephens Creek cross section downstream of the I-5 culvert is a V-shaped, canyon-like valley form where the creek has cut down to bedrock, and the streambed contains boulders and cobbles with some pockets of gravels and sands. In plan view, meandering is very limited, being constrained by resistant canyon walls. Flood plains tend to be small, linear, and bounded by the canyon walls and the stream channel.

2.1.4 Geology and Soils

The geology and soil properties produce a basin morphology of broad, rolling ridge tops and convex hillsides that descend into steep lower canyons. The majority of the watershed is set upon basalt or siltstone formations that are often covered in loess (fine wind-blown silt) with an average depth that ranges from 3 to 10 feet. Typically, between soil depths of about 2 to 3 feet, there is a hard-clay fragipan. The soils have low permeability and high runoff potential. Loess, like all forms of silt, has very low infiltration rates compared to sands and gravels. When saturated it does not release its pore water pressure easily, becomes weakened and is therefore prone to erosion or mass wasting. Near the confluence with the Willamette River, geology of the watershed consists of recent alluvium deposited during flooding of the Willamette River.

Known landslide locations can be found throughout the watershed, concentrated along the north side of I-5. Historic landslide deposits are present in the eastern portion of the watershed around the Mausoleum Tributary. Landslide risk areas are present north and south of I-5 and along SW Macadam Avenue near the mouth of Stephens Creek (Figure 2-2).

Since the 1940s the watershed has been urbanized, changing watershed characteristics through increased impervious surface, road cuts, slope stabilization, and other activities. While the basin may have reached a state of relative stability after the major landuse changes of the past several decades, it should be noted that stable channel form is not an indicator of broader watershed health.

2.1.5 Groundwater

Little is known about groundwater in the Stephens Creek watershed. Perched groundwater is commonly encountered within interbeds of the loess deposit or perched on top of the very low permeability residual soil of the weathered basalt and siltstone. Springs are common in the watershed and are often seasonal. Regional groundwater levels are mapped at elevations of greater than 50 feet below ground level except in the lower reaches of the watershed near the confluence with the Willamette River.

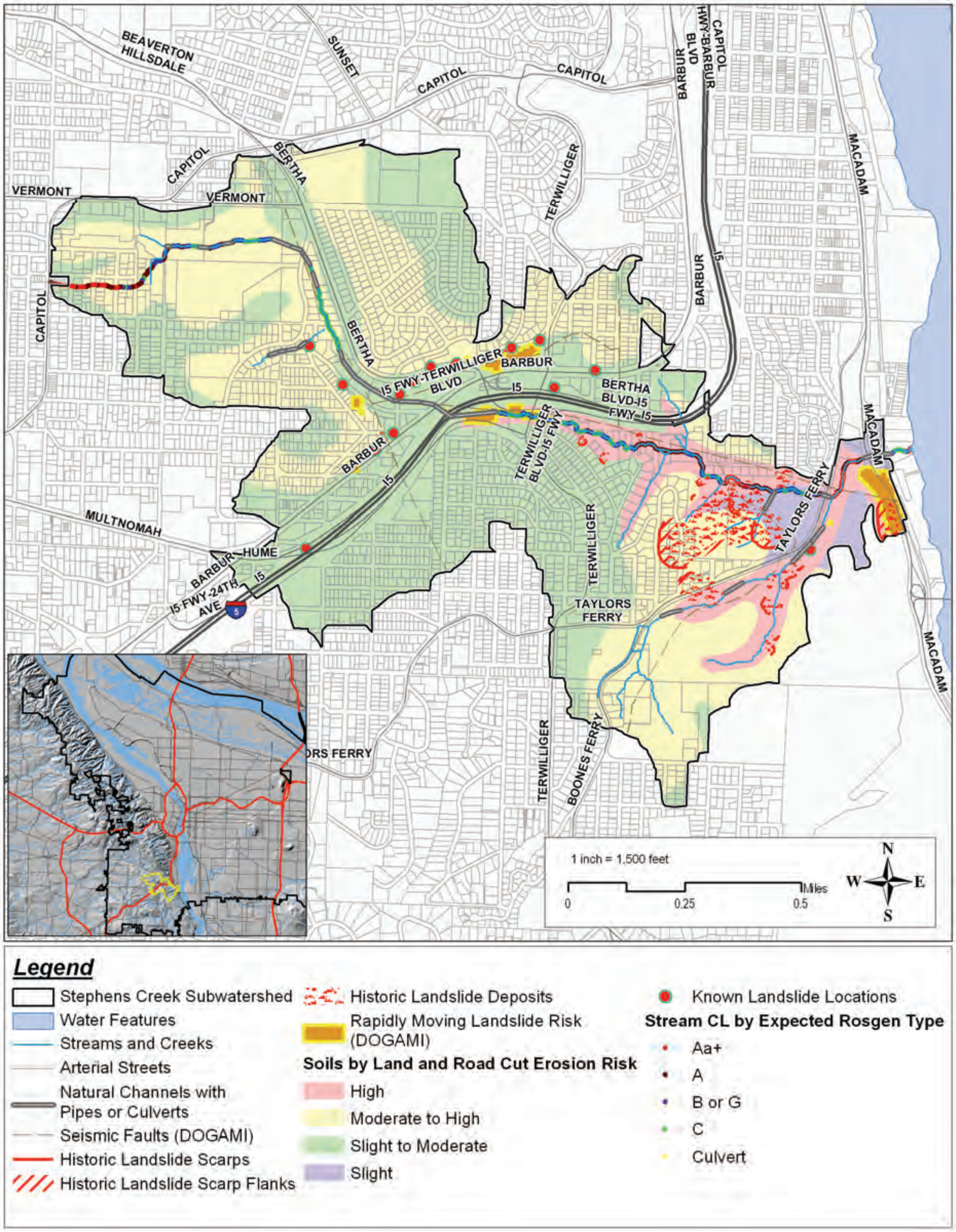

Figure 2-2
Stephens Creek Watershed Geologic Features and Stream Types

2.1.6 Infrastructure

The sanitary sewer and stormwater systems that drain the Stephens Creek watershed are separated.

Sanitary waste from residential and commercial areas is collected in sanitary sewer pipes and is routed to the Columbia Boulevard Wastewater Treatment Plant for treatment. The main trunk line of the pipe system runs along the Stephens Creek mainstem. Stormwater runoff throughout the watershed, including runoff from I-5 and Barbur Boulevard, is routed into pipes and ditches that discharge into Stephens Creek and it's tributaries. This leads to various problems such as pollutants entering the creek, significant increases in flow rate and volume during rain events, and erosion of the creek bed.

The City of Portland's 2008 Grey to Green initiative expands stormwater management techniques that mimic natural systems, protect and restore natural areas, and improve watershed health. Part of this initiative is to track the city's green infrastructure assets, which are shown in Figure 2-3 through Figure 2-5.

2.2 Characterization Results

Information about the Stephens Creek watershed was compiled, analyzed, and summarized to identify the state of the watershed and stormwater sewer system, potential stormwater-related problems, their sources, and assets to be protected. This basin characterization considered base conditions with existing development as well as the effect of planned future redevelopment and development in the watershed.

The characterization results are presented below for the sixteen fundamental LOS developed for the Stephens Creek stormwater system (refer to Table 1-1) subdivided into three categories: (1) hydrology and hydraulics, (2) water quality, and (3) stream condition, habitat, and biological communities. More detailed information about characterization methods and results can be found in *TM 4.6 Characterization Summary* (BES, 2011g).

2.2.1 Hydrology and Hydraulics

Provide Stormwater Infrastructure (LOS A1)

Taxlots in the watershed were evaluated using GIS to estimate which taxlots do not have an approvable stormwater discharge location and how much of the right-of-way does not has an approved stormwater system. An approved discharge point was assumed to be infiltration into the ground where conditions are suitable for infiltration, discharge to an approved stormwater system, or a stream or river. An approved stormwater system was assumed to be a publicly- owned stormwater pipe or ditch, or a street with curb and gutter.

The findings showed that approximately 22% of the taxlots in the watershed (376 taxlots) do not have an approvable discharge point and approximately 25% of the city managed right-of-way in the watershed (31,268 linear feet) does not have an approved stormwater system. The locations of taxlots with no approvable discharge point are shown in Figure 2-6.

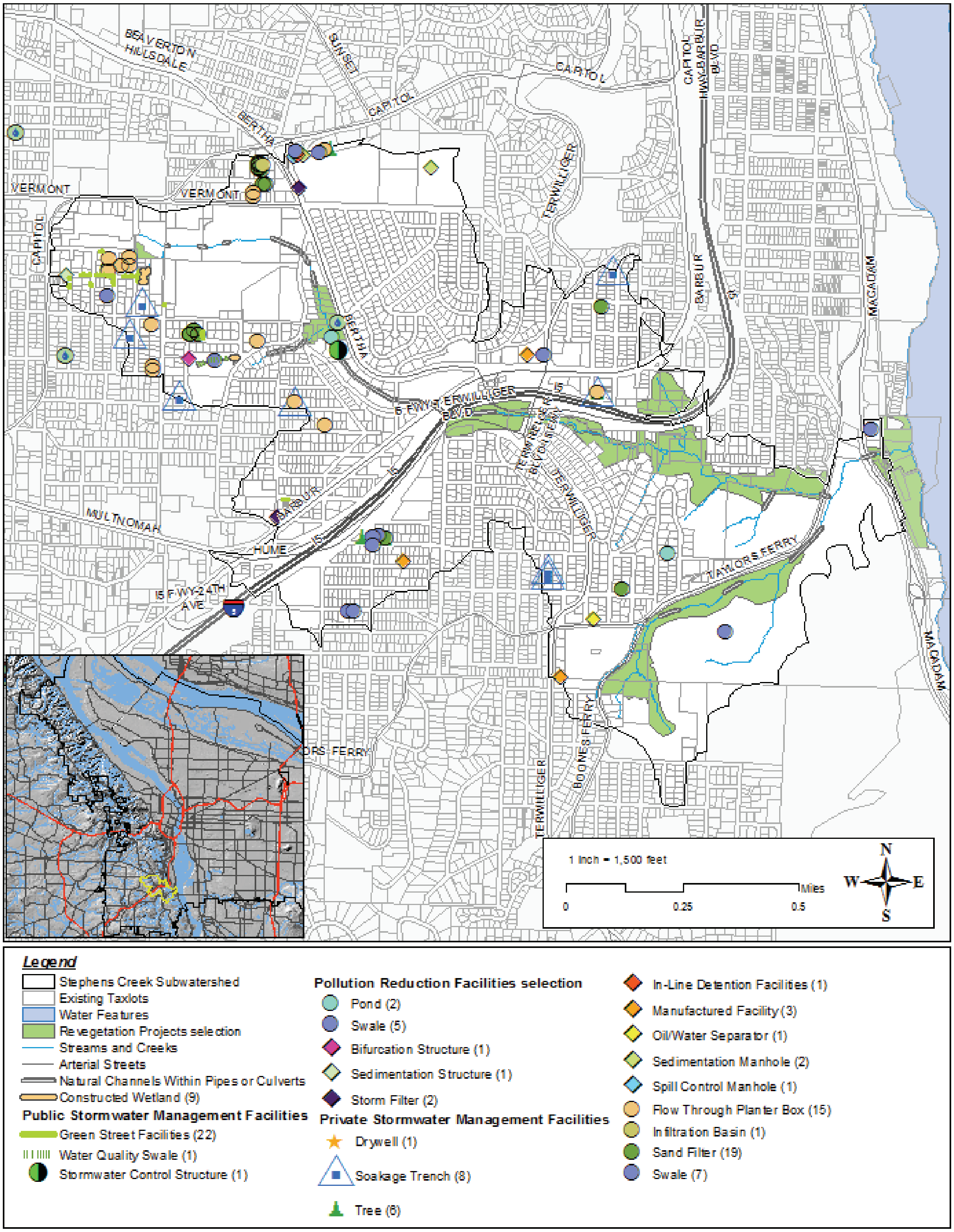

Figure 2-3
Stephens Creek Watershed Green Assets Map 1

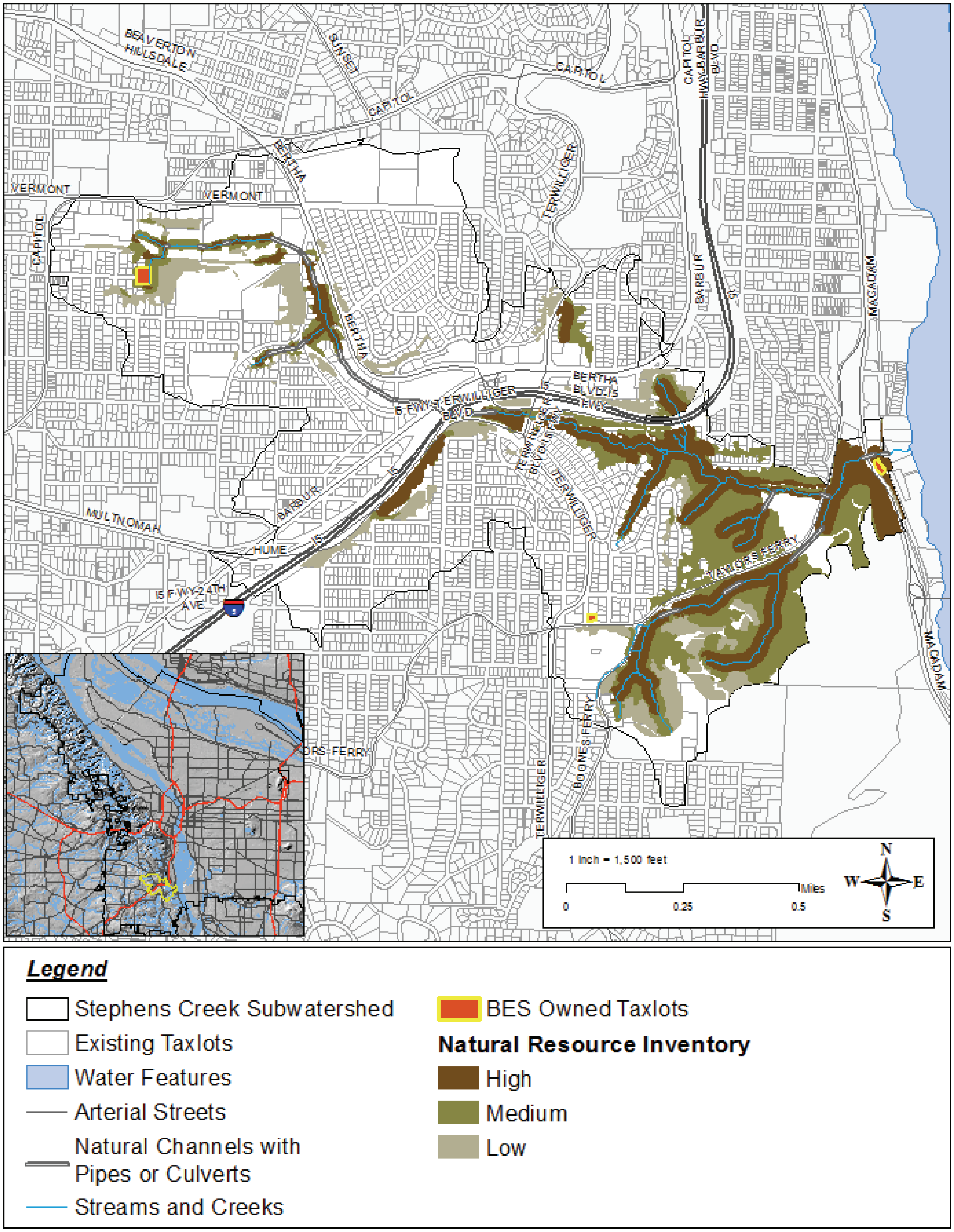

Figure 2-4
Stephens Creek Watershed Green Assets Map 2

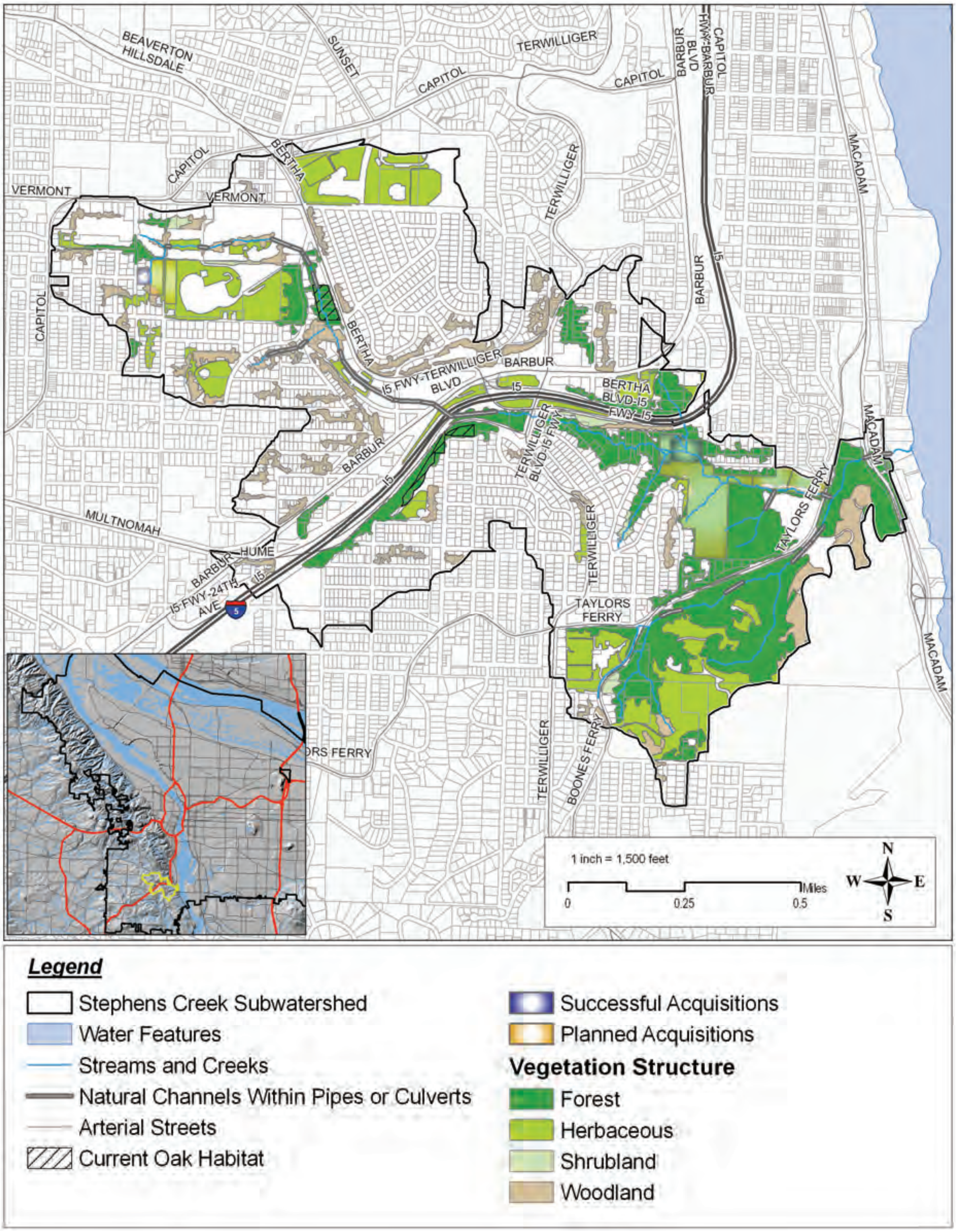

Figure 2-5
Stephens Creek Watershed Green Assets Map 3

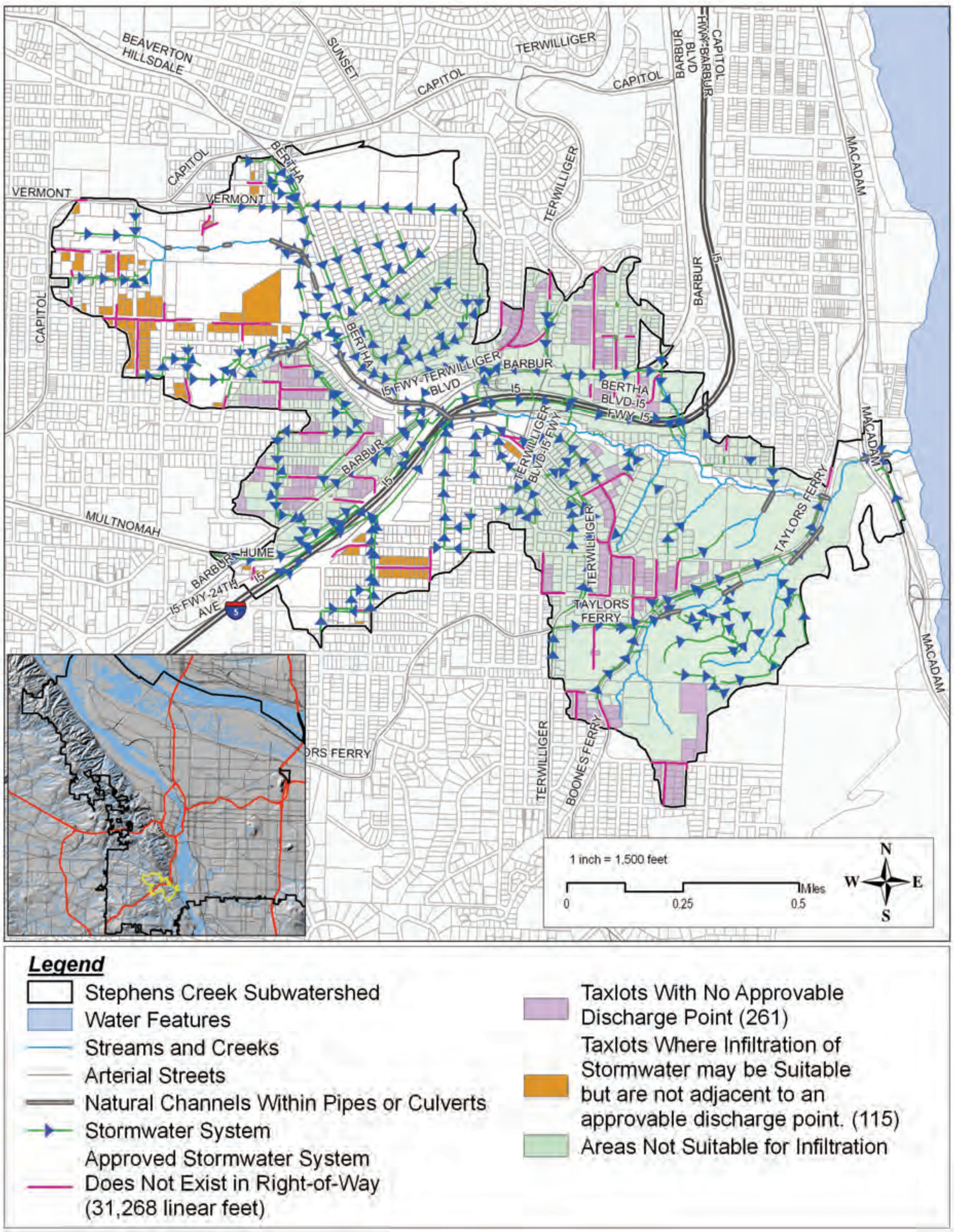

Figure 2-6
Taxlots with No Approvable Discharge Point

Conveyance System Capacity (LOS A2)

Conveyance system capacity was evaluated for existing and future (year 2050) conditions for the 10-year design storm. Hydrologic and hydraulic model results were used to estimate capacity of the pipes, culverts, and ditches upstream of an outfall. Elements in the natural system (Stephens Creek, tributaries, and locations where creeks pass through culverts) were not characterized for conveyance system capacity. Details of the modeling assumptions are available in *TM 4.6 Characterization Summary* (BES, 2011g).

Five pipe segments within the watershed were identified as capacity constrained during existing conditions. These represent 2% of pipes and culverts in the conveyance system by length. One additional 20-foot length of pipe was identified as capacity constrained for future conditions. Only one of the capacity constrained segments along SW Barbur Boulevard is expected to result in significant business risk. Recommendations to address this reach are discussed in Section 4.6.2. Details of the capacity constrained segments are available in *TM 7.1.1 Capacity Constraint Overview* (BES, 2012d).

Outfall Energy Dissipation (LOS A4)

Fifty outfalls were identified and mapped in GIS using the Hansen asset management system and the Asset Systems Management modeling database. Existing documentation such as photographs or as-built drawings was used to assess some outfalls, and field assessments were completed for the majority of the remaining outfalls.

Of the fifty assessed outfalls, 26 required no further action, and 16 required retrofitting for energy dissipation. Additionally, four may need potential future retrofit. The remaining four were not assessed due to lack of access. Of the 16 outfalls requiring retrofit: BES owns six, five of which are located along SW Taylors Ferry Road; eight are privately owned (primarily by River View Cemetery); one belongs to the Oregon Department of Transportation (ODOT); and the ownership of the remaining one is unknown.

Hydrologic Indicators of Stream Health (LOS B1)

Three hydrologic indicators (high pulse count, high pulse range and 7-day annual minima) were selected to evaluate stream health. High pulse count is the number of times in a year that the daily time step hydrograph rose above two times the annual mean flow. High pulse range is the range in days within a year between the start of the first high flow pulse and the end of the last high flow pulse. The 7-day annual minima are the 7-day average minimum flow rates for each calendar year. These indicators were evaluated for historic (predevelopment), existing, and future conditions by modeling the watershed hydrologic and hydraulic conditions through a 55-year continuous simulation.

Indicators were evaluated at four locations within the watershed: near the mouth of Stephens Creek, the I-5 culvert, Custer Park, and the Riverview tributary (Figure 2-1). All four areas showed:

- An increase in the number of high pulses (count), ranging from 22% to 53%.
- An increase in the time period in which the high pulses occurred (range), ranging from 63% to 139%. Under predevelopment conditions, high pulses were generally limited to

the period between early December and late April. Under existing conditions, high pulses occur throughout the year.

- A reduction in low flows (minima) relative to historic conditions, ranging from 14% to 53%.

The increases and reductions in low flows were less in the cemetery tributary, which is dominated by the River View Cemetery, which has a relatively low percentage of impervious area. The other three locations drain areas that have experienced a significant increase in impervious area from predevelopment conditions.

Prevent Flood Hazards (LOS G1)

There is no known historic flooding concern in Stephens Creek and there are not many structures near the creek. The federal Flood Insurance Rate Map (FIRM) was used as a cross-check. There are no mapped flood hazard areas along the Stephens Creek mainstem or tributaries. The FIRM does show flood hazard areas adjacent to the Willamette River at the mouth of Stephens Creek, but there are no structures within the Stephens Creek watershed in that area.

Protect Public Infrastructure (LOS G2)

A qualitative analysis of stream stability was conducted at three road crossing locations. It is recommended that a more detailed analysis (e.g., HEC-20 Level 2) be performed at the SW Taylors Ferry Road culvert since there is existing erosion and risk of further erosion that could encroach upon the roadway fill. Periodic maintenance should continue at all three locations, including debris removal and periodic assessments of stability.

The bank erosion hazard index (BEHI) was utilized to evaluate the risk of erosion along the stream channel. Information from a 2000 BEHI study was used except for the area along Stephens Creek between I-5 and Taylors Ferry Road, where a pipe protection and stream channel restoration project was completed in 2008. In this area the BEHI was re-evaluated in the field by BES Asset Systems Management staff.

Sanitary pipes parallel the stream channel along Stephens Creek and Ruby Creek. The BEHI is low to moderate for stream banks adjacent to sanitary infrastructure. Potential hazards to sewer infrastructure near the stream channel include a lined pipe in poor condition and sanitary pipes crossing above the stream bed. The Burlingame sanitary trunk parallels Stephens Creek and has been protected from stream channel migration.

2.2.2 Water Quality

Total Maximum Daily Load (LOS E2)

Stephens Creek has a Total Maximum Daily Load (TMDL) for bacteria (E. coli), established as part of the Willamette Basin TMDL in 2006. E. coli samples were collected at 40 locations in Stephens Creek from 1996 to 1997 and from 2002 to the present. Over 60% of samples collected had E. coli counts exceeding the 406 organisms per 100 milliliters water quality standard for single samples. Most of the elevated E. coli concentrations are associated with storm events.

In 2008, BES completed the Burlingame Sewer Repair and Stream Enhancement Project, which eliminated sanitary wastewater leaks within the Stephens Creek central canyon area from SW Taylors Ferry Road west to I-5. E. coli samples from a station downstream of the project were aggregated into pre- and post-Burlingame groups. Results showed a slight improvement in exceedance rates (61% pre-project versus 50% post-project); the improving trend was not considered conclusive due to a relatively small number of samples collected during the post-project compared to the pre-project period.

Microbial Source Tracking analysis was performed for two samples collected in Stephens Creek during March 2010. The analysis indicated that both samples contained residual human fecal contamination but no evidence of direct sources of contamination. The results indicated that some recent fecal contamination was most likely from bird, dog, or other animal feces that entered the stream via stormwater runoff.

Portland Water Quality Index (LOS E4)

The Portland Water Quality Index (PWQI) is one component of an overall watershed health index that is being developed as part of the implementation of the Portland Watershed Management Plan. It includes eight water quality indicators that address human, aquatic, and salmonid health concerns: dissolved copper, dissolved oxygen, E. coli, total mercury, ammonia nitrogen, total phosphorus, total suspended solids, and temperature. The scores range from 0 to 100 and a PWQI score of 60 is considered the minimum for good condition.

Annual PWQI scores were calculated for a monthly water quality monitoring station (ST04, located roughly 500 feet upstream of the confluence of Willamette River where SW Macadam Avenue crosses the creek) and two Portland Area Watershed Monitoring and Assessment Program (PAWMAP) stations (0524, near the confluence of Stephens Creek and the Willamette River; and 0012, in a tributary that drains into Stephens Creek from the north, approximately 3,300 feet upstream of the confluence) which were sampled five times each in 2010-2011 (Figure 2-1). The PWQI scores for ST04 range from 24 to 51 for the time period 2002 to 2010, indicating relatively poor water quality for most of this monitoring period. E. coli is the lowest scoring component for each monitoring year, and total suspended solids is the most common second-lowest scoring component. The PWQI scores for 0524 and 0012 were 76 (very good) and 39 (poor), respectively.

Temperature Water Quality Standard (LOS F1)

Continuous temperature data were collected at four monitoring stations covering portions of a year from 2002 to 2007 and 2009 to 2010 in Stephens Creek. Monitoring took place generally between May and November. Three of the four stations (ST04, SCT1, and 0524) are located close to the confluence with the Willamette River; the fourth (0012) is in a tributary that drains into Stephens Creek from the north, approximately 3,300 feet upstream of the confluence (Figure 2-1).

The stream water temperature standards were exceeded approximately 11% of the time during the monitoring periods at station ST04. The exceedance rates were less for 2006 and 2007 as compared to the rates for 2003, 2004, and 2005 at ST04. The exceedance rates are 4% for PAWMAP station 0012 and 11% for the downstream PAWMAP station 0524. Monitoring station SCT1 had the highest exceedance rate of 25%. This relatively high exceedance rate is most likely related to warm summer temperatures in 2009.

2.2.3 Stream Condition, Habitat and Biological Communities

Wetland Function (LOS B5)

Wetlands hydro-geomorphic assessments (HGMs) were conducted on eight wetlands in the Stephens Creek watershed, using an HGM assessment tool available from the Oregon Division of State Lands. Using this tool, wetlands were assigned scores in thirteen functional areas and compared to reference wetlands in the Willamette Valley and Portland metropolitan area (Figure 2-7).

Wetland assessment results revealed a diversity of wetlands and functional capacities across the watershed. This suggests that the wetlands in Stephens Creek are providing a range of functions that support biological and physical processes in the watershed. However, the results also suggest that stormwater runoff has modified the wetlands and changed species composition, lowered storage capacity, and decreased functions that support both aquatic and terrestrial wildlife.

The assessment results indicate some areas where wetlands are functioning at a high level, suggesting that these functions should be protected. For example, wetlands in the Fulton Park Canyon, Taylors Ferry Tributary, and Texas Raz property are functioning at a high level for nitrogen removal. Other wetland functions rated lower, suggesting these functions could be improved through restoration or enhancement. For example, all wetlands scores were below 0.75 (on a scale of 0 to 1) for water storage and delay. In both cases changes to stormwater inputs are likely to move the functional values in both positive and negative directions.

Native Fish and Macroinvertebrates (LOS F2)

The macroinvertebrate communities in Stephens Creek were sampled in five locations in fall 2010. Results were analyzed using the DEQ Predictive Assessment Tool for Oregon Model, which compares macroinvertebrates found at a site (“observed”) to those expected to be found at a comparable reference location (“expected”). If the observed-to-expected ratio is less than 1, there are fewer taxa at a site than expected. If it is greater than 1, macroinvertebrate communities are equivalent to or better than those found at reference sites.

The macroinvertebrate communities found in Stephens Creek are dominated by urban tolerant species. The observed-to-expected score results for the five locations ranged from 0.19 to 0.39, indicating that Stephens Creek has significantly fewer taxa than expected to occur in the stream, based on taxa observed at reference sites with similar environmental characteristics.

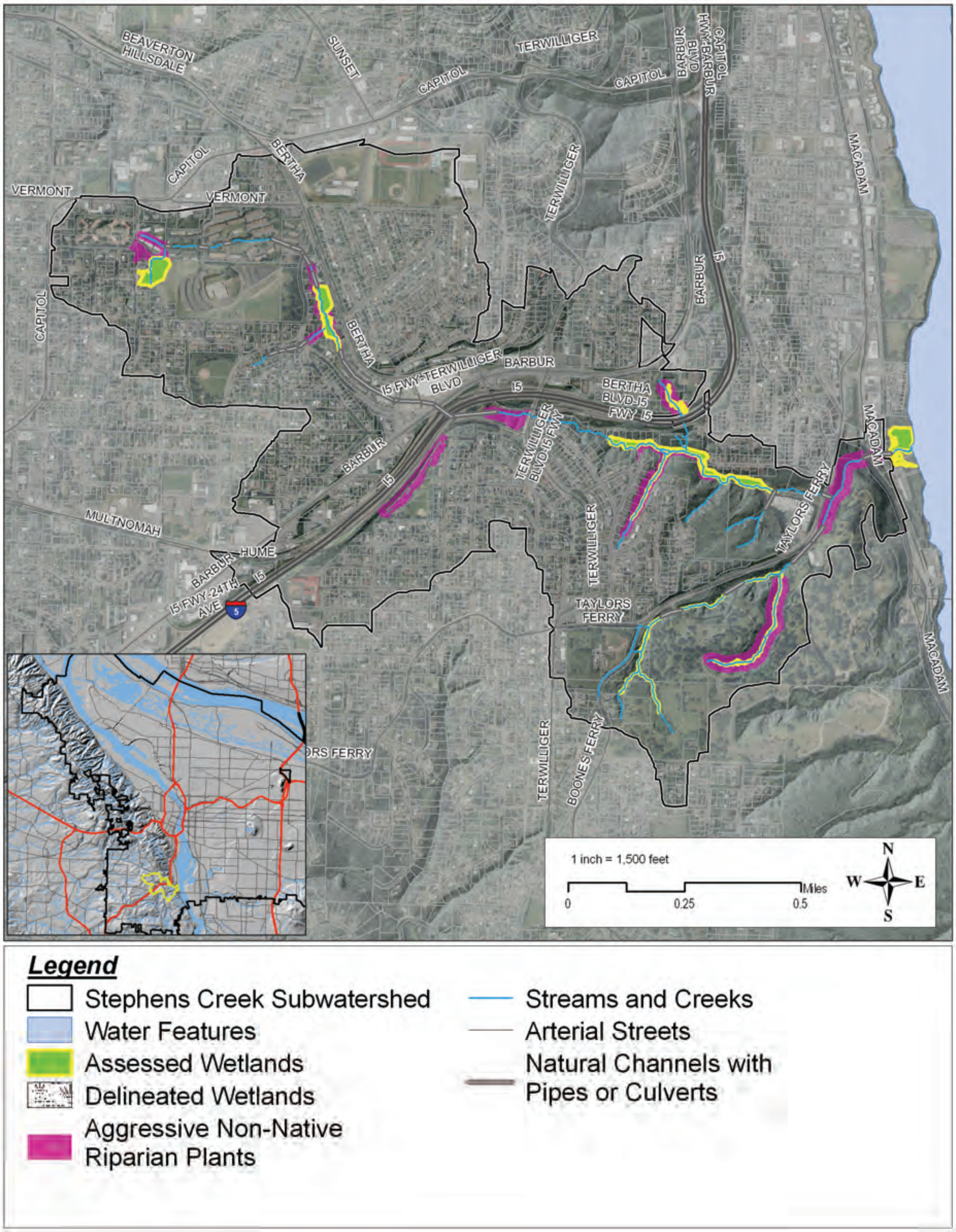

Figure 2-7
Stephens Creek Wetlands Current Function and Riparian Conditions

Assessments of fish communities in Stephens Creek mainstem were conducted by electro-fishing in 2008 by the Oregon Department of Fish and Wildlife (ODFW) and by BES in 2010 and 2011. BES fish monitoring at the Stephens Creek confluence has consistently found salmonids present and the number of native species nearly always outnumbered the number of non-native species. No fish have been found upstream of the Willamette Greenway Trail/Willamette Shore Trolley rail line and Macadam Avenue culverts, 250 feet upstream of the confluence. The absence of anadromous fish in the upper parts of the watershed is due to the presence of fish passage barriers, both natural and human built.

Urban-related land uses have significantly altered biological assemblages in Stephens Creek by creating unfavorable habitat, hydrology, and water quality conditions (discussed further in those LOS). More data are needed to depict and quantify trends for these biological communities in the basin.

In-stream Habitat Conditions (LOS F3)

It is likely that before development Stephens Creek was actively interconnected with its floodplain, wetlands, and riparian areas. These stream features provided storage for floodwaters and sediment, nutrient exchange, groundwater and wetland recharge, and a source of organic material. They also provided extensive areas of refuge for fish and aquatic organisms.

An initial assessment of aquatic habitat quality in Stephens Creek was conducted by Harza consultants under contract from BES in 2000. In 2011 BES staff conducted an assessment to update the 2000 information. The 2011 stream survey found that habitat elements such as large wood, in-stream cover, channel shape, and riparian vegetation have all been degraded due to alterations in the watershed. These alterations, which have occurred over several decades, include road construction, filling for development, removal of large wood in streams, intentional stream channelization, native vegetation removal, and an increase in impervious surfaces. Habitat conditions are also degraded by the presence of invasive vegetation species.

The reaches of Stephens Creek with highest quality habitat for fish are located within the Burlingame sewer rehabilitation project area (Stephens Creek mainstem between SW Taylors Ferry Road and the I-5 culvert).

Riparian Vegetation (LOS F6)

A visual assessment of riparian vegetation was conducted in summer 2011. Specific riparian invasive plant species of concern were noted because of their known detrimental effects on water quality and negative influence on hydrology.

Approximately 30 percent of the riparian and aquatic areas of Stephens Creek contain aggressive invasive species (Figure 2-7). These areas should be considered in the development of future improvements to support hydrologic, water quality, and stream condition improvements.

Off-Channel Connectivity (LOS F7)

It is assumed that the majority of the off-channel connectivity potential exists in areas that are relatively low-gradient in relation to the steep, canyonized reaches that predominate much of the channel. These areas are more likely to be adjacent to low-lying areas that exhibit varying degrees of off-channel connectivity, or have the potential to have connectivity restored.

Non-wetland lowlands and/or riparian areas adjacent to streamside wetlands are important for off-channel connectivity because they may represent areas that have undergone minor filling or other alterations and may be restored to full wetland function with relatively minimal effort and cost.

Sediment Delivery (LOS F8)

All streams function by maintaining a balance between mass (sediment load) and energy (discharge), and a change in either will cause some response in the stream system that can be measured as some form of change in the sediment size distribution in the streambed material or its slope (aggradation or degradation).

About 53% of the total mainstem length of Stephens Creek is classified by the Rosgen Geomorphological Stream Classification System as Type A or B. These stream types are high gradient, have V-shaped channels, are dominated by cascades or riffle-and-pool sequencing and exhibit no significant meandering or point bar formations. Type A and B streams have high potential for sediment transport, and often derive sediment from colluvial input as a result of mass wasting from adjacent stream banks or steep canyon walls. 21% of the Stephens Creek mainstem is composed of the Type C channel form, which is characterized as having a lower gradient with features like floodplains, more pronounced meandering, riffles, pools, and point bar formations. Type C reaches exhibit depositional landforms, and due to their lower slope and energy, tend to be more depositional in nature as compared to transport reaches (Figure 2-2).

About 26% of the total length of the Stephens Creek mainstem is in pipes or culverts, primarily the Burlingame culvert passing under the I-5 freeway and Barbur Boulevard. Given the steep gradient (about 5%) of the reach containing the Burlingame culvert, it is likely that that reach was originally a Rosgen Type A stream and exhibited sediment transport characteristics.

Hydraulic Conditions Support Fish Passage (LOS F10)

Barriers to fish passage exist at the railroad and Willamette trail culvert just upstream of the confluence restoration area, and at the Highway 43 culvert. The absence of fish in the upper part of the watershed is due to the presence of fish passage barriers, both natural and human built, and the additional limiting factors of unfavorable habitat, hydrology, and water quality that are discussed further in those LOS.

2.3 Conclusions

Development throughout the watershed has led to increases in impervious surface, stormwater runoff, water quality impacts, and habitat degradation in Stephens Creek. In response, BES has made significant improvements to stormwater management in the watershed, such as the Burlingame Sewer Repair and Stream Enhancement Project, and has implemented the *City of Portland Stormwater Management Manual* (SWMM) (BES, 2008) for redevelopment and new development. Even so, it remains for BES to address many (possibly conflicting) issues in the SCSWSP. It will be necessary to provide approvable discharge points for redevelopment and new development while preventing negative impacts to hydrology, water quality, and stream condition.

The characterization results summarized in this chapter were reviewed to identify stormwater system deficiencies and roughly map where problems and solutions may overlap. On the basis of this review, it was determined that alternatives development should focus on addressing stormwater system deficiencies related to the following priority LOS:

- Provide stormwater infrastructure (LOS A1)
- Improve stream health as measured by Portland Water Quality Index (LOS E4) and hydrologic indicators (LOS B1)
- Improve in-stream habitat conditions (LOS F3)

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CHAPTER 3

Alternatives Development and Evaluation

ENVIRONMENTAL SERVICES
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3 Alternatives Development and Evaluation

This chapter discusses the alternatives development and evaluation process and presents results of the analysis.

3.1 Overview

A high-level overview of the alternatives development and evaluation process is presented here. Details of the process and results of the analysis follow in later sections. Figure 3-1 depicts the steps that were taken to develop and evaluate alternatives and develop a recommended plan. The process is similar to other BES planning projects.

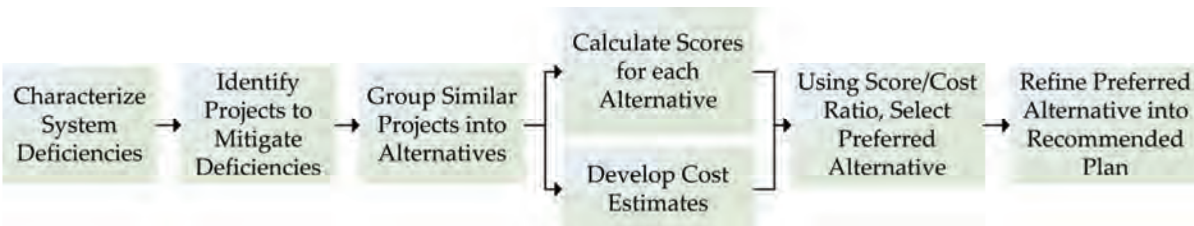

Figure 3-1
Alternatives Development and Evaluation Steps

These steps are described below:

- **Characterize System Deficiencies**. As described in Chapter 2, the Stephens Creek watershed stormwater system deficiencies were characterized with regard to LOS.
- **Identify Projects to Mitigate Deficiencies**. As recommended by the Stephens Creek watershed characterization, the project team identified potential projects to mitigate system deficiencies. The watershed was subdivided into 33 project areas and 130 potential projects were developed from a previously established list of BES best management practices for solving stormwater system problems. This list was called the Toolbox (BES, 2012h).
- **Group Similar Projects into Alternatives**. The 130 potential projects were grouped into different combinations to develop four watershed-scale alternatives for comparison and evaluation. The alternatives development process that was used is described in detail in Section 3.2, Alternatives Development.
- **Calculate Scores for Each Alternative and Develop Cost Estimates**. The project team developed evaluation criteria and calculated scores to reflect how well each alternative met the goals and objectives. The team also developed cost estimates to assist in the evaluation of the four watershed-scale alternatives. Section 3.3, Alternative Evaluation Process, and Section 3.4, Alternative Evaluation Results, provide details on the steps taken and the findings.
- **Using Score-to-Cost Ratio, Select Preferred Alternative**. The score-to-cost ratio of each alternative was calculated. The score-to-cost ratio is the alternative score from the MUA analysis divided by the net present worth in millions of dollars. This ratio was a way to assess the cost-effectiveness of each alternative. The project team compared the four

alternatives and their score-to-cost ratios to select the preferred alternative described in Section 3.5, Preferred Alternative.

- **Refine Preferred Alternative into Recommended Plan**. The preferred alternative was further refined and developed into a recommended plan encompassing operating recommendations, three phases of capital improvements, and guidelines for conveyance improvements, as described in Section 4, Recommended Plan.

3.2 Alternatives Development

The characterization and LOS were the basis for the alternatives, clarifying the problems that needed to be solved in the Stephens Creek watershed in order to meet the goals described in Section 1.2.2, Stephens Creek Pilot Project. The goals were broken down into objectives, using the LOS as a guide. This is discussed in greater depth in Section 3.3.1, Multi-Attribute Utility Analysis Approach. The alternatives development process is summarized in Figure 3-2.

Project staff compiled a list of methods for solving stormwater system problems. This list, or toolbox, was intended to serve as a menu of options for the development of projects. A wide variety of potential projects that could be implemented within Stephens Creek watershed were considered. The project team also met with stormwater system stakeholders to identify needed changes in policy and technical guidance as well as operating investments.

The watershed was broken into 33 smaller project areas to allow for targeted project development. Initially, any identified project that could impact the stormwater management objectives was inventoried. One hundred and thirty potential projects were identified. The projects were then grouped into several approaches. A separate set of approaches was developed for each management goal.

Four distinct approaches were developed to meet Goal 1. These are designated a, b, c, and d in Figure 3-2. Similarly, three approaches were developed to meet Goal 2. These are designated x, y, and z in Figure 3-2. Goal 3 did not require a distinct approach, but instead was woven into all of the alternatives that were developed and was considered during the alternatives evaluation process.

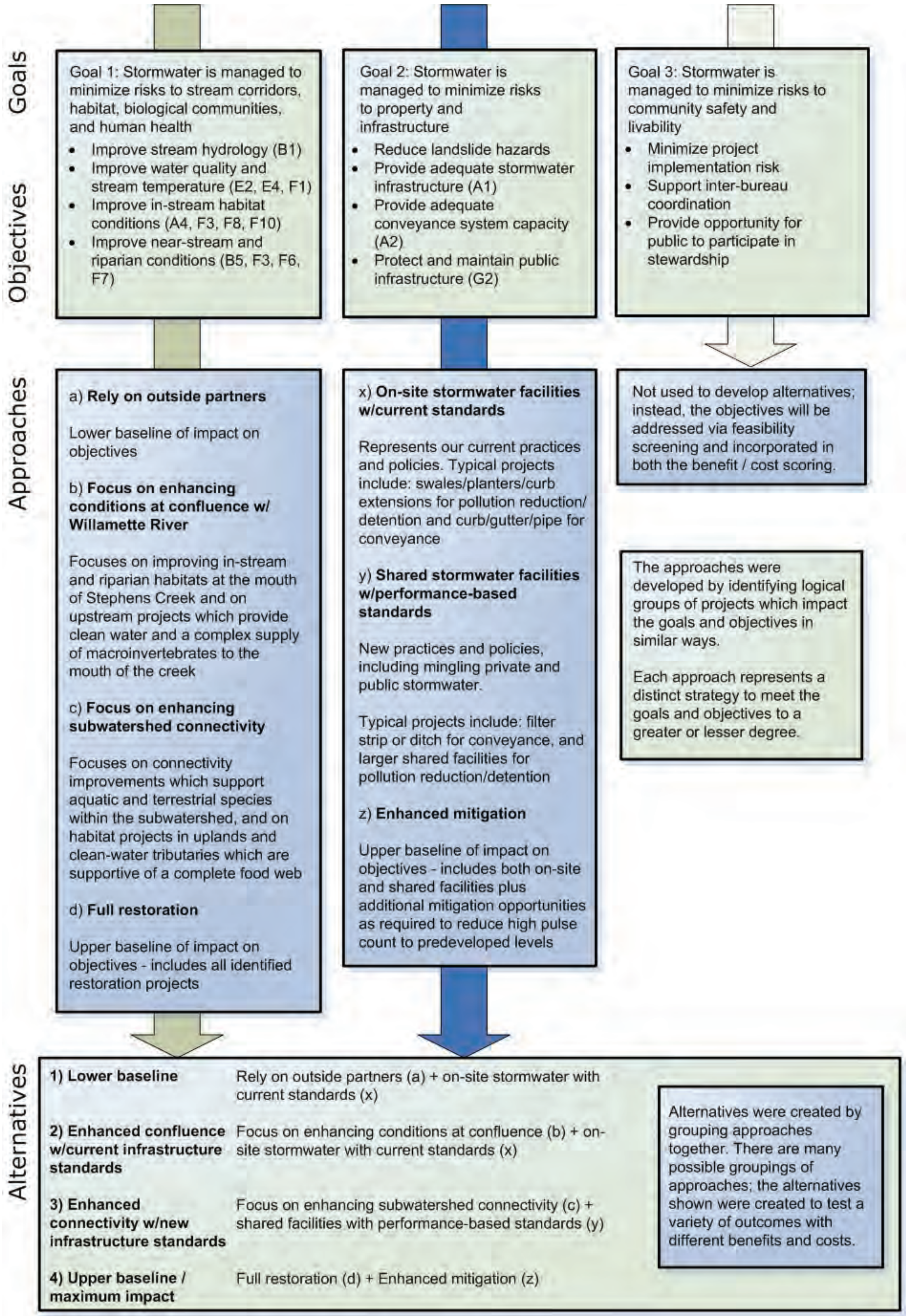

Figure 3-2
Alternatives Development Process

For Goal 1, the four approaches were developed considering both ecological outcomes and BES' ability to implement the identified projects. The various approaches, as shown in Figure 3-2, range from the least impact in addressing the goal to the most impact. The intermediate approaches were formulated to accomplish specific ecological outcomes, which can serve as a management tool for evaluating a cost-effective level of investment. The fourth approach is the upper baseline for restoration activities.

BES' current approach to stormwater management, as contained in the SWMM (BES, 2008), requires managing stormwater on-site, preferably via infiltration to the degree feasible. However, this approach is difficult to apply in the Westside watersheds where native soil infiltration rates are low, terrain is steeply sloped, landslide susceptibility is widespread, and available right-of-way is limited.

Considering this, three approaches were developed for addressing Goal 2. The first approach represents BES current standards and practices for providing stormwater infrastructure. The second approach represents a shift in standards, which includes a preference for shared facilities, or facilities that treat and/or detain stormwater from multiple properties, rather than a preference for managing stormwater on-site. The use of shared facilities represents a shift from current policy, which favors on-site facilities. The third approach is the upper baseline on mitigation activities, and includes both on-site and shared facilities.

The Goal 1 and 2 approaches were combined to produce four alternatives. The alternatives were developed to explore distinct approaches to safely conveying and managing stormwater while mitigating negative impacts on watershed health and to answer two questions:

- What is the range of possible impacts on the stormwater management objectives/LOS for a variety of management approaches?
- Would a change in BES's stormwater management approach result in a greater benefit-to-cost ratio, or a lower total cost than the current approach?

Two of the alternatives were developed to establish an upper and lower limit on the degree to which the stormwater system addressed the SCSWSP goals and objectives, and an upper and lower limit on the cost of system improvements. The other two alternatives were developed to fall between the upper and lower limits in addressing goals and objectives, and were designed to evaluate the outcome of two distinct management approaches: on-site versus shared facilities.

The four alternatives were as follows:

- **Alternative 1—Lower Baseline**: Rely on outside partners for restoration and maintain current conveyance standards and requirements.
- **Alternative 2—Enhance Confluence and Maintain Current Infrastructure Standards:** System-wide improvements with the goal of improving conditions at the confluence and manage stormwater on-site. This alternative is representative of BES's current stormwater management approach.

- **Alternative 3—Enhanced Connectivity and Implement New Infrastructure Standards:** System-wide improvements to improve Stephens Creek connectivity and manage stormwater in larger shared facilities.
- **Alternative 4—Upper Baseline/Maximum Impact:** Restoration of Stephens Creek and management of stormwater with both on-site and shared facilities.

The four alternatives are described in more detail below.

Note that none of the alternatives presented were intended to become the preferred alternative in an unaltered form. Rather, the alternatives were developed to provide a variety of possible outcomes that could be compared against each other to understand how best to work with the many constraints in southwest Portland (such as steep slopes, lack of infiltration, constrained and undeveloped right-of-way, landslide hazards, among others). As discussed in Section 3.4.1, Refinement Principles, the preferred alternative is a hybrid of the various alternatives created using alternative refinement principles.

3.2.1 Alternative 1—Lower Baseline

Alternative 1 relies on outside partners and on-site stormwater with current standards. It is a lower baseline for a stormwater system. It will have least cost, but also the lowest impact on the stormwater management objectives.

Stormwater conveyance infrastructure for unserved properties is provided by stormwater facilities in the right-of-way flowing to a pipe network as new development occurs or other opportunities arise. In areas with landslide hazard risk, lined facilities are proposed.

Restoration projects in this alternative are selected only where there is a possibility of an outside partner leading the project. The outside partners could be an agency such as ODOT or the West Multnomah County Soil and Water Conservation District, or by private parties such as the River View Cemetery. This alternative represents a worst-case scenario of alternatives considered, which will explore the cost and benefit impacts of BES taking a minimal approach to the stormwater management objectives. In the evaluation process, scores will reflect the likelihood of the outside partners actually implementing the project.

3.2.2 Alternative 2—Enhanced Confluence and Maintain Current Infrastructure Standards

Alternative 2 focuses on enhancing conditions at the confluence and on-site stormwater management with current standards.

Alternative 2 is intended to represent BES' current practices for stormwater management. Like Alternative 1, stormwater conveyance infrastructure for unserved properties is provided by stormwater management facilities in the right-of-way, likely flowing to a pipe network. In areas with landslide hazard risk, lined, flow-through facilities are proposed.

In addition to providing stormwater management facilities in areas without existing infrastructure, transportation retrofit opportunities are also included in this alternative. The retrofit opportunities are included in areas that were identified as high-priorities for transportation improvements (pedestrian and bicycle safety improvements) in conjunction with PBOT staff.

Restoration projects are included in this alternative with the intent of improving conditions at the confluence of Stephens Creek and the Willamette River. Note that this includes projects not located at the confluence. In addition to improving in-stream and riparian habitats at the mouth of Stephens Creek, this alternative includes upstream projects that aim to deliver clean water and a complex supply of macroinvertebrates to improve conditions at the mouth of the creek.

3.2.3 Alternative 3—Enhanced Connectivity and Implement New Infrastructure Standards

Alternative 3 focuses on enhancing watershed connectivity and shared facilities with new performance-based stormwater management standards. Alternative 3 investigates a new set of standards and practices for stormwater management. Stormwater conveyance infrastructure for unserved properties is provided by surface facilities wherever possible. In areas with landslide hazards curb, gutters and pipes are proposed for stormwater conveyance. In all other areas, the surface facilities proposed in this alternative include roadway shoulder improvements which can consist of vegetated ditches, rock-lined ditches, or filter strips. The ditches may be filled or open.

To complement the surface conveyance infrastructure, shared facilities are proposed throughout the watershed to provide pollution reduction and detain stormwater. These facilities can be detention ponds, enhanced or restored wetlands, or in-stream configurations that also improve habitat conditions.

Restoration projects are included in this alternative with the intent of enhancing overall watershed connectivity. Projects included in this alternative support the movement of terrestrial and aquatic species within the watershed, and improve habitat in uplands and clean-water tributaries which are supportive of a complete food web.

This alternative is aligned with the PBOT Street by Street initiative, also known as Performance Based Streets. The Street by Street initiative is a program which will modify street standards for some undeveloped streets with low traffic counts. Under this program, current street design standards will not be applied to undeveloped streets; instead, this program will provide street standards which will be less costly and more appropriate for low traffic streets with narrow right-of-way. For stormwater this translates in to more context sensitive surface conveyance with open or filled ditches or filter strips.

Implementation of this alternative is dependent on changes to BES policies and standards. Specific changes include: acceptance and design criteria to combine private/public stormwater, allowances for shared or neighborhood facilities where on-site management is not feasible, and expanded use and definition of context sensitive, surface conveyance including drainageways/drainage reserves. More detail on the recommendations is provided in Chapter 4, Recommended Plan.

3.2.4 Alternative 4—Upper Baseline/Maximum Impact

Alternative 4 is an upper limit alternative, consisting of full restoration plus enhanced mitigation. It will have the highest cost of all the alternatives, but also the greatest impact in addressing the goals and objectives.

This alternative was developed to include all identified restoration and habitat projects in order to understand the full cost and full benefit of restoring Stephens Creek as much as possible given existing development and land use.

Conveyance and stormwater management is provided by stormwater facilities with new curb/gutter/pipe, and larger shared pollution reduction and detention facilities. Detention facilities were included as needed to reduce high pulse count to predeveloped conditions. Alternative 4 does not incorporate the PBOT Street by Street approach; instead it consists of full build out of green streets/curb extensions and a piped conveyance system.

To meet the goal of reducing high pulse count to predeveloped conditions, retrofits are included in this alternative for the entire right-of-way within Stephens Creek. Additionally, private property retrofits consisting of rain gardens or ecoroofs will be applied as needed to reduce high pulses if right-of-way controls are inadequate.

3.3 Alternative Evaluation Process

3.3.1 Multi-Attribute Utility Analysis Approach

As described in Chapter 1, the project team originally intended to follow an asset management framework, where alternatives could be evaluated on how much risk each alternative could mitigate, as measured in dollars. As the project progressed and alternatives development and evaluation began, the project team agreed that the information needed to measure risk in dollars was not available and could not be gathered without extending the project schedule. The project team agreed to use Multi-Attribute Utility Analysis (MUA) to evaluate alternatives for the Stephens Creek Stormwater System Plan.

MUA is a formal analytic approach for evaluating and comparing alternatives for decisions with multiple objectives. This decision-making tool allows the decision-maker to incorporate objectives that are measured on different scales, and to generate a prioritized list of alternatives. Previous applications of this method include internal BES projects (BES, 2007; BES, 2009a) and external projects found in various professional periodicals (Dunning et. al, 2000; Keeney, 1977; and Wedley, 2004).

The MUA process is not intended to prescribe which alternative should be selected as the final recommended plan. Rather, it is a tool to identify what is important and evaluate how well each alternative meets project goals. It informs, but does not dictate the decision.

MUA follows the following basic steps:

- Establish goals and specific objectives.
- Establish an indicator, or scoring system, for each objective. Indicators are used to quantify objectives.
- Assign weights to the objectives. Weights represent the relative importance of the objectives.
- Develop alternatives.

- Assign indicator scores to each alternative.
- Calculate final MUA scores for alternatives.

For more information on the MUA process as applied to this project, see *TM 6.4 Alternative Evaluation Methodology and Criteria* (BES, 2012e) and *TM 6.7 Preferred Alternatives* (BES, 2012f).

LOS were established early in the project under the asset management approach. MUA uses objectives. The project team revised the LOS somewhat to better fit the MUA approach. The objectives hierarchy is presented in Table 3-1. LOS identification numbers (e.g., B1) are listed to show which LOS are represented by which objectives. These identification numbers are shown in this table for clarity but were not carried forward through the process after the objectives were established. All but one of the sixteen fundamental LOS were incorporated into the objectives. The LOS regarding Flood Hazards (G1) was not carried forward because large-scale flooding has not been a problem in the Stephens Creek watershed. In some cases, LOS were reworded to be framed in terms of risk. Several LOS were combined. Additional objectives were developed to represent risks not adequately represented by LOS. These are the objectives without LOS identification numbers. The objectives hierarchy was produced through several iterations, first reviewed and revised several times by the project team, and then approved by the Advisory and Oversight Teams.

It should be noted that cost is not in the Objectives Hierarchy. Similar to other BES projects, the project team decided to keep cost separate. In Section 3.4, Alternative Evaluation Results, cost effectiveness is reflected by a ratio of the MUA score to the present worth cost estimate in millions of dollars (score-to-cost ratio). The cost estimating methodology is discussed below.

The overarching goal is articulated in the hierarchy as guidance for the Stephens Creek Pilot Project, where the intent is to select and implement projects that will minimize risk throughout the Stephens Creek watershed. Minimizing risk is the focus of an asset management approach. While unable to apply a purely asset management approach to alternative evaluation (by evaluating alternatives based on risk in dollars), the goals are articulated as they relate to risks.

Weights were assigned to the objectives by the Management Team. These can also be found in Table 3-1. Ranking and weighting is intended to be specific to Stephens Creek watershed.

Table 3-1
Objectives Hierarchy and Ranking

Overarching Project Goal: *Create and manage a stormwater system that minimizes risk to people, property, and watershed health*

Goal	Objective	Rank	Weight (Rounded)
Goal 1: Stormwater is managed to minimize risks to stream corridors, habitat, biological communities, and human health	Improve stream hydrology (B1)	4	12%
	Improve water quality and stream temperature (E2, E4, F1)	2	14%
	Improve in-stream habitat conditions (A4, F3, F8, F10)	7	7%
	Improve near-stream and riparian conditions (B5, F3, F6, F7)	6	9%

Table 3-1
Objectives Hierarchy and Ranking

Overarching Project Goal: *Create and manage a stormwater system that minimizes risk to people, property, and watershed health*

Goal	Objective	Rank	Weight (Rounded)
Goal 2: Stormwater is managed to minimize risks to property and infrastructure	Reduce landslide hazards	7	7%
	Provide adequate stormwater infrastructure (A1)	1	15%
	Provide adequate conveyance system capacity (A2)	3	13%
	Protect and maintain public infrastructure (G2)	5	12%
Goal 3: Stormwater is managed to minimize risks to community safety and livability	Minimize project implementation risk (e.g., parking loss, type of construction, street closure, uncertainties of work on private property)	9	4%
	Support inter-bureau coordination	9	4%
	Provide opportunity for public to participate in stewardship	9	4%

Each alternative received a score for each objective. Normalized, weighted objective scores were then summed to calculate a final MUA score for each alternative. This score represented the extent to which each alternative met the project's collective goals and objectives. Evaluation results for the Stephens Creek Pilot Project alternatives are presented in Section 3.4, Alternative Evaluation Results. These results informed the selection and refinement of the final preferred alternative.

3.3.2 Cost Estimating

Planning level cost estimates were prepared to evaluate and compare the alternatives. Planning level costs were estimated without detailed engineering or natural resource inventory data. Taking into account the end use, estimating method, and preparation effort, these estimates are expected to have an accuracy range of +40% to -20%.

Estimates included the following types of cost:

- Direct construction cost: an estimate of what it will cost to build the project—restricted to the cost of construction; for example, what it would cost a contractor to build the project.
- Capital cost: includes direct construction cost plus indirect costs such as engineering design, permitting, public involvement, and construction inspection.
- Property acquisition: includes the cost to acquire right-of-way and property for projects that include items such as wetland enhancement or the development of stormwater/water quality facilities.
- Annual operation and maintenance (O&M) cost: costs that BES would incur for O&M of the alternative.
- Present worth cost: calculated for 100-year analysis period at a discount rate of 2.5 percent incorporating total capital cost, O&M cost, replacement cost, and salvage value.

Costs were estimated by project staff through the use of cost estimating spreadsheet templates that were developed for this system plan. The quantity of each item that is included in an alternative cost estimate was either estimated by the team members responsible for that project area or through basin-wide queries of GIS data.

The criteria and guidelines that form the basis of the cost estimates are documented in *TM 5.4.1 Cost Estimation Methodology* (BES, 2012g).

3.4 Alternative Evaluation Results

Table 3-2 shows how the alternatives scored for each objective. Subtotals are calculated for each goal, and overall alternative scores are summed at the bottom. Alternative total MUA scores fell between 55 and 99 out of a total possible score of 100. The higher the total score, the better an alternative performed in meeting the project goals and objectives. Not surprisingly, Alternative 4 received the highest score, 99. It was intended to be the upper limit alternative. Alternative 3 followed with a score of 73. Alternative 2 had the next highest score of 66, and Alternative 1 scored lowest at 55.

Figure 3-3 shows the results of Table 3-2 graphically. Objectives are shown in weighted order, with the greatest weights are at the bottom of the chart.

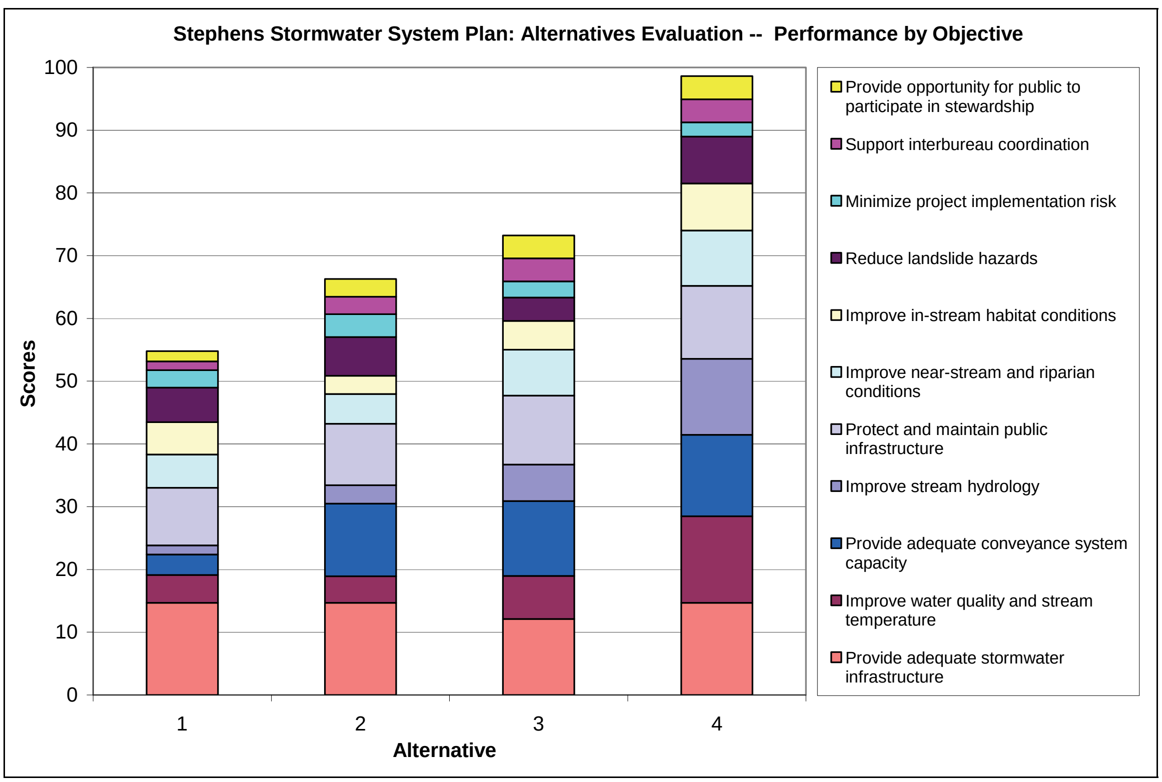

Figure 3-3
Performance by Objective

Table 3-2
Alternatives MUA Scoring Results

Goal	Objective	Weight (Rounded)	System Perspective				
			Alt 1	Alt 2	Alt 3	Alt 4	
Goal 1: Stormwater is managed to minimize risks to stream corridors, habitat, biological communities and public health	Improve stream hydrology	12%	1	3	6	12	
	Improve water quality and stream temperature	14%	4	4	7	14	
	Improve in-stream habitat conditions	7%	5	3	5	7	
	Improve near-stream and riparian conditions	9%	5	5	7	9	
			16	*15*	*25*	*42*	*Goal Subtotal*
Goal 2: Stormwater is managed to minimize risks to property and infrastructure	Reduce landslide hazards	7%	6	6	4	7	
	Provide adequate stormwater infrastructure	15%	15	15	12	15	
	Provide adequate conveyance system capacity	13%	3	12	12	13	
	Protect and maintain public infrastructure	12%	9	10	11	12	
			33	*42*	*39*	*47*	*Goal Subtotal*
Goal 3: Stormwater is managed to minimize risks to community safety and livability	Minimize project implementation risk	4%	3	4	3	2	
	Support inter-bureau coordination	4%	1	3	4	4	
	Provide opportunity for public to participate in stewardship	4%	2	3	4	4	
			6	*9*	*10*	*10*	*Goal Subtotal*
		100%	*55*	*66*	*73*	*99*	***Total***
			4	**3**	**2**	**1**	***Rank***

Table 3-3 and Figure 3-4 show the alternative scores relative to their 100-year present worth. The score-to-cost ratio is shown for each alternative. Higher score-to-cost ratios represent more cost-effective alternatives. Alternative 3 has the best score-to-cost ratio.

Table 3-3
Alternative MUA Scores and Costs (System Perspective)

Alternative	MUA Score	100-year Present Worth Cost	Score-to-Cost Ratio*
1	55	$44,000,000	1.2
2	66	$48,400,000	1.4
3	73	$37,700,000	1.9
4	99	$113,500,000	0.9

*MUA score/project net present worth cost in millions of dollars.

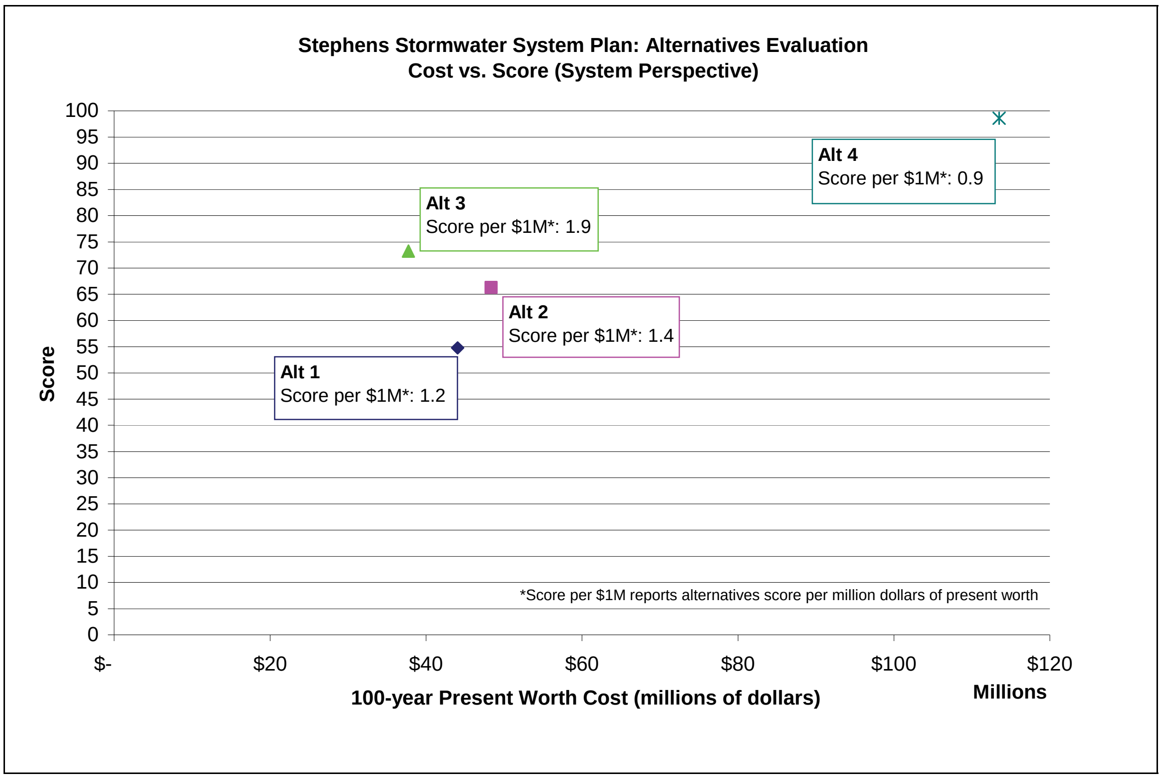

Figure 3-4
System-Perspective Alternative Scores and Costs

The four alternatives were initially created to represent different approaches to addressing stormwater problems and solutions in Stephens Creek. The results of the alternatives analysis indicated, in general, that the Alternative 3 approach was most cost effective, with the highest (best) score-to-cost ratio. As described in Section 3.2, Alternatives Development, the Alternative 3 approach included:

- Shared (private and public) stormwater management facilities to treat and detain stormwater

- New conveyance infrastructure provided by surface facilities where possible
- Habitat improvements focused on improving overall watershed connectivity
- Implementation of new street standards, in alignment with the PBOT Street-by-Street initiative

Alternative scores were designed to represent the relative performance of each alternative toward meeting the project goals and objectives. The alternative ranks alone do not dictate the selection of a recommended plan. Rather, they inform the decision of a preferred alternative.

While Alternative 3 had the best score-to-cost ratio, the project team recognized that improvements to the alternative could be made. For example, it is not always possible to locate larger facilities to capture stormwater from priority areas. In these cases, it may make sense to use smaller facilities in the right-of-way. Considerations such as this led to hybridization and the development of a preferred alternative.

3.4.1 Refinement Principles

The project team developed and agreed to refinement principles to guide the selection of projects and actions to include in the preferred alternative. Some decisions were appropriate at the alternative scale, while others were appropriate at the project scale. The refinement principles included the concepts described below as part of the discussion regarding alternative-level and project-level decisions.

Alternative Level Decisions

The stormwater system in southwest Portland is not owned and managed exclusively by BES. Many stakeholders share responsibility for the management and conveyance of stormwater, including private property owners and outside agencies. A key decision in the Stephens Creek Pilot Project was to analyze the entire stormwater system, including natural channels and drainageways that are not owned by BES. Projects were developed and evaluated to achieve stormwater management objectives regardless of which entity owns the drainage area or conveyance channel. In some cases it may be cost-effective for BES to invest in projects or actions that are not in BES's traditional or exclusive domain.

In order to illustrate this distinction, the score-to-cost ratio analysis was conducted in two ways. The first method takes a System Perspective and uses the full project scores and present worth costs, assuming BES pays for all improvements. The second method accounts for the fact that many of the proposed projects rely on non-city partners and includes assumptions to frame the proposed projects from a BES perspective. The BES perspective assumes that there is a 30% likelihood of occurrence for a project requiring a non-city partner with BES contributing 70% of the costs. To capture this assumption, the MUA scores of these projects were multiplied by 30%, and the costs were multiplied by 70%.

The Alternative 3 approach to detention and treatment (larger facilities allowing stormwater from multiple properties) forms the baseline for a preferred alternative. However, low scoring detention and treatment projects were reviewed and replaced in the preferred alternative with local facilities or other approaches.

In addition to on-the-ground projects, policy, technical, and program options were developed to add definition to the approach of the alternatives. These options have impacts on operating costs, which are difficult to estimate and score and are therefore not included in the project scoring or costs. The preferred alternative will highlight the highest operating priorities based on discussions to date. Further scoping and assessment of these options will be necessary.

The team identified options to provide new conveyance infrastructure to unserved areas but will not submit these projects for CIP funding; instead, this analysis will be available for future reference. The preferred alternative assumes BES will follow the current approach of providing new service via local improvement districts (LIDs) or as development occurs. In residential areas with low traffic, road-shoulder improvements (e.g., ditches, filter strips) may be considered an approvable discharge point. Design standards for these road-shoulder improvements will be developed in conjunction with PBOT as part of their Street-by-Street initiative and tested with pilot project implementations.

Project Level Decisions

The team assigned prioritizations (high/medium/low) to all projects in the preferred alternative. The BES perspective score-to-cost ratio informed the decision along with other elements of the refinement principles.

Most restoration projects stayed in the preferred alternative and were defined as near-, mid-, and long-term projects with dependencies to hydrology and water quality improvements before habitat is constructed. The project team felt this was akin to keeping low-priority, small-diameter sewer line replacements in a sanitary system plan; the projects may not rise to the top of an implementation list, but the fact that the work is eventually needed should be documented.

Pipe capacity projects received some of the highest score-to-cost ratios because of the high rank of the "capacity objective." However, capacity constraints identified through hydraulic modeling were not found to be significant level-of-service deficiencies in this basin, in that they tended to be pipes surcharging rather than manholes flooding. This made a number of projects appear to be overly important. The rankings of these projects and their places in the preferred alternative were carefully considered.

3.4.2 Adjusted Results

As discussed above, scores and costs for projects requiring non-city partners were reduced to reflect a lower likelihood of occurrence and a cost share by the partner, respectively.

Estimated costs for the BES perspective of each alternative are shown in Table 3-4. The 100-year total present worth column represents all costs associated with each alternative. O&M costs are broken out to show 100-year present worth and annual costs. The Alternative 3 BES perspective costs are lowest. This is due in part to the stormwater detention and treatment approach in Alternative 3. Maintaining relatively few large stormwater management facilities costs much less than maintaining many small facilities.

Table 3-4
Cost Estimates for Alternatives from BES Perspective

Alternative	100-Year Total Present Worth Cost	100-Year O&M Present Worth Cost	Annual O&M Cost
1'	$36,400,000	$3,500,000	$150,000
2'	$37,400,000	$6,500,000	$230,000
3'	$29,000,000	$1,600,000	$110,000
4'	$83,200,000	$19,600,000	$620,000

Table 3-5 compares score-to-cost ratios for the two perspectives. Alternative 3 has the best ratio from both perspectives.

Table 3-5
Score-to-Cost Ratios for Alternatives from System and BES Perspectives

Alternative	System Perspective	BES(') Perspective
1	1.2	1.0
2	1.4	1.4
3	1.9	1.6
4	0.9	0.9

Note: Score-to-cost ratio = MUA score/project net present worth cost in millions of dollars.

Figure 3-5 is similar to Figure 3-4, but also shows the BES perspective. Data points representing the System Perspective are denoted with the alternative number. Data points representing the BES perspective are denoted with the alternative number and an apostrophe (').

3.5 Preferred Alternative

The capital and operating recommendations that together form the preferred alternative are described here.

3.5.1 Included Projects

Projects listed in Table 3-6 are those selected for the preferred alternative. Detailed descriptions of the projects can be found in Chapter 4, Recommended Plan. The Recommended Plan is the means by which the preferred alternative will be implemented, and considers logistics, phased implementation, and project dependencies.

Projects in Table 3-6 are arranged in color-coded blocks by primary project-type. Within each colored block, projects are sorted first by priority and then by score-to-cost ratio. Higher priority projects typically have higher score-to-cost ratios. However, the project team did use best professional judgment in some instances to assign a higher or lower priority, according to the refinement principles described above.

Two projects in Table 3-6 indicate they are "On hold in WIF" in the Request Funding column. The Watershed Investment Fund (WIF) is an umbrella program in the BES CIP that funds watershed improvement projects, particularly smaller projects or those that are "early action" from planning processes and can leverage other resources. The two projects with this notation are related and require participation by ODOT to continue.

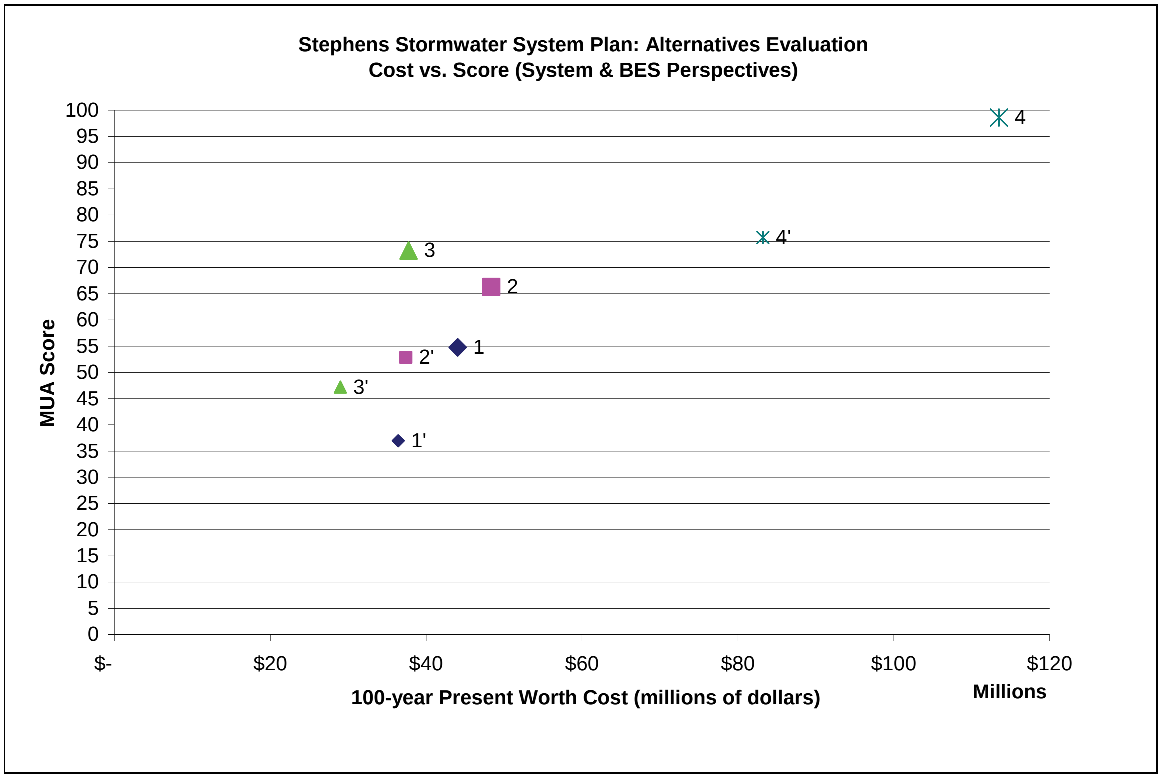

Figure 3-5
Final Alternative Scores and Costs

Figure 3-6 and Figure 3-7 make up the map to accompany Table 3-6. Color–coding in the table corresponds to the callout color-coding in the map. For simplicity, callouts are shown in this map for high priority projects only. All projects are discussed in Chapter 4, Recommended Plan.

Table 3-6
Project Scores and Costs

	Ref. No. [a]	Project ID [b]	Project Title	Project Net Present Worth Cost	BES Net Present Worth Cost [c]	Non-City Partner Required [d]	MUA Score [e]	Score-to-Cost Ratio [f]	Priority (H/M/L) [g]	Term (Long/ Near) [h]	Request Funding [i]
Neighborhood	1	5.2	Expand and enhance existing Custer Park neighborhood wetland facility	$309,000	$309,000		3.90	12.61	High	Near	CIP FY14
Neighborhood	2	31.1a, b	Stephens Natural Area In-Line Detention and wetland enhancement	$883,000	$883,000		4.87	5.51	High	Near	CIP FY14
Neighborhood	3	21.2b	Fulton Park Neighborhood Wetland Facility Adjacent to the Community Garden	$580,000	$580,000		0.62	1.06	High	Near	CIP FY15
Neighborhood	4	24.6	Raz wetland enhancement and neighborhood detention	$1,125,800	$1,125,800		0.76	0.68	High	Near	CIP FY14
Neighborhood	5	23.1a	SW Terwilliger Shared Neighborhood Facility	$1,511,000	$1,057,700	x	0.68	0.65	High	Medium	CIP FY15
Neighborhood	6	21.2a	A-Boy neighborhood detention facility adjacent to I-5 in existing low point	$302,000	$211,400	x	2.59	12.26	Medium	Near	CIP FY15
Neighborhood	7	17.3	SW Evans neighborhood facilities	$626,000	$626,000		1.00	1.60	Medium	Medium	
Neighborhood	8	2.1b	Boones Ferry neighborhood detention pond	$405,000	$283,500	x	0.10	0.34	Medium	Medium	
Neighborhood	9	6.1 & 6.3	Greater Portland Bible Church neighborhood facility	$1,373,000	$961,100	x	0.32	0.33	Medium	Medium	CIP FY14 Alternate
Neighborhood	10	14.2	Real-time controls stormwater retrofit at Burlingame Fred Meyer and nearby apartments	$76,000	$53,200	x	0.07	1.32	Low	Long	
Restoration	11	24.10	Spring Creek riparian restoration	$3,000	$2,100	x	0.12	56.03	High	Near	Op FY15
Restoration	12	31.3	Improve near-stream habitat Clover Leaf Apt.	$2,000	$1,400	x	0.05	39.15	High	Near	Op FY15
Restoration	13	3.1	Expand and enhance Texas Wetland	$21,000	$21,000		0.60	28.75	High	Near	Op FY14
Restoration	14	32.3	Fulton Park revegetation	$36,000	$36,000		0.24	6.69	High	Near	Op FY14
Restoration	15	26.7	Restore historic channel at Miles Creek	$437,000	$437,000		2.44	5.59	High	Near	On hold in WIF
Restoration	16	12.4	Crestline Creek improve near-stream habitat	$62,000	$43,400	x	0.15	3.57	High	Near	CIP FY15
Restoration	17	19.3	Ruby Creek improve near-stream habitat	$34,000	$23,800	x	0.08	3.33	High	Medium	CIP FY15
Restoration	18	28.3a	Taylors Ferry culvert replacement	$326,000	$326,000		0.99	3.05	High	Long	
Restoration	19	25.2	Wetland enhancement Burlingame reach	$67,000	$46,900	x	0.14	3.00	High	Long	
Restoration	20	27.3	Wetland enhancement Burlingame reach	$67,000	$46,900	x	0.14	2.96	Medium	Long	
Restoration	21	25.1a	Lay back banks Burlingame reach	$334,000	$233,800	x	0.31	1.32	Medium	Long	
Restoration	22	25.1b	Culvert removal and daylighting in Burlingame reach	$145,000	$101,500	x	0.13	1.25	Medium	Long	
Restoration	23	29.5	Macadam improve near-stream habitat	$188,000	$131,600	x	0.16	1.24	Medium	Long	
Restoration	24	28.3b	Taylors Ferry stream daylighting	$1,386,000	$970,200	x	0.42	0.44	Medium	Long	
Restoration	25	32.1	Fulton Park stream daylighting	$1,076,000	$1,076,000		0.44	0.41	Medium	Medium	CIP FY17
Restoration	26	23.4b	SW Terwilliger improve in-stream habitat	$419,000	$293,300	x	0.10	0.32	Medium	Long	

Table 3-6
Project Scores and Costs

	Ref. No. [a]	Project ID [b]	Project Title	Project Net Present Worth Cost	BES Net Present Worth Cost [c]	Non-City Partner Required [d]	MUA Score [e]	Score-to-Cost Ratio [f]	Priority (H/M/L) [g]	Term (Long/ Near) [h]	Request Funding [i]
Restoration	27	26.2	Large wood installations, invasives control and revegetation in Stephens Canyon	$890,000	$623,000	x	0.17	0.28	Medium	Long	
	28	31.4	Improve in-stream habitat Clover Leaf Apt.	$471,000	$329,700	x	0.06	0.18	Medium	Medium	CIP FY17
	29	31.2a, b, c	Raz Transportation acquisition, stream daylighting, LUST Cleanup	$1,341,000	$938,700	x	0.16	0.17	Medium	Long	
	30	24.8	Capitol Hills Condos stream daylighting	$864,000	$604,800	x	0.10	0.17	Medium	Medium	CIP FY17
	31	28.3d	Taylors Ferry improve in-stream habitat	$1,474,000	$1,031,800	x	0.16	0.16	Medium	Medium	CIP FY17
	32	24.9	Shadow Hills Apt. stream enhancement	$2,112,000	$1,478,400	x	0.23	0.16	Medium	Medium	CIP FY17
	33	25.1c	Improve in-stream habitat Burlingame reach	$1,862,000	$1,303,400	x	0.05	0.04	Medium	Long	
Pub. Infra.	34	28.6 & 9.2c	Taylors Ferry Rd., River View Cemetery and Mausoleum outfall repairs	$963,000	$674,100	x	4.32	6.41	High	Near	CIP FY14
River View	35	9.5	River View neighborhood wetland facility	$67,000	$46,900	x	0.17	3.57	High	Medium	CIP FY15
	36	9.3a	River View improve near-stream habitat	$403,000	$282,100	x	0.49	1.74	Medium	Near	CIP FY15
	37	28.3c	Natural fish ladder above Hwy 43 culvert	$1,318,000	$922,600	x	0.15	0.16	Low	Long	
	38	9.3b	River View Cemetery improve in-stream habitat	$8,972,000	$6,280,400	x	0.43	0.07	Low	Medium	
	39	9.4	Restore in-stream connectivity for fish passage - Taylors Ferry Tributary	#N/A	#N/A	x	0.14	#N/A	Medium	Medium	
	40	9.1	River View Cemetery retrofit	#N/A	#N/A	x	0.07	#N/A	Medium	Medium	
	41	28.1 & 28.2	River View Cemetery Retrofits	#N/A	#N/A	x	0.05	#N/A	Medium	Medium	
Mausoleum	42	27.4a	Mausoleum property revegetation	$161,000	$112,700	x	0.19	1.69	Medium	Near	Op FY15
	43	27.1 & 27.2	Mausoleum retrofit	$55,000	$38,500	x	0.04	1.07	Medium	Medium	
	44	27.4b	Mausoleum Tributary property acquisition	$2,268,000	$1,587,600	x	-	-	Medium	Near	
	45	27.6	Mausoleum North property acquisition	$851,000	$595,700	x	-	-	Medium	Near	
ODOT	46	26.1a	Treat Stephens Canyon I-5 runoff with Stormfilter	$1,099,000	$769,300	x	0.70	0.92	High	Near	On hold in WIF
	47	23.2	Stormwater filter Vault at ODOT ROW to treat I-5 runoff	$594,000	$415,800	x	0.20	0.49	High	Near	CIP FY15
	48	25.5	Rain gardens for bioremediation of I-5 outfalls	$137,000	$95,900	x	0.03	0.34	High	Near	CIP FY15
	49	23.3	Local stormwater treatment facilities on I-5 freeway and Bertha and Terwilliger overpasses	$150,000	$105,000	x	0.02	0.15	High	Near	CIP FY15
	50	23.4a	SW Terwilliger improve near-stream habitat in ODOT	$55,000	$38,500	x	0.08	2.12	Medium	Long	

Table 3-6
Project Scores and Costs

	Ref. No. [a]	Project ID [b]	Project Title	Project Net Present Worth Cost	BES Net Present Worth Cost [c]	Non-City Partner Required [d]	MUA Score [e]	Score-to-Cost Ratio [f]	Priority (H/M/L) [g]	Term (Long/ Near) [h]	Request Funding [i]
			right-of-way								
	51	29.1	Macadam culvert - Daylight	$438,000	$306,600	x	0.14	0.44	Medium	Long	CIP FY17
	52	26.1f	Stephens Canyon I-5 Runoff to Willamette or Combined System	$4,069,000	$2,848,300	x	0.70	0.24	Low	Long	
Private Retrofit	53	21.1	StormFilter A-BOY parking lot	$10,000	$7,000	x	0.02	2.71	Medium	Medium	
Private Retrofit	54	6.2	Greater Portland Bible Church parking lot depaving	$48,000	$33,600	x	0.02	0.51	Medium	Near	
Private Retrofit	55	24.5	Apt Retrofit (Spring Creek, Shadow Hills and Capitol Hill)	$1,602,000	$1,121,400	x	0.17	0.15	Medium	Long	
Private Retrofit	56	22.1	Capitol Hill School and St Claire Church retrofits	$2,653,000	$1,857,100	x	0.06	0.03	Medium	Medium	
Private Retrofit	57	14.1 & 14.2	Stormwater retrofit planters at apartments and Fred Meyer	$460,000	$322,000	x	0.07	0.22	Low	Long	
Private Retrofit	58	3.4	Stormwater retrofit at Hillsdale Community Church	$668,000	$ 467,600	x	0.01	0.02	Low	Long	
Basin-wide	59	BWRF.1	Curb extension retrofits on PBOT high-priority streets	$4,565,000	$4,565,000		11.07	2.43			CIP FY14 Select
Basin-wide	60	BWRF.2	Curb extension retrofits on all right-of-way	$23,386,000	$23,386,000		25.45	1.09			
Basin-wide	61	BWRF.3	Private property retrofits as required to reduce high pulse count to predeveloped level	$2,007,000	$1,404,900	x	0.80	0.57			CIP FY15 Select
Basin-wide	62	BWRF.5	Commercial property retrofit with ecoroof and pervious pavement	$850,000	$595,000	x	0.19	0.33			
Basin-wide	63	BWRF.4	Basin-wide street tree planting	$1,660,000	$1,660,000		0.23	0.14			

[a] Reference number for this table. It does not imply any priority.
[b] Reference number corresponding to project development. More detail on individual projects can be found by looking up projects in Project Fact Sheets provided on the SCSWSP intranet site.
[c] Net present worth from the BES perspective.
[d] An "x" indicates non-City partner required, triggering score and cost reductions described above.
[e] Project's score contribution to the overall alternatives.
[f] MUA score divided by BES net present worth cost in millions of dollars.
[g] High, medium, or low project priority.
[h] Timing recommendation.
[i] Recommended funding year, operating or capital funds.

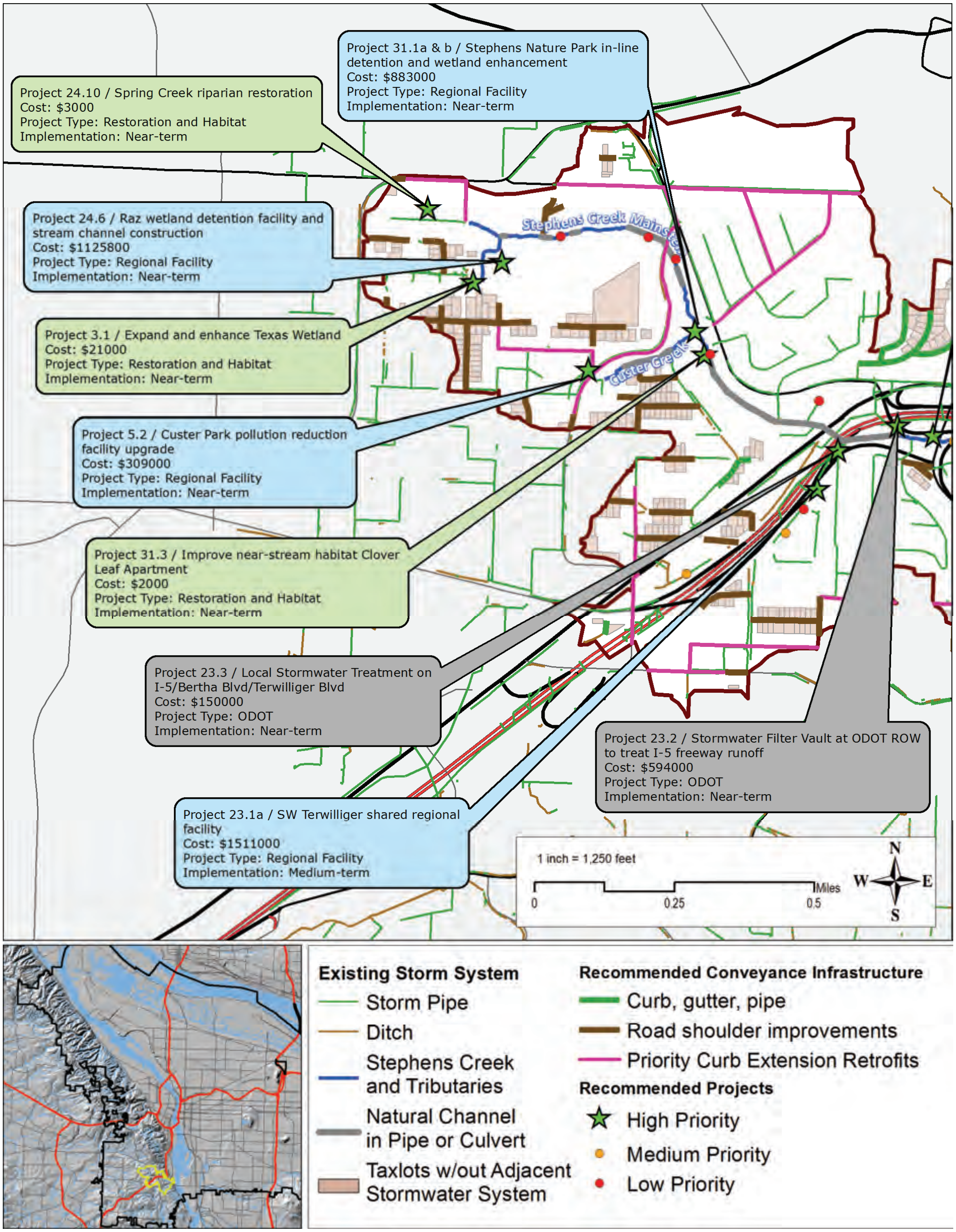

Figure 3-6
Recommended Plan Map (West)

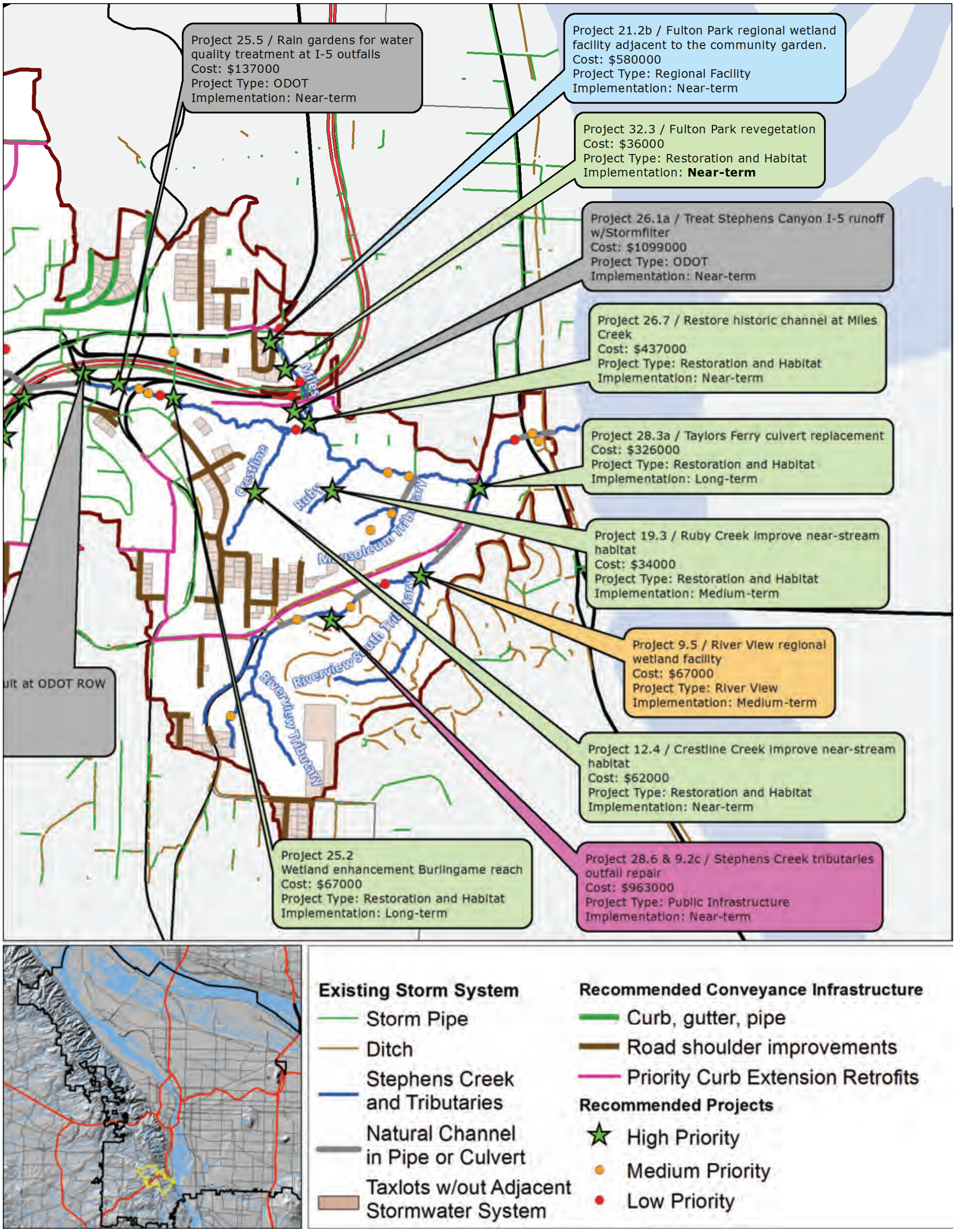

Figure 3-7
Recommended Plan Map (East)

3.5.2 Operating Recommendations

While much of the alternative evaluation focused on capital improvements, Alternative 3 also included operating project recommendations that were developed with stormwater system stakeholders. The term "operating" qualifies these recommendations to distinguish them from capital investments and acknowledges that they are subject to a separate BES decision making process. These recommendations include early actions, policy, program, and technical options (see Table 3-7).

As acknowledged in Section 3.4.1, Refinement Principles, these options have impacts on operating costs, which are difficult to estimate and score and were therefore not included in the project scoring or costs. Table 3-7 lists all of the operating recommendations collected from the stormwater system stakeholders and prioritizes them based on discussions to date. Further scoping and assessment of these options is necessary. All technical options will be forwarded to the next SWMM revision work plan. The highest priorities are discussed further in Chapter 4, Recommended Plan.

Table 3-7
Operating Recommendations

No.	Description	Level of Priority
Early Actions		
E1	Centralize all stormwater and drainage complaints for private, public and the right-of-way (from BDS, BES Watershed Services, CRR, SSMP, Maintenance Engineering, Development Review, SPCR, MIP and others) in an on-line database linked to GIS to facilitate response and future activities and programs. Include training for employees. Provide means for residents to report problems to the centralized database through phone and website.	Very High
E2	Have a program discussion with PP&R about what mutually beneficial projects and programs can be initiated to improve stormwater system and park system in the Stephens Creek watershed. Inquire about opportunities to retrofit existing properties and park acquisition plans.	Very High
E3	Continue participating in PBOT's Performance Based Streets initiative to explore more flexibility for stormwater management when improving local, SFR streets.	Very High
E4	Resolve maintenance responsibility issues with ODOT so project implementation can proceed.	Very High
E5	Continue E. coli investigations and monitoring to determine and eliminate E. coli sources.	Very High
Policy Options		
P1	Identify potential acquisition sites for stormwater management, that provide other benefits such as habitat and neighborhood pocket-parks (like Crystal Springs at SE 21st and SE Tenino and SW 17th and Taylor's Ferry).	High
P2	Establish mechanisms to support capital funding for small projects on unimproved streets. Related to P6	High
P3	Secure continuous conveyance authority through evaluation of OR drainage law, International Building Code, and drainage reserves with the creation of a Southwest Stormwater Partnership. Preliminary scope includes whether private-to-private and public-to-private stormwater connections can be considered an approvable discharge point if a drainage reserve is established. The city could provide standardized contract language to be used between property owners to facilitate establishment of drainage reserves. Upon establishment, drainage reserve will be mapped and added to the city's asset database as a part of the stormwater conveyance network.	Medium

Table 3-7
Operating Recommendations

No.	Description	Level of Priority
	Private-to-private drainage reserves would be at the mutual convenience of both parties. The city can provide a framework for discussions between property owners and typical guidelines on negotiations. A mediator may be provided. This could be triggered when a property is developed or redeveloped and/or new impervious area is added or at the request of the neighbors to resolve issues.	
P4	When public flow goes through private property consider:	Medium
	a. Acquiring public easements over drainage areas both within and outside the environmental zone in order to allow implementation of cost effective improvements on multiple properties at once. Title 17 Drainage reserve code, provides for 15 feet of non-developed clearance on both side of the channel and prohibits filling open drainage-ways. Easements provide more flexibility than drainage reserve since easements have site specific limitations rather than prescribed parameters (i.e., many drainage ways have less than 15 foot non-developed clearance on both sides).	
	b. Strengthening enforcement of the drainage reserve code. Currently drainage reserves are added during land use review.	Medium
	c. Investigate established drainage reserves for code violations.	Medium
	d. City maintenance of drainageways going on private property (Johnson Creek change-change easements as a model?).	Medium
P5	Make code changes to clarify and help resolve neighbor-to-neighbor conflicts about stormwater. (Currently, BDS has code authority but does not typically respond to these issues. BDS only has authority under the plumbing code which does not consider how stormwater is routed off site.) Also, make sure that any code change recognizes that properties without an approved disposal point may not necessarily be causing environmental damage.	Medium
P6	Update off-site management fees to reflect true costs of managing stormwater off-site and use those funds to restore private and public stream channels.	Medium
P7	Allow pollution reduction or flow control trading within the drainage basin, prioritizing critical areas.	Medium
P8	Set up a facilitated permitting program (like Stormwater Retrofit's rain gardens) for specific types of retrofits or restoration for targeted projects in SW.	Medium
P9	Streamline permitting and/or permit costs for stormwater retrofits and in-stream restoration projects on private property. Clean River Rewards equivalent (reduction of stormwater fees) for:	Medium
	a. Offsite/public facility maintenance	
	b. Increasing vegetation buffer in riparian areas.	
	c. In-stream enhancements	
P10	In areas with stormwater LOS deficiencies, consider moratorium on development, re-zoning to decrease or prevent development, or target mitigation projects in these areas.	Low
Program Options		
Pr1	Plant trees	High
	a. Coordinate with Watershed Revegetation to prioritize and plant riparian areas	
	b. Coordinate with Urban Forestry to plant large trees strategically in ROW or on the edges of private property to maximize canopy over road surfaces where there's no room for SWMM facilities.	

Table 3-7
Operating Recommendations

No.	Description	Level of Priority
Pr2	Partner with River View Cemetery to retrofit outfalls and support stormwater master planning.	High
Pr3	Funding to help BES resolve neighbor-to-neighbor conflicts about stormwater. Create Incentive program with grants and technical assistance to help private property owners address stormwater problems. (CWSP program is too small and community focused).	High
Pr4	Fund a comprehensive education and outreach program that starts 18 months before any BES construction begins. Lay the groundwork in the community for acceptance of projects by painting the big picture for water quality, stream health, stormwater system, sanitary system and the benefits of the work. (ECTOPIC in Tabor to the River was capitalized.) Include educational information for development and construction business sectors.	High
	Develop brochures and other outreach material including the Bes website that describes how the stormwater system relies on public and private property.	
	a. Develop a brochure, “How to talk to your neighbor about stormwater.”	
	b. Offer watershed walking tours help people to understand the stormwater system and connect with the stream.	
	c. Identify Green Street champions who are willing to serve as ambassadors and share experiences of living with green streets	
	d. Self-guided tour of stormwater facilities for SW.	
	e. Connect people with stormwater and stormwater-related events through social media.	
	f. Partner with WMSWCD, Southwest Watershed Center, West Willamette Partnership, Backyard Habitat, Tryon/Fanno outreach staff.	
Pr5	Evaluate funding needs for the BES Maintenance Inspection Program (MIP), allowing them to increase inspections on commercial properties residential properties, as well as drainage reserves.	Medium
Pr6	Increase funding for maintenance of public stormwater facilities to allow for proactive solutions.	Medium
Technical Options		
T1	Update SWMM to create stormwater management requirements specific to west side:	High
	a. Focus on-site management for smaller summer storm, not large winter storm.	
	b. Allow some flexibility with the standard infiltration rate for approved infiltration - 2” / hour depending on site conditions	
	c. Support more flexibility for stormwater management with performance-based streets and performance-based design review and approval on private property.	
	d. Vary flow control requirements to reflect specific hydrology of receiving stream	
T2	Explore standards and criteria to allow mixing public and private stormwater in public or private stormwater management (WQ and flow control) facilities.	High
T3	Find pervious materials (e.g., concrete, asphalt, pavers) that are ADA-compliant, that could work for pedestrians & bikes and meet stormwater management objectives.	High
T4	Line and provide underdrains for permeable pavement that drain to multi-objective constructed wetlands.	High
T5	On streets where grades are challenging, allow cross-sloped street sections to manage runoff on one side of street.	High

Table 3-7
Operating Recommendations

No.	Description	Level of Priority
T6	Create "simple green street" design guidelines (narrow cross section, with and w/out curbs, ditches with check dams, rush/sedge plantings with large rock storage areas below grade).	High
T7	Prioritize areas for ecoroofs, permeable pavement driveways, cisterns… any tools that can maximize flow control on private property (support with outreach program).	Medium
T8	Explore criteria for when it might be desirable to provide a piped bypass where natural channel sections cannot be augmented to meet the needs of the existing drainage area flowing to it.	Medium
T9	Have PBOT identify:	
	a. Flow-based criteria for when inlets are required.	
	b. Where curbs are required.	
	c. Where pedestrians could be protected by vegetation strips	
	d. Where feasible to combine downhill bike lanes with downhill car lane to make room for stormwater facility (with reduced speeds and explicit signage that downhill roadways are shared with bicycles).	Medium
	Partner with large campus or parcel owners to prepare stormwater master plan.	Medium
T10	Develop attractive, affordable flow through planter for residential scale.	Medium
T11	Allow non-lined elevated underdrain configuration (similar to Seattle)	Medium
T12	Increase infiltration in SW Portland by promoting conversion of lawns and impervious areas to deeper rooted native vegetation.	Low
T13	Specify criteria when stormwater can be discharged to weepholes in curb.	Low

BDS = Bureau of Development Services
CRR=Clean river Rewards
MIP = Maintenance Inspection Program
SPCR =Spill Prevention/Citizen Response
SSMP = Sustainable Stormwater Management Program

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CHAPTER 4

Recommended Plan

ENVIRONMENTAL SERVICES
CITY OF PORTLAND
working for clean rivers

4 Recommended Plan

This chapter documents the development of the recommended plan from the preferred alternative presented in Chapter 3. A summary of the recommended plan is presented, followed by a phased approach to implementing the specific capital and operational recommendations.

4.1 Foundations of the Recommended Plan

Chapter 3, Alternatives Evaluation and Development, presented a prioritized set of projects to improve the stormwater system. The preferred alternative includes components that are more cost-effective for southwest Portland, but it also represents a significant shift from BES' current stormwater management approach. The recommended plan presented here further refines projects from the preferred alternative into phased packages that consider project proximity, priority, relative cost-effectiveness, and internal or external project dependencies.

The recommended plan differs from current management practices via the endorsement of low-cost road shoulder improvements on residential streets to convey stormwater to neighborhood-scale stormwater management facilities. The recommended plan incorporates an ecologically-based approach to prioritizing habitat and restoration improvements, and it recognizes the need to partner with outside partners in project implementation. Together these directions help formulate a strategically phased incremental approach to implementing the recommended plan.

4.1.1 Conveyance System Improvement Approach

As mentioned above, the recommended approach to providing adequate system drainage infrastructure for private properties and the right-of-way incorporates road-shoulder improvements as approvable discharge points for stormwater conveyance in low-traffic areas. This approach is dependent upon the following principles:

- Adoption of performance-based standards for stormwater conveyance on low-traffic residential streets as a cost-effective means to provide adequate stormwater infrastructure. The performance-based approach to stormwater conveyance includes surface conveyance of stormwater on the road-shoulder via vegetated or filled road-shoulder improvements, which can include ditches or filter strips.
- Managing right-of-way stormwater in downstream neighborhood-scale detention and pollution reduction facilities when on-site management is not practicable due to lack of infiltration, steep terrain, landslide hazards, and other constraints.
- Broadening the LID approach to constructing street improvements on sub-standard roadways by encouraging lower-cost stormwater infrastructure options on residential streets, and by allowing off-site management in constrained areas. This also includes future work to formalize the appropriate level of City contribution to future LIDs using an asset-management approach emphasizing cost-effective risk-reduction opportunities.

4.1.2 Neighborhood Facilities

The recommended approach to retrofit the existing stormwater system focuses on surface stormwater conveyance directed to neighborhood-scale stormwater management facilities that provide local pollution reduction and detention. Neighborhood facilities, like the restored wetland that was part of the LID improvements on SW Texas Avenue, manage a larger drainage area per facility than green street facilities, but are typically smaller than a regional facility (see Figure 4-1). Green street facilities are included in the recommended plan in areas with greater pollutant loading and impervious area, which are typically arterial streets where other transportation system needs warrant stormwater improvements. While neighborhood facilities are emphasized in the SCSWSP, stormwater system planning should incorporate a range of tools, allowing the most appropriate facility type for the specific system needs and site constraints.

Relative to smaller facilities, neighborhood-scale stormwater management facilities are more cost-effective from an on-going operations and maintenance perspective. Vegetation is generally easier to maintain at a larger site because it can be maintained as a natural area allowing native plants to grow with less human intervention. Overall the aesthetics of the facility has to meet the needs of the neighborhood, but for the most part the facility can be left to grow as a natural area, potentially including non-motorized transportation connections and passive recreation amenities.

	Facility Category:		
	Green Streets	Neighborhood Facilities	Regional Facilities
	Smaller	→	Larger
Typical Facility Footprint:	200 sq. ft.	2,000 sq. ft.	20,000 sq. ft.
Typical Drainage Area:	5,000 sq. ft.	50,000 sq. ft.	500,000 sq. ft.
Can be located close to source of runoff?	Yes	→	No
Construction and O&M cost per gallon treated:	Higher	→	Lower
Facility Location:	Typically on-site	Integrated with stormwater system	Often end-of-pipe
Typical Facility Types:	Curb extensions; Swales; Rain gardens	Constructed wetlands; Detention basins	Retention ponds; In-stream controls;

Figure 4-1
Comparison of Facility Sizes

The annual maintenance costs of neighborhood facilities, once established, are significantly lower than the currently distributed green street facilities. A cost analysis conducted several years ago identified a 1-acre parcel as costing approximately $0.10 per square foot to maintain per year versus $1.55 per square foot per year for a typical green street (D. O'Brien, Personal Communication, July 27, 2012). These numbers provide some evidence of reduced maintenance costs in the long-term for neighborhood scale facilities. BES is currently analyzing the fiscal year 2012 expenditures over a larger sample size and will compare/ contrast the variance in these costs by facility type. Preliminary results show that neighborhood facility maintenance costs may be closer to $0.05 per square foot.

In addition to the O&M efficiencies, neighborhood facilities present other opportunities and benefits. In the most constrained portions of southwest Portland and the west hills, neighborhood facilities may be the only feasible option to perform necessary stormwater collection and treatment functions because of the steep gradients and impermeability of the native soils in the area. Neighborhood facilities also provide other ecosystem services to the community, especially by providing public green space and multiple ecological functions that are different than what can be achieved with smaller green street facilities.

Given land availability and the importance of proximity, neighborhood facilities will not provide the answer to every stormwater system deficiency, but they do add another tool to the toolbox, especially in southwest Portland where currently few options exist.

4.1.3 Natural System Improvement Approach

The recommended plan includes a prioritized set of restoration and habitat improvement projects. The recommended approach for restoration of natural assets incorporates the following principles:

- Focusing initial habitat and restoration investments on portions of the watershed that are less impaired by degraded water quality or modified hydrology.
- Habitat and restoration improvements in the most degraded portions of the watershed are dependent upon first implementing upstream stormwater system improvements to reduce pollutant loading and restore modified hydrology. Habitat and restoration improvements in the most impaired areas will be phased after the necessary upstream system improvements have been constructed.
- Retrofitting the existing stormwater system with neighborhood stormwater facilities as a cost-effective means to treat and detain stormwater runoff from the most impaired catchments.
- Prioritizing projects that maximize delivery of clean water to the mouth of the creek to improve conditions for benthic communities as measured by the benthic index of biotic integrity.

4.1.4 Building Partnerships

Another key component of the SCSWSP recommended plan is the recognition that the stormwater system in southwest Portland is not controlled or managed entirely by BES. Portions of the stormwater conveyance network are the responsibility of ODOT, PBOT, PP&R, as well as private institutions such as the River View Cemetery, and individual property owners. Many of the existing drainageways and natural channels are located on private property.

Although BES is prepared to take the lead in capital investment, efforts to build partnerships to manage the shared components are critical to the success of implementing stormwater system improvements. Stormwater system partnerships include three primary areas:

- Public agencies such as ODOT, PBOT, and PP&R.
- Private institutions such as River View Cemetery and the Greater Portland Bible Church.
- Individual property owners.

Many of the projects in the recommended plan include shared responsibility between BES and the partners identified here. Implementation of these projects is therefore dependent on the willingness of these partners to participate in design, implementation, and long-term operation. As discussed in the next section, projects which require more involvement from outside partners are staged in later phases, after activities to build and strengthen these partnerships have occurred.

4.1.5 Phased Implementation Approach

It is recommended that projects from the SCSWSP be conducted in phases, with each phase containing multiple projects. Figure 4-2 shows the proposed CIP implementation schedule for the recommended plan.

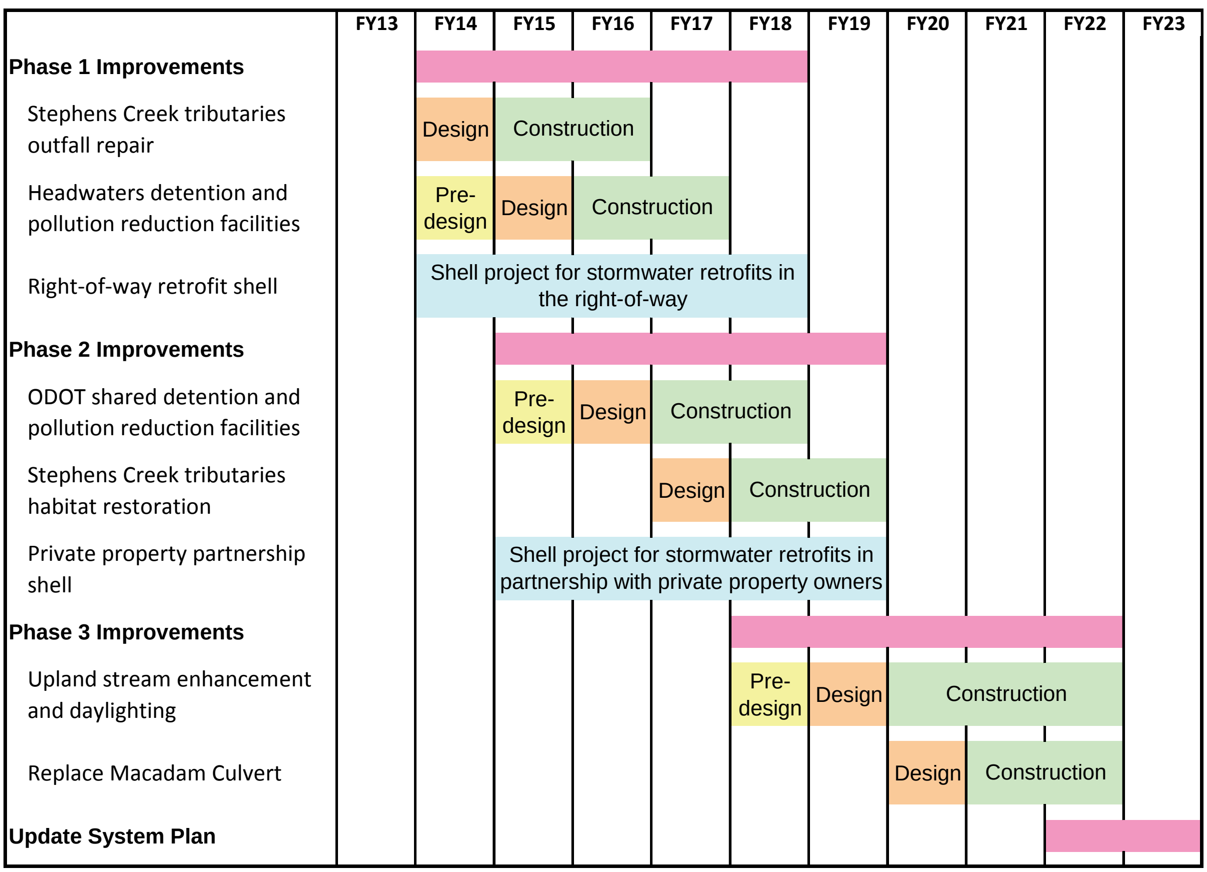

Figure 4-2
Recommended Implementation Schedule

The phased implementation approach takes in to account geographic proximity of the various projects, dependencies on work with outside partners, ecological principles of improving water quality and hydrology to prepare the way for habitat restoration, and establishment of leveled funding requirements.

A funding plan for the recommended implementation schedule is shown in Figure 4-3. Details of the projects for the three phases are described in the following sections. Note that there are many identified projects that are not included in the implementation plan. These projects have been designated for long-term implementation. It is expected these projects will be re-evaluated during the next iteration of the SCSWSP, which per BES planning practices would typically occur in 10 years.

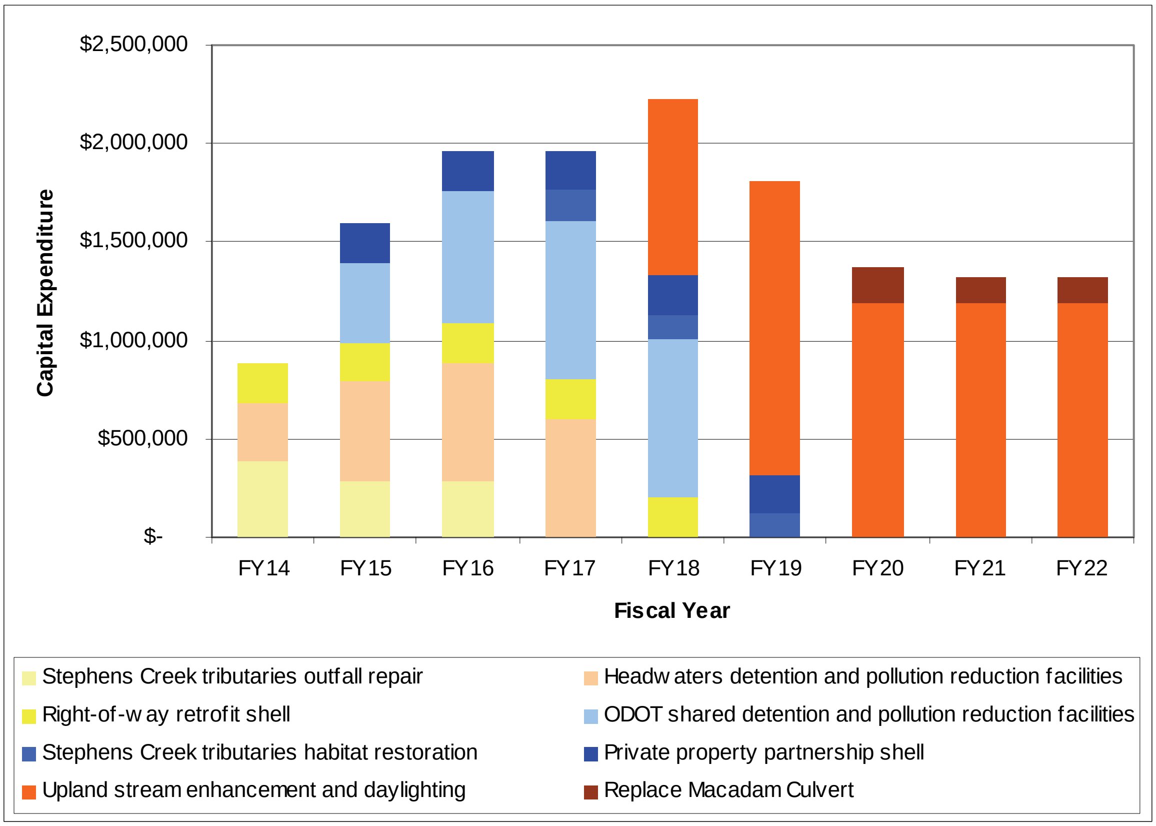

Figure 4-3
Recommended Funding Plan

Note that projects to provide approvable discharge points and localized conveyance infrastructure are not included as specific capital recommendations. Instead, it is expected that these types of projects will be initiated by developers or local improvement districts, consistent with historic city practice. It is recommended that BES be ready to participate in these local improvements to cost-effectively retrofit and improve existing infrastructure at the same time that new local drainages are improved.

Initial funding to support localized conveyance improvements is proposed via the shell projects described as part of the Phase 1 and Phase 2 improvements. Each of the three recommended implementation phases is described in the following sections. Details of the localized conveyance infrastructure recommendations are presented later, in Section 4.6, Conveyance Recommendations.

The final recommended plan endorses low-cost road shoulder improvements on residential streets to convey stormwater to neighborhood-scale stormwater management facilities. It promotes shared, neighborhood-scale stormwater management facilities that provide local pollution reduction and detention. It utilizes an ecologically-based approach to prioritizing habitat and restoration improvements, and it strongly acknowledges the need to rely on outside partners for successful implementation. These ideas combined formulate a phased implementing approach that includes recommendations for both operating and capital investments.

The following sections present various phases of capital projects and operational activities to fully implement the recommended plan.

4.2 Phase 1 Capital Improvements

The Phase 1 package includes three priority projects that are recommended for submittal to the 2014 CIP. The Phase 1 projects are listed in Table 4-1 and shown in Figure 4-4. The total estimated cost for the three projects is $3,960,000. A summary of each project is presented below.

Table 4-1
Phase 1 Capital Improvements

Project Title	Description	Site Cost
Stephens Creek tributaries outfall repair	Repair and enhancement of 17 public and private stormwater outfalls on the River View, River View South, and Ruby Creek tributaries of Stephens Creek	$960,000
Headwaters detention and water quality facilities	Construction of three neighborhood scale detention and pollution reduction facilities in the portion of the watershed above I-5	$2,000,000
Right-of-way retrofit shell	Provides a flexible means to construct stormwater retrofits to the existing system on streets identified as high-priority for detention and/or and pollution reduction	$1,000,000

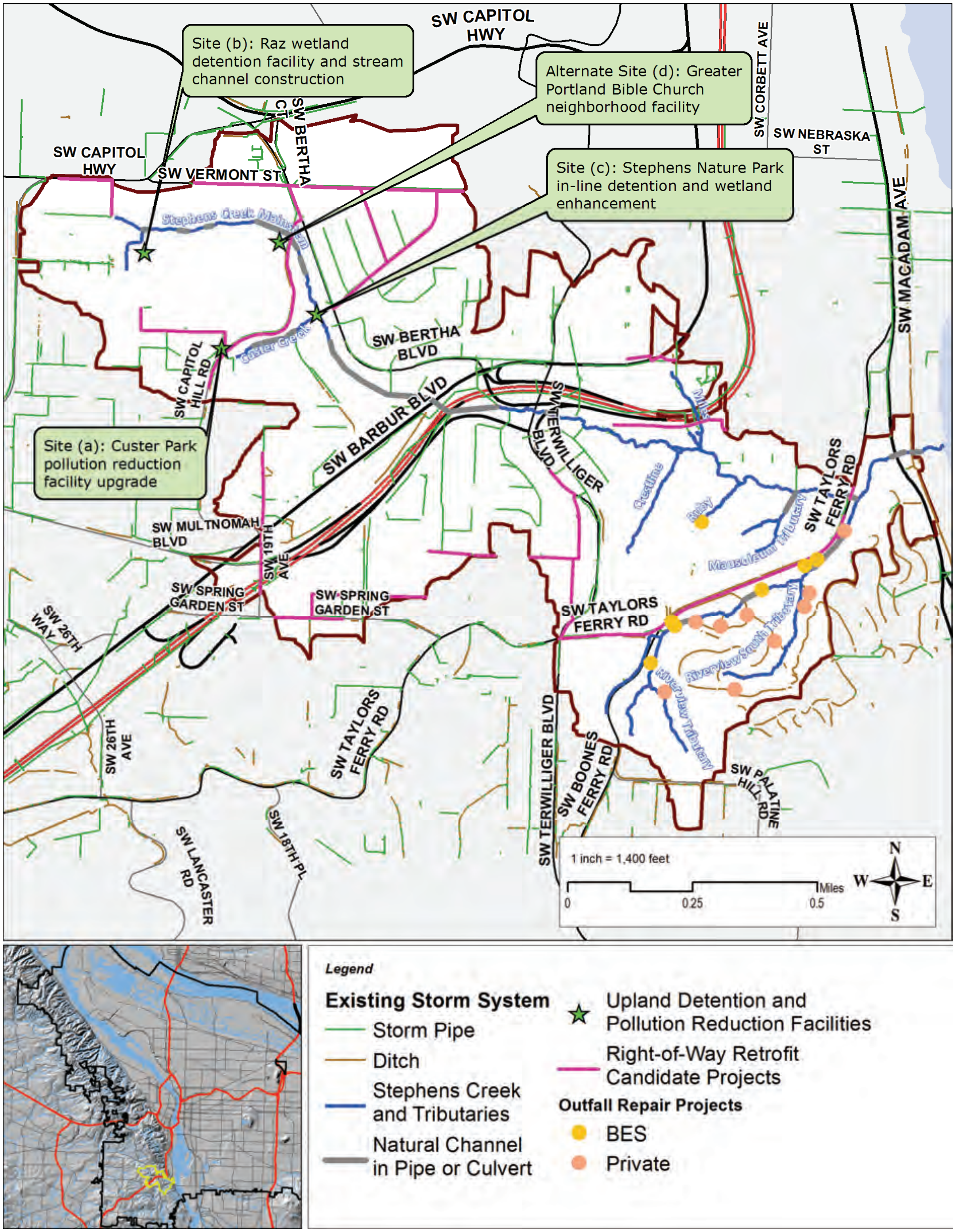

Figure 4-4
Phase 1 Capital Improvements

4.2.1 Stephens Creek Tributaries Outfall Repair

Sixteen outfalls in the Stephens Creek watershed are identified as lacking adequate energy dissipation. Fifteen of the sixteen outfalls are in the River View Tributary sub-basin, and most of these drain either Taylors Ferry Road or access roads in the River View Cemetery. One outfall is located at the head of Ruby Creek and potentially threatens the structural integrity of an adjacent sanitary pipe.

The outfall repair projects will include filling incised ravines, providing adequate energy dissipation between the outfall and the stream via step-pools or other low-impact designs, removal of invasive species, planting native vegetation, and reconstruction of collapsed or deficient outlet structures.

In addition to the sixteen outfalls, this project includes remediation of an inadequate drainage ditch along SW Taylors Ferry Road. Runoff from the roadways collects into a small channel along the road shoulder and is then discharged down the bank to the River View Tributary, about 50 feet below the road. Scour at the discharge point is up to 12 feet deep in three or four channels below the road. The erosion threatens to undermine a water main, a fire hydrant, a power pole, and the roadbed. This portion of the project will include road shoulder drainage improvements on SW Taylors Ferry Road and construction of energy dissipation features between the roadway and the creek.

This project is estimated to cost $960,000. This cost includes repair of both the public and private outfalls. It is expected that a portion of the project cost would be shared with River View Cemetery for improvements to the privately-owned facilities.

4.2.2 Headwaters Detention and Pollution Reduction Facilities

This project includes construction of three neighborhood scale stormwater management facilities to provide detention and pollution reduction in the upper portion of the Stephens Creek watershed. This project will undergo a predesign process, which may identify additional opportunities to provide detention and pollution reduction beyond those included here.

Three facilities were identified as high-priority locations for detention and pollution reduction; these facilities form the basis for this recommended project. A fourth location is also included as an alternate site that can be evaluated during predesign.

The specific facilities included in this project are listed in Table 4-2.

Table 4-2
Headwaters Detention and Pollution Reduction Project Sites

Site Identifier / SCSWSP Project Identifier	Site Description	Site Cost
Site (a)/Project 5.2	Custer Park pollution reduction facility upgrade; expansion of capacity and function of existing swale and pond located along Custer Creek in Custer Park to improve stormwater services and recreation use.	$230,000

Table 4-2
Headwaters Detention and Pollution Reduction Project Sites

Site Identifier / SCSWSP Project Identifier	Site Description	Site Cost
Site (b)/Project 31.1a/b	Stephens Nature Park in-line detention and wetland enhancement; construct detention facility in Stephens Creek upstream of the Burlingame culvert and enhance existing wetland, consistent with 2005 *A Functional Plan for Stephens Creek Nature Park* and planned 2013 trail improvements.	$750,000
Site (c)/Project 24.6	Raz property wetland detention facility; detention and stream channel construction in undeveloped property at the headwaters of Stephens Creek. Note that the site cost does not include land acquisition.	$1,030,000
Alternate Site (d)/ Project 6.1/6.3	Greater Portland Bible Church neighborhood facility; an opportunity exists to construct a vegetated stormwater treatment facility on a taxlot adjacent to the Greater Portland Bible Church.	-

4.2.3 Right-of-Way Retrofit Shell

Request for Capital Funds

The SCSWSP requests capital funds for stormwater system improvements in the public right-of-way to be designated the Stormwater Right-of-Way Retrofit Shell. This request will provide a flexible means to construct stormwater management facilities (including pollution reduction, flow control, and conveyance) for areas identified as high-priority stormwater system needs.

Note that although this project is called the Right-of-Way Retrofit Shell, projects funded under this shell are not required to exist exclusively in the right-of-way. Instead, it is intended to fund capitalizable improvements to any BES-owned stormwater assets. This can potentially include improving assets within existing easements and acquisition of new easements.

The Stephens Creek characterization identified 25% of the streets in the basin (approximately 6 miles) are unimproved and lack access to an adequate stormwater system. While the remaining streets have some stormwater infrastructure, many are substandard. Generally, steep slopes and poor infiltration make stormwater management challenging, but also the streets in this basin were constructed before stormwater requirements were in place and now require capital investment to reduce risk and improve system function. Owing to the scale of the system needs and limited funding, this SCSWSP recommends a street investment program that incrementally focuses on the most cost effective and highest priority system needs as other right-of-way improvements are made.

Draft criteria for projects to be funded with stormwater right-of-way retrofit shell include:

- Improve stormwater conveyance infrastructure that does not meet current standards or presents high risk
- Meet or exceed SWMM stormwater management (pollution reduction and flow control) requirements for new and existing impervious area in the right-of-way

- Providing an approvable discharge point for flow currently entering the BES sanitary sewer system as rainfall-derived infiltration and inflow; for example, creating a BES stormwater asset by converting an unmanaged private drainageway into an engineered surface conveyance facility and obtaining an easement (associated work on private property would commence under the Stormwater Retrofit Partnership Shell described in Section 4.3.3)
- Other city objectives are met (e.g., transportation safety improvements and projects that facilitate rainfall-derived infiltration and inflow reduction) and matching funds are available
- Securing an easement for built infrastructure, natural channels, or drainageways to convey stormwater

The following SW Sunset Boulevard project case study illustrates a circumstance where this funding might apply.

Case Study: SW Sunset Boulevard

In FY 2012-13, PBOT plans to construct approximately 900 linear feet of sidewalk and bike lane on Sunset Boulevard between SW 18th Avenue and SW Capitol Highway. This project provides important pedestrian and bike safety improvements on a well-traveled route in southwest Portland and the project has high community support. Two schools, Wilson High School and Robert Gray Middle School, are located within ¼ mile of this project. The community also requested on-street parking in addition to the pedestrian and bike improvements.

Usable space in the Sunset Boulevard right-of-way is very limited and several retaining walls are necessary to fit the proposed improvements and to preserve existing trees. With input from the neighborhood, the project team decided to locate the sidewalk and bike lane on the east side of the street and parking and stormwater facilities on the west side. Street pavement is currently crowned without curbs. This project will leave existing pavement in place but add curbs on both sides. On the east side, most of the sidewalk will be separated from the street with a narrow planter strip and new street trees where space allows. The rest of the sidewalk will be installed “curb-tight” with only the curb separating the sidewalk from the street. On the west side, curbs are needed to route stormwater into the facilities and away from private property, and to define the parking areas.

Per the SWMM, pollution reduction and flow control are required. However, infiltration is poor and space is limited, so the stormwater management facilities can only be sized for pollution reduction for the runoff they receive from the west side of the street. Though flow control for the entire right-of-way drainage is highly desirable, it is not required by the SWMM and is not achievable in the available right-of-way. Also, collecting and conveying previously dispersed runoff with new curb and gutter creates the need to find an approvable discharge point.

- Runoff from the east side of the street will be directed to an existing catch basin that is connected to a makeshift series of storm sewers that ultimately drain to combined sewer system.

- Runoff from the west side of the street will receive pollution reduction through a series of four stormwater facilities. Overflow from SW 18th Avenue to SW Pendleton Street will go to a storm sewer main on private property. Overflow from SW Pendleton Street to SW Capitol Highway will flow into a catch basin that connects to the storm sewer in SW Capitol Highway. Both lines drain to Fanno Creek.

Although the project met minimum SWMM requirements for pollution reduction, the stormwater design would likely be different if the scope of the analysis and design were broadened to address stormwater system needs in the drainage area instead of just stormwater management for new and redeveloped impervious area.

Perhaps not every issue can or should be addressed, but the following system needs warrant consideration:

- Stormwater upstream of the drainage at the intersection at SW 18th Avenue and SW Sunset Boulevard is conveyed in a piecemeal configuration of ditches and pipes and eventually ends up in a storm sewer main on private property.
- The condition and configuration of the BES storm sewer on private property (previously mentioned) needs further investigation (a segment of the line is not in an easement and jogs around existing residential development).
- The makeshift storm lines in SW Sunset Boulevard (from SW Dewitt Street to SW Capitol Highway) need to be assessed and likely upgraded.
- Because half the street drains to a stream and half the street drains to a combined sewer, further analysis should be conducted to determine if one or the other is a preferable discharge point.
- Determine if there are any adjacent undeveloped properties that could serve as a neighborhood stormwater management facility.
- There are a number of land use actions in the area. BES needs to be prepared to respond to new development proposals on private property with an approvable discharge point.

Application of Requested Funds

The proposed CIP request for stormwater right-of-way retrofit shell provides a means for BES to leverage funds for SWMM-required facilities against internal capital investment. Essentially, it is more cost-effective to address unmet system needs and to improve non-standard conveyance infrastructure at the same time stormwater management projects are being implemented. The Stormwater Right-of-Way Retrofit Shell provides a means to do this.

Without this funding, cost-effective opportunities for system improvements will be lost, resulting in higher costs for both BES and those responsible for constructing stormwater management facilities.

The Stormwater Right-of-Way Retrofit Shell is intended as flexible means to coordinate right-of-way improvements that are funded by other agencies or parties with BES's stormwater system improvements needs. This could include funding larger facilities than would otherwise be required by the SWMM, upgrading non-standard or aging conveyance infrastructure, property acquisition for neighborhood-scale stormwater facilities, and obtaining easements for drainageways that convey public stormwater.

The initial project list from this shell was developed in coordination with PBOT and includes streets identified for future transportation improvements in their Transportation System Plan and other plans, and focuses on streets that are identified as in need of pedestrian and bicycle safety and connectivity improvements.

The potential projects that are eligible for this fund were identified during alternatives development. These projects are presented in Table 4-3 in order of priority.

Note, however, that this fund is intended as a flexible means to respond to opportunities on the ground. The actual implementation sequence is subject to change, and the list does not include all possible opportunities that meet the shell program requirements.

Table 4-3
Right-of-Way Retrofit Shell Candidate Projects

Retrofit Area	Opportunity	Relative Water Quality Benefit	Priority	Length of ROW for Retrofit (ft)	Number of Facilities	Total Facility Volume (ft^3)	Capital Cost Estimate
SW Capitol Hwy and SW 26th Ave	High	High	1	1,300	8	1,600	$190,000
SW 14th Ave & SW Spring Garden St	High	Medium	2	2,200	14	2,800	$330,000
SW Vermont St	High	Medium	3	2,900	18	3,600	$430,000
SW Capitol Hill Rd & SW Bertha Blvd	Medium	Medium	4	3,300	21	4,100	$490,000
SW 19th Ave	High	Low	5	1,400	9	1,800	$210,000
SW Custer St	High	Low	6	1,300	8	1,600	$190,000
SW Miles St	High	Low	7	500	4	700	$90,000
SW Taylors Ferry Blvd	Low	High	8	3,800	24	4,800	$570,000
SW 6th Ave & SW Hume St	Medium	Low	9	2,900	18	3,700	$440,000
SW Chestnut Dr & SW 13th Ave	Medium	Low	10	2,900	18	3,600	$430,000

Areas were prioritized considering the relative water quality benefit and the relative available opportunity to redevelop or retrofit the area.

Water quality benefit was assessed using street traffic class. Streets identified as local service traffic were assigned a low benefit; neighborhood collector streets were assigned as medium benefit; and district collectors or higher were assigned high benefit.

Opportunity was assessed using both available right-of-way and steepness of the terrain. Streets with adequate right-of-way and flat slopes were assigned a high feasibility. Streets with either limited right-of-way or steeper slopes were assigned a medium feasibility. Streets with both limited right-of-way and steep slope were assigned a low feasibility.

The priority of each retrofit area was calculated by assigning the water quality benefit and opportunity scores to a number where High = 3, Medium = 2, and Low = 1. The water quality benefit and opportunity scores were then multiplied to determine a priority ranking.

4.3 Phase 2 Capital Improvements

The Phase 2 package includes three projects that are recommended for submittal to the 2015 CIP. The Phase 2 capital projects are shown in Figure 4-5 and described below. The total estimated cost for the three projects is $4,100,000. A summary of each project is presented below.

4.3.1 ODOT Shared Detention and Pollution Reduction Facilities

This project builds upon the recommended operating action to strengthen the interagency relationship between BES and ODOT, as discussed in Section 4.6, Programmatic, Policy, and Operating Recommendations.

The specific sites included in this project are shown in Table 4-4. They contain facilities that treat stormwater from both BES's MS4 area and from ODOT's MS4 area. This project includes a predesign phase to determine which sites are most feasible and cost-effective, and to determine the relative contribution of BES impervious surface versus ODOT impervious surface. The relative flow contribution to the total set of facilities constructed under this project should be used as the basis for determining cost-sharing between BES and ODOT.

Table 4-4
ODOT Shared Detention and Pollution Reduction Facilities

Site Identifier / SCSWSP Project Identifier	Description	Site Cost
Site (a)/Project 23.1a	SW Terwilliger shared detention facility	$220,000
Site (b)/Project 21.2b	Fulton Park neighborhood wetland facility adjacent to the community garden	$470,000
Site (c)/Project 21.1a	A-Boy Plumbing neighborhood detention facility adjacent to I-5 in existing low point	$1,280,000
Site (d)/Project 23.2	Stormwater filter vault at ODOT right-of-way, which can treat both I-5 runoff, city streets, and private property	$500,000
Site (e)/Project 23.3	Local stormwater treatment facilities on I-5 overpasses	$110,000
Site (f)/Project 25.5	Rain gardens for bioremediation of I-5 outfalls adjacent to Stephens Creek	$140,000

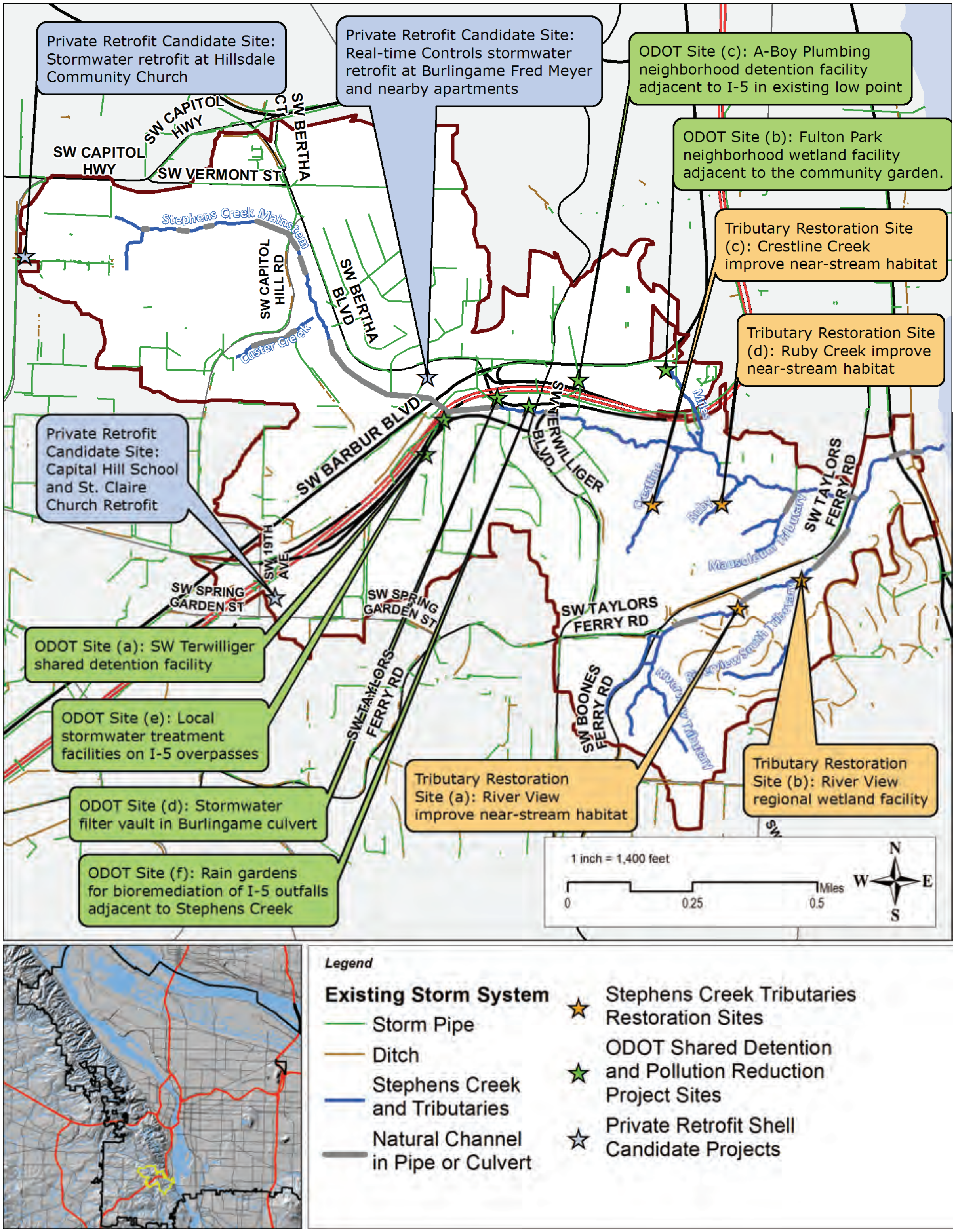

Figure 4-5
Phase 2 Capital Improvements

4.3.2 Stephens Creek Tributaries Habitat Restoration

This project focuses on restoring in-stream habitat that has been impaired over the years by uncontrolled stormwater discharges. The creeks identified for restoration in this project are tributaries of Stephens Creek that have the least degraded water quality, and are therefore suitable for a near-term focus on habitat restoration. The outfall repair projects in Phase 1 are critical predecessors for these projects to remove excess fine sediment loading to the Ruby Creek and River View tributaries.

Specific sites included in this project are listed in Table 4-5.

Table 4-5
Stephens Creek Tributaries Restoration Projects

Site Identifier / SCSWSP Project Identifier	Description	Site Cost
Site (a)/Project 9.3a	River View Tributary—improve near-stream habitat; this project will improve habitat conditions in the stream by restoring in-stream habitats and wetlands, and improving habitat connectivity through bank layback, and installation of large wood. It will improve the diversity of native plants in the riparian area.	$260,000
Site (b)/Project 9.5	River View neighborhood scale wetland facility; this project will enhance wetlands associated with River View and Taylors Ferry tributaries to improve habitat, peak flows, and water quality.	$67,000
Site (c)/Project 12.4	Crestline Creek—improve near-stream habitat; this project will include removal of invasive plants and revegetation with native plants, improvement of near-stream habitat, and educate and encourage property owners to remove invasive plants and re-populate with riparian vegetation along the Crestline Creek riparian corridor, including the area along the surface channel near the headwaters.	$40,000
Site (d)/Project 19.3	Ruby Creek—improve near-stream habitat; this project will focus on education and outreach to encourage property owners to remove invasive plants and re-populate revegetation with native plants and riparian vegetation along the Ruby Creek riparian corridor to where it flows into the mainstem Stephens Creek.	$22,000

4.3.3 Private Property Partnership Shell

This project is similar to the Right-of-Way Retrofit Shell project described in Section 4.3.3. However, in contrast to the Right-of-Way Retrofit shell, this shell will fund projects that mitigate stormwater runoff from existing impervious surface on private property or create stormwater assets not owned and operated by BES.

Currently, when new impervious area is constructed on private property, the SWMM requires stormwater management facilities to manage runoff from new impervious surface. Facilities are designed and sized to meet the SWMM requirements for the new impervious surface, but do not consider broader system needs and opportunities.

The Private Property Partnership Shell is intended as a flexible means to incentivize stormwater projects on private properties that help cost-effectively meet BES's stormwater system improvements needs. This could include funding larger facilities than would otherwise be required by the SWMM or construction of habitat and restoration projects in natural systems that are impaired by runoff from the BES stormwater system.

Draft criteria for projects to be funded with the Private Property Partnership Shell funds include project that:

- Provide a stormwater management benefit to the BES stormwater or sanitary sewer system such as improved conveyance, reduced pollutant loading to the BES storm system or restoration of natural channels that are impaired by stormwater from the BES system
- Facilitate partnering with private property owners to redirect stormwater out of the sanitary sewer system, such as directing foundation drains or improperly collected inlets to an appropriate public or private storm system.
- Result in securing an easement for either built infrastructure, natural channels, or drainageways to convey BES stormwater
- Have a contributing matching funding source available

Potential projects that are eligible for this fund were identified during development of alternatives. These projects were analyzed during the alternatives evaluation, and are presented in Table 4-6 in order of priority. Note, however, that this fund is intended as a flexible means to respond to opportunities on the ground with willing property owners and redevelopment efforts. The actual implementation sequence is subject to change, and the list does not include all possible opportunities that meet the shell program requirements.

It is not expected that every project identified in Table 4-6 will necessarily be implemented. Rather, these are candidate projects that should be evaluated when willing partners are available to participate in this work and the projects can be shown to provide cost-effective benefits to the BES stormwater system.

Table 4-6
Private Retrofit Shell Candidate Projects

SCSWSP Project Identifier	Project Title	MUA Score	Project Net Present Worth Cost	Score-to-Cost Ratio*
Project 21.1	StormFilter in A-Boy Plumbing parking lot	0.02	$10,000	2.71
Project 14.2	Real-time controls stormwater retrofit at Burlingame Fred Meyer and nearby apartments	0.07	$76,000	1.32
Project 6.2	Greater Portland Bible Church Depaving	0.02	$48,000	0.57
Project BWRF.3	Private property retrofits as required to reduce high pulse count to predevelopment level	0.80	$2,007,000	0.57
Project BWRF.5	Commercial property retrofit with ecoroof and pervious pavement	0.19	$850,000	0.33
Project 14.1	Stormwater retrofit planters at Burlingame Fred Meyer store and nearby Cloverleaf Apartments	0.07	$460,000	0.22
Project 24.5	Apartment retrofits (Spring Creek, Shadow Hills, and Capitol Hill)	0.17	$1,600,000	0.15
Project 22.1	Capitol Hill School and St. Claire Church retrofits	0.06	$2,650,000	0.03
Project 3.4	Stormwater retrofit at Hillsdale Community Church	0.01	$670,000	0.02

*MUA score/project net present worth cost in millions of dollars.

Note that the project costs shown above include all identified potential improvements, and that it is not expected that all improvements on a given site would be funded via this shell. A large fraction of the total cost for the apartment retrofit projects is associated with large scale replacement of impervious asphalt with pervious pavement.

Actual implementation of projects via this shell will focus on the most cost-effective improvements, which will generally include elements such as downspout disconnection, rain gardens, and protection of sensitive natural resources on private property. At time of implementation, all properties draining to the area of concern would be solicited for participation, including residential properties.

4.4 Phase 3 Capital Improvements

The Phase 3 package includes two projects that are recommended for submittal to the 2017 CIP. The Phase 3 capital projects are shown in Figure 4-6 and described below. The total estimated cost for the two projects is $6,400,000. A summary of each project is presented below.

4.4.1 Headwaters Stream Enhancement and Daylighting

This project focuses on restoring natural assets in the upper portion of the Stephens Creek watershed. Work completed during Phase 1 is expected to improve hydrology and water quality deficiencies to the extent that systematic habitat and natural resource restoration projects will be ecologically justified.

Several sites in the upper watershed have been identified for stream enhancement and potential daylighting. Note that many of these sites are located on private property, and may require obtaining an easement or private property investment. It is not expected that every site identified here will be implemented as part of this project. Rather, these are candidate sites that should be evaluated during a predesign phase. Before predesign, outreach to private property owners should occur to determine whether willing partners are available to participate in this work. Specific sites included in this project are listed in Table 4-7.

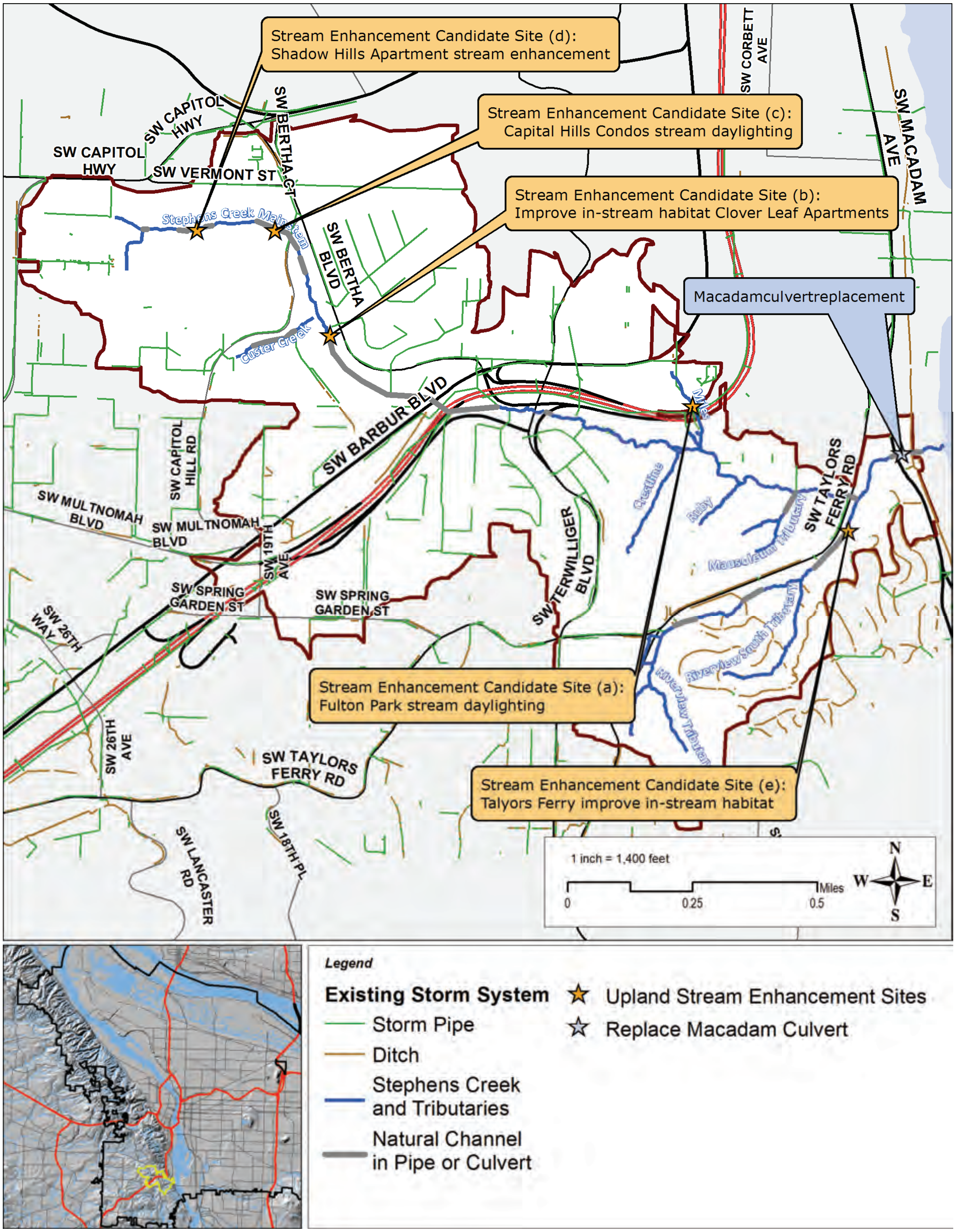

Figure 4-6
Phase 3 Capital Improvements

Table 4-7
Headwater Stream Enhancement Projects

Site Identifier / SCSWSP Project Identifier	Description	Site Cost
Site (a)/Project 32.1	Fulton Park stream daylighting; there is an opportunity to daylight the piped stormwater runoff in Fulton Park to the adjacent historic channel (Miles Creek), which would ultimately lead to improved habitat and biological communities. The runoff would be attenuated and treated before returning to the pipe and being conveyed under I-5.	$860,000
Sites (b)/Project 31.4	Improve in-stream habitat at Cloverleaf Apartments; this project consists of restoration work at the Clover Leaf reach of the Stephens Creek mainstem. This project should consider the presence of hydric soils and work to improve connectivity of the stream to springs and remnant floodplain elevations. Riparian and in-stream restoration will include bank layback where down-cutting has occurred, installation of large wood complexes to create small in-stream pools, addition of coarse sediment materials to improve in-stream habitat. Riparian enhancement will include replanting with riparian and emergent vegetation. Reconstruct discharge outfalls from building and parking stormwater runoff to enhance floodplain function.	$2,100,000
Site (c)/Project 24.8	Capitol Hills Condos stream daylighting; work with private property owners to remove piped section of Stephens Creek through the Condo complex. Replace with restored stream channel and adjacent riparian area.	$1,470,000
Site (d)/Project 24.9	Shadow Hills Apartments stream enhancement; restoration work at the Shadow Hills reach of Stephens Creek should consider the presence of hydric soils and work to improve connectivity of the stream to springs and remnant floodplain elevations (present or created). Riparian and in-stream restoration of the Shadow Hills reach of Stephens Creek will include bank layback where down-cutting has occurred, installation of large wood complexes to create small in-stream pools, addition of coarse sediment materials to improve in-stream habitat. Riparian enhancement will include replanting with riparian and emergent vegetation. Reconstruct discharge outfalls from building and parking stormwater runoff to enhance floodplain function.	$470,000
Site (e)/Project 28.3d	Taylors Ferry improve in-stream habitat; add in-stream cover for aquatic organisms and to stabilize banks. This project is intended to meet the alternative themes to emphasize biological communities and habitat restoration.	$1,080,000

4.4.2 Replace Macadam Culvert

Remove existing culverts under Highway 43 and replace with a larger culvert/span and restore natural substrate to Stephens Creek. Remove invasive species (English ivy and Himalayan blackberry) and plant native riparian vegetation in the currently degraded buffer zones between Macadam and Stephens Creek. Increase in-stream habitat to support benthic invertebrates and native fish. The estimated capital cost for this project is $440,000.

4.5 Programmatic, Policy, and Operating Recommendations

Program, policy, and other work funded with operating dollars are essential to the success of stormwater system planning. Stormwater is visibly present in the landscape and it affects how neighborhoods look, how streets and parks function, and how people interact. The work proposed in this plan is much different than sanitary pipe projects that fix underground infrastructure that is out-of-sight and out-of-mind. There are many more stakeholders in stormwater system planning, and they are not just immediate construction project neighbors. This plan acknowledges that the stormwater system affects other public infrastructure and private property in ways that require a significant organizational shift in how BES defines its responsibilities and risk.

This section presents high-priority recommendations that include a wide range of early actions, policy, program, and technical options to support capital project investments. As acknowledged in Section 3.4.1, Refinement Principles, these options impact operating costs, and are difficult to estimate and score. This work may or may not require new resources, but it will likely require leadership and perhaps refocusing of existing efforts.

While further scoping and assessment is needed for many of the recommendations, priorities were established based on staff discussions to date, acknowledging key activities needed to support the recommended capital improvements. The priority recommendations are presented as Early Actions (work that has begun or needs to start immediately) and Phase 1. Given the resources needed to plan and implement the Early Actions and Phase 1 work, Phase 2 and 3 recommendations were not developed at this time. See Section 4.7, Summary of Capital and Operating Improvements, for a summary of both capital and operating recommendations.

4.5.1 Early Actions (FY 12-14)

Recommended early actions are described below.

Citywide Centralized Stormwater Database

First and foremost, this plan recommends centralizing all stormwater and drainage complaints for private, public, and the right-of-way. Complaints that currently go to a variety of work groups (including the Bureau of Development Services, Watershed Services, the Clean River Rewards Program, Sustainable Stormwater Management Program, Maintenance Engineering, Development Review, Spill Prevention/Citizen Response, the Maintenance Inspection Program, and others) should be directed to an online database linked to GIS to expedite response, future activities, and programs. Assessment of existing system conditions is very difficult, if not impossible, without field records. While the available records or stormwater drainage complaints were evaluated for this study, staff acknowledged drainage complaints are directed to a number of different program areas and that consolidation is necessary. This likely requires a minimal technology investment and will yield numerous benefits to BES, including improving public perceptions about customer service.

E. coli Investigations

Continue to conduct E. coli investigations and monitoring in Stephens Creek. Although the characterization task identified E. coli as one of the greatest water quality concerns in Stephens Creek, uncertainty about the source and its potential relationship to deficiencies in the sanitary system went beyond the scope of this effort. More condition assessment data are needed to determine the scope of the problem and integrate solutions into sanitary system planning and project development where appropriate.

PBOT Partnership

PBOT and BES have a strong working relationship but representatives from each bureau are frequently challenged to make difficult decisions in order to meet multiple and competing needs in the right-of-way. Generally speaking, where there are road improvements, there are stormwater conveyance and management needs. PBOT and BES need to continue to work collaboratively and support each other's mission at a project scale but this partnership would benefit greatly from taking a broader system planning approach considering the broader policies and priorities of each bureau. The public disapproves of differing bureaucratic objectives that interfere with effective and cost-efficient development solutions. This challenge can be addressed more productively by taking a broader, system-scale perspective.

Also it is important to acknowledge that PBOT has a much different budget structure than BES, as it relies primary on the highly constrained City of Portland general funds for operating activities and very limited grant funding for capital investments.

Portland Parks & Recreation Partnership

This work is also ongoing and needs to develop a more programmatic approach. BES and Parks collaborate frequently on natural area restorations and incorporate stormwater management into many PP&R projects. Like working with PBOT, Parks and BES need to continue to work collaboratively and support each other's mission at a system scale. The public has a strong sense of ownership in park property, and may not lightly accept BES proposed improvements. Stormwater improvements will need to show community benefits beyond stormwater system needs, and should be consistent with Parks' goals. Like PBOT, PP&R is constrained by limited capital and O&M budgets.

BES has built good capacity for land acquisition and an ongoing O&M partnership with Parks under the Grey to Green program, and is currently planning for a future opportunity-based, prioritized land acquisition strategy after the remaining Grey to Green budget is expended. This is proposed for the FY14-18 CIP as the "Watershed Land Acquisition Program." As stormwater system planning and implementation continues, opportunistic acquisition of stormwater facility sites would fit into that acquisition program. Coordination with Parks is critical to identifying potential acquisition sites that meet BES's priorities for stormwater management and watershed health while also providing multiple community and/or environmental benefits, such as new neighborhood pocket parks.

Park land, without built infrastructure, is easy to view as underutilized and available for other public projects such as stormwater or transportation facilities, when in fact developed parks are fully programmed for a variety of active and passive recreational uses. New models for stormwater facilities need to be developed that allow for maintaining and improving park uses such as recreation and open space, especially in developed parks. Traditional stormwater facilities such as vegetated swales may be more compatible with natural area sites than developed parks. Stormwater projects in parks should be designed to maintain existing design and programming, or offer recreational enhancements to offset impacts.

River View Partnership

BES needs to continue to partner with River View Cemetery to retrofit River View outfalls and support potential stormwater master planning.

4.5.2 Phase 1 Operating Recommendations (FY 13-18)

Priority Phase 1 operating recommendations include ODOT partnership, tree program coordination, stormwater policy revisions, SWMM revisions, and private property partnerships and stewardship. Each of these recommendations is described below. Also, the issue of global climate change is discussed separately.

ODOT Partnership

There are significant portions of right-of-way in the Stephens Creek watershed that are managed by ODOT. This primarily includes I-5, SW Barbur Boulevard, and a small portion of SW Macadam Avenue. Stormwater runoff from ODOT impervious surface is often conveyed through BES-owned pipes or ditches. Certain components of the shared conveyance system are poorly mapped, and it is difficult to accurately determine the specific flow path of stormwater through the conveyance system in the ODOT right-of-way.

Operations and maintenance of the shared stormwater assets is governed by a contract between the City and ODOT, referred to as the 1944 agreement. It is the recommendation of this plan that the 1944 agreement be renegotiated to reflect changes to the practice of stormwater conveyance and treatment over the past 70 years. Specific limitations of the 1944 agreement include:

- Does not consider the Clean Water Act and regulatory requirements under the NPDES MS4 permit
- Does not address replacement of assets at the end of useful service life
- Does not consider detention and pollution reduction objectives
- Pre-dates the construction of I-5 and associated drainage infrastructure

An update to the 1944 agreement should include addressing capital replacement of stormwater conveyance assets, and opportunities for treating mingled stormwater in shared facilities. As discussed in Section 4.4, Phase 2 Capital Improvements, it is cost-effective for both BES and ODOT to share investments in facilities that treat mingled stormwater. Both agencies have similar requirements under the NPDES MS4 regulations, and, therefore, have a mutual interest in cost-effective investment in the identified projects.

It is the recommendation of this SCSWSP that conversations between BES and ODOT should occur at a high level at both agencies; this could include the Director of BES (or designate) and the Director or Regional Manager at ODOT (or designate).

Tree Program Coordination

Trees are an integral part of the city's green infrastructure. Portland's trees help manage 1.3 billion gallons of stormwater each year through rainwater interception and evapotranspiration. The city's green infrastructure helps BES meet its regulatory obligations and its clean river and healthy watershed goals.

This plan recommends coordination with the Watershed Revegetation program to prioritize revegetation in high-priority riparian areas, including the recommended revegetation projects shown in Table 3-6 Coordination should also occur with the Grey-to-Green Program and Urban Forestry to plant large trees strategically in the right-of-way and on private property to maximize canopy over road surfaces where there is limited room or poor conditions for stormwater management facilities.

As Grey to Green tree funding expires in the coming years, it is essential to continue an appropriate level of urban (street/yard) tree planting that is coordinated with system planning. Tree planting and care is a popular, participatory way for Portlanders to partner with BES in solving stormwater problems while also meeting other neighborhood and citywide objectives (tree canopy goal, climate change plan, etc.). BES and other bureaus should continue to explore new models and incentives for planting and maintaining trees, including new financing options that account for trees as capitalizable assets.

Stormwater Policy Revisions

Currently, much of BES's stormwater management policy is contained within Portland's 2008 SWMM. This SCSWSP supports the proposal to separate the policy from the facility design guidelines with the next SWMM revision (estimated to begin in 2013). In this scenario, stormwater policy that informs both stormwater system planning and stormwater facility design would be contained within its own policy document and addressed in the city's administrative rules and Comprehensive Plan as appropriate.

The following policy changes need to be mapped out and evaluated for work planning consideration:

- Describe and document the terms and influences of Oregon Drainage Law for stormwater system planning.
- Modify and clarify the definition of "approvable discharge point" in terms of system needs. Includes allowing surface conveyance/road-shoulder improvements/street-by-street initiative. Note, local conveyance improvements are not included as specific capital recommendations, but will be funded by developers or LIDs consistent with the current city approach. Recommend modifying current approval process and working with PBOT to make process more accessible.
- Expand definition of shared stormwater facilities including the funding mechanisms that will allow mingling stormwater that:
  - Originates on private property; for instance, allow a private property owner to pay an off-site management fee to fund a larger neighborhood facility for the equivalent cost of an on-site facility.
  - Originates on new impervious right-of-way; PBOT or private property owner constructs new sidewalks, bike paths, or paving of an unimproved street and contributes funding for a larger neighborhood facility for the equivalent cost of an on-site facility.

- Originates on existing impervious right-of-way. BES provides the "buy-up" funding to size the neighborhood facility to meet unmet system needs (retrofit), and potentially for future development in anticipation of future SWMM-required facilities.

Stormwater Management Manual Revisions

Recommendations for revisions to the SWMM include:

- Modify on-site stormwater management requirements to better suit conditions on the west side of the city. Develop provisions for neighborhood facilities in constrained areas.
- Develop design guidelines for performance-based streets that emphasize low cost and ease of implementation.
- Reintroduce yard trees as an impervious area reduction technique and/or mitigation option available to meet stormwater management requirements consistent with new tree code requirements. Provide provisions to ensure the trees are properly planted and established to reach their mature canopy potential and develop a maintenance and inspection program to ensure they are retained.

Private Property Partnerships and Stewardship

Recommendations for partnering with private property owners include:

- Creating a program that allows BES to assist with resolving neighbor-to-neighbor stormwater and drainage conflicts. BES must be careful to assume responsibility for private drainage conflicts, but is in a unique position to provide tools to help neighbors reach a negotiated agreement. BES can work to create an incentive program with grants and technical assistance to help private property owners address stormwater problems.
- Funding a comprehensive education and outreach program that will lay the groundwork in the community for acceptance of stormwater projects by painting big picture for stream health, sanitary sewer system, and other benefits of stormwater improvement projects. This should include educational information to development and construction communities. It may be useful to brand stormwater-related efforts in southwest or other specific regions, similar to the Tabor to the River initiative, using professional marketing and branding support to ensure success and efficient delivery of CIP projects and other programs. This includes describing and documenting in brochures and the BES website, using easily understood terms, how the stormwater system relies on both public assets and private drainages.

Looking Ahead: Global Climate Change

It is important for infrastructure planning to consider the potential effects of global climate change on future infrastructure needs. A literature review was undertaken to evaluate the current state of regionally-specific down-scaled global climate models. At this time the available down-scaled climate models have insufficient confidence to draw quantitative conclusions regarding changes to local precipitation patterns.

Given the uncertainty in quantitative climate models, it is BES's current adopted practice to base facility planning on historic rainfall patterns. However, that is not to say that BES or the SCSWSP neglect to consider potential impacts of global climate change on the stormwater system. Instead, this planning effort, in line with BES's strategic plan, emphasizes natural assets and vegetated facilities as the preferred means of stormwater management. These types of facilities are expected to offer greater resiliency and flexibility in the face of uncertain future climate patterns.

It is the recommendation of this report that future planning should evaluate the best available down-scaled climate models. As the state of climate modeling advances to the point where relatively high-confidence estimates of expected regional climate trends are available, these models should be incorporated into future stormwater system plans.

4.6 Conveyance Recommendations

Recommendations for providing conveyance infrastructure to unserved areas, and to address the few capacity constrained conveyance elements within the watershed, are presented here.

4.6.1 New Conveyance Infrastructure

The recommended plan for providing stormwater conveyance infrastructure to unserved areas is shown in Figure 4-7. Recommended new conveyance infrastructure falls into two categories: areas where road-shoulder improvements can potentially serve as approvable discharge points, and areas where traditional curb, gutter, and pipe should be required.

Recommendations are included for providing new conveyance infrastructure to all undeveloped right-of-way in the Stephens Creek watershed.

There is approximately 22,000 linear feet of right-of-way in the Stephens Creek watershed that lacks adequate stormwater infrastructure. The total cost to provide conveyance infrastructure to all unimproved right-of-way within the watershed ranges from a low of $4,000,000 if the area is served entirely with road-shoulder improvements, up to $20,000,000 for service entirely with piped infrastructure.

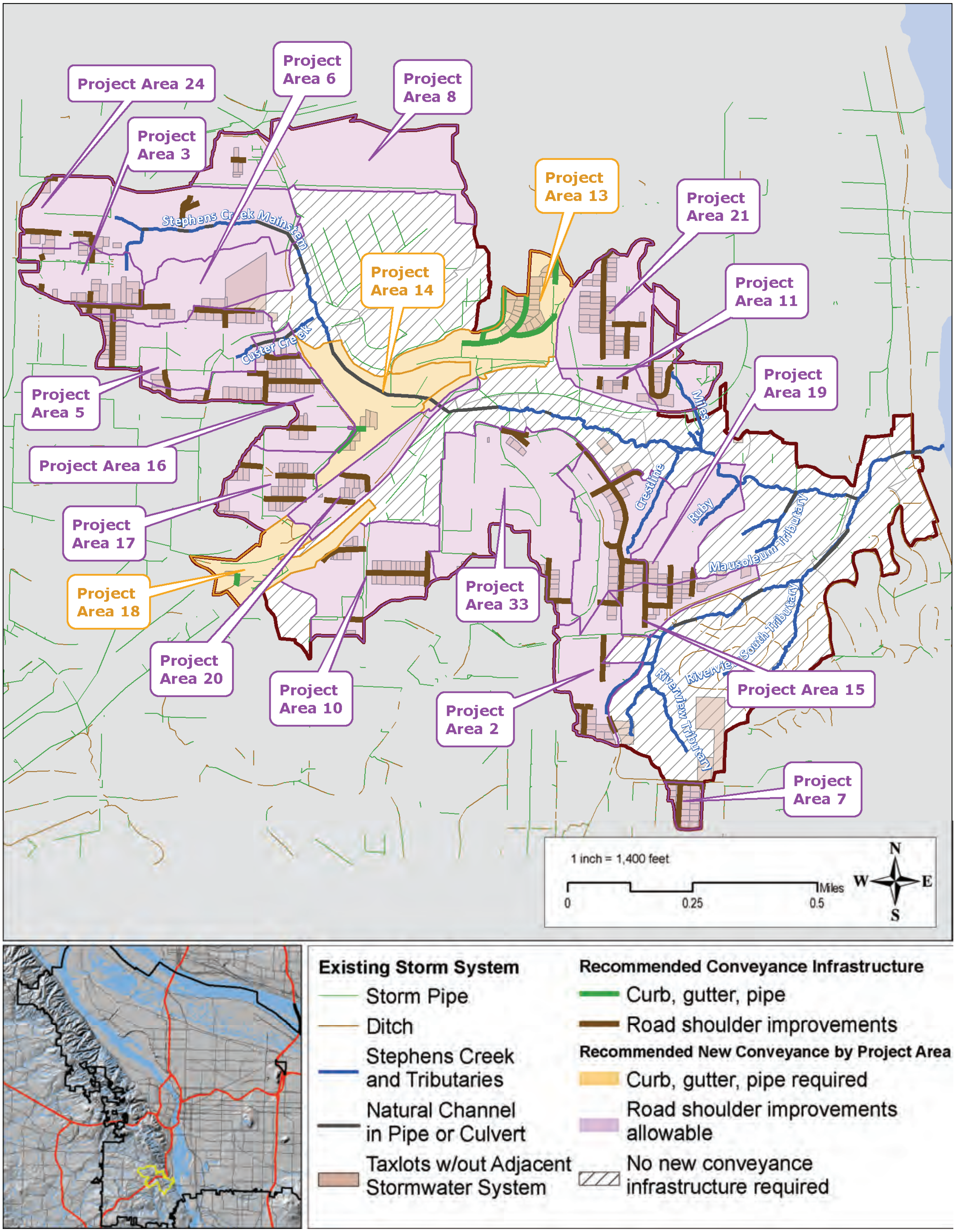

Figure 4-7
Recommended Conveyance System Improvements

Cost estimates for the recommended conveyance infrastructure are shown in Table 4-8. For each project area, the total length of right-of-way without adequate infrastructure is shown. Cost estimates to provide service to the unserved right-of-way are shown for both road-shoulder improvements and for traditional curb, gutter, and pipe.

Table 4-8
Cost Estimates for New Conveyance Infrastructure

Project Area ID	Project Area Name	Length of ROW without Stormwater Conveyance (ft)	New Conveyance System Cost	
			Curb, Gutter, Pipe with Curb Extensions	Road-shoulder Improvements
2	Boones Ferry	710	$651,000	$141,000
3	Cali/Texas	850	$738,000	$168,000
5	Custer Park	1,610	$1,627,000	$352,000
6	GPB Church	1,220	$1,192,000	$291,000
7	Palatine Hills	950	$876,000	$187,000
8	Rieke/Wilson	170	$149,000	$34,000
9	Riverview Cemetery	150	$141,000	$30,000
10	SW 14th	860	$767,000	$475,000
11	SW 4th	280	$521,000	$166,000
12	SW 5th	2,100	$1,847,000	$416,000
13	SW Caldew	1,770	$1,915,000	Not recommended
14	SW Canby	370	$309,000	Not recommended
15	SW Carson	1,300	$1,211,000	$257,000
16	SW Custer	2,130	$1,445,000	$264,000
17	SW Evans	1,120	$994,000	$232,000
18	SW Hume Ct	130	$185,000	Not recommended
19	SW Hume St	340	$312,000	$68,000
20	SW Multnomah Blvd	790	$848,000	$214,000
21	SW Nevada	1,810	$1,737,000	$360,000
24	Stephens Headwaters	750	$658,000	$149,000
26	Stephens Canyon	140	$132,000	$28,000
32	Fulton Park	820	$714,000	$163,000
33	Terwilliger Heights	1,370	$1,271,000	$272,000
		Total	**$20,240,000**	**$4,267,000**

ROW = right-of-way.

Note that gaps in stormwater infrastructure primarily exist on unimproved residential streets in the upper portions of the watershed. No major gaps in the stormwater conveyance system were identified; the trunk of the conveyance system utilizes natural channels, including Stephens Creek and its tributaries.

For project areas with high landslide hazard risk, road-shoulder improvements are not appropriate and piped conveyance infrastructure is recommended. For other areas, road-shoulder improvements are presented as a low-cost option; however, current conveyance and stormwater management standards can be used in any area if this option is preferable to adjacent property owners.

It is recommended that localized expansion of the conveyance system on unimproved residential streets should be funded by the benefitting parties, e.g., residents, property owners, and developers. Improvements can be funded via formation of local improvements districts or in response to new development. This is a continuation of current City practice for improvements to sub-standard roadways.

The use of road-shoulder improvements as approvable discharge points is recommended here in recognition of PBOT's Street by Street initiative. The acceptance of new, lower-cost design standards for stormwater conveyance goes hand-in-hand with the lower-cost design standards currently under development by PBOT.

4.6.2 Conveyance Capacity

In general, there is significant uncertainty in the modeled pipe capacity. Several factors contribute to uncertainty in the hydrologic and hydraulic model of stormwater collection system:

- System connectivity is not known for portions of the stormwater conveyance system, particular in the vicinity of the ODOT-managed right-of-ways (SW Barbur Boulevard and I-5), which lack as-built or survey data
- Overland flow paths are often not understood and available details are insufficient to predict flow in pipes in the upper portions of the collection system
- The flow monitors used for model calibration were all located in natural channels (both Stephens Creek mainstem and tributaries), but not in the piped portion of the collection system; the model has therefore not been validated against measured data in the vicinity of the modeled capacity constraints

Additionally, the modeled capacity constraints are typically not associated with significant business risk. Unlike the sanitary and combined sewer systems, incidental contact with water escaping from the separated storm sewer system does not provide a direct threat to human health. For several of the modeled capacity constraints, any stormwater leaving the conveyance system would likely re-enter the stormwater conveyance system via a downstream inlet.

Note that other sources of uncontrolled stormwater flow are likely to be more widespread than releases due to conveyance system capacity constraints. For instance, inlets clogged with leaves, sedimentation in treatment facilities, and improperly directed surface flow are widespread throughout the separated stormwater system. Although it is not quantified in this study, it is expected that a dollar spent on increased O&M activities would provide a greater risk reduction than the same dollar spent on increased conveyance system capacity.

As such, the SCSWSP does not include recommended projects to increase conveyance system capacity. Instead, recommendations are focused on gathering additional data to better understand business risk associated with conveyance capacity in the stormwater system. In general, the following actions are recommended:

- Outreach to residents and property owners to determine where capacity constraints (or unmet O&M needs) are contributing to business risk. This is included in SCSWSP Operating Recommendation E1.
- Work with ODOT to map and survey the conveyance system in the vicinity of SW Barbur Boulevard and I-5.
- For those capacity constraint associated with significant business risk, evaluate structural condition (i.e., TV inspection) of critical conveyance system assets to determine whether replacement/upsizing or inflow controls is the preferred approach.

Only one capacity constraint in the Stephens Creek watershed is expected to produce serious business risk: three segments of 12-inch diameter pipe in SW Barbur Boulevard from SW Terwilliger Boulevard to SW Bertha Boulevard are predicted to have insufficient capacity due to inflows from SW Barbur Boulevard. 10-year design storm flow in this pipe segment increases from 2.7 cubic feet per second (cfs) upstream to 5.1 cfs at the downstream end of capacity constrained segments.

Given the high traffic and automobile speeds on SW Barbur Boulevard, this capacity constraint is considered a relatively high source of risk. BES staff witnessed a surcharging manhole during the January 18, 2012, storm event, which is shown in Figure 4-8. The surcharging manhole caused ponded water on SW Barbur Boulevard to an extent that could be hazardous to motor vehicles.

The following actions are recommended to address this capacity constraint:

- Determine ownership of stormwater conveyance assets receiving flow from SW Barbur Boulevard (State Highway 99W) and I-5.
- Evaluate structural condition of critical stormwater conveyance infrastructure beneath SW Barbur Boulevard, much of which was built in 1933 and may be approaching end of service life.
- Investigate contributing drainage area and conveyance system connectivity for stormwater conveyance assets that lack as-built data in the vicinity of SW Barbur Boulevard near SW Bertha Boulevard.

Details of the other capacity constrained reaches and recommended actions are documented in *TM 7.1.1 Conveyance Capacity Overview* (BES, 2012d).

Figure 4-8
SW Barbur Boulevard Capacity Constraint

4.7 Summary of Capital and Operating Improvements

Recommended capital and operating improvements are summarized in Table 4-9. Capital recommendations were developed to fund and implement projects in three phases (see Sections 4.4, 4.5, and 4.6). BES has learned through other recent capital investments that program and policy work is needed to support the capital activities. As such, operating recommendations are presented as Early Actions and Phase 1 recommendations. Note that the term "operating recommendations" is used as short-hand for projects or ongoing activities that are not typically funded through the capital budgeting process.

Table 4-9
Summary of Operating and Capital Improvement Recommendations

Phase	Operating Recommendations	Capital Improvement Recommendations
Early Actions		
	Centralized Drainage Complaint Database E. coli Investigation PBOT Partnership PP&R Partnership River View Partnership	

Table 4-9
Summary of Operating and Capital Improvement Recommendations

Phase	Operating Recommendations	Capital Improvement Recommendations
Phase 1		
	ODOT Partnership Tree Program Coordination Stormwater Policy Revisions Stormwater Manual Revisions Private Property Partnerships	Outfall Repair Pollution Reduction/Detention Facilities Right-of-Way Retrofit Shell
Phase 2		
		ODOT Improvements Tributary Restoration Private Property Retrofit Shell
Phase 3		
		Stream Enhancements Culvert Replacement

4.8 Long-Term Projects

Potential long-term projects not included in the implementation plan phases are shown in Figure 4-9. Note that many of these projects were scored during the alternatives evaluation task as high-priority projects for their impact on the stormwater management objectives, but are not included in the implementation plan because they are dependent upon first implementing the projects in Phases 1, 2, and 3. Other projects are lower priority and should be re-evaluated during the next planning cycle.

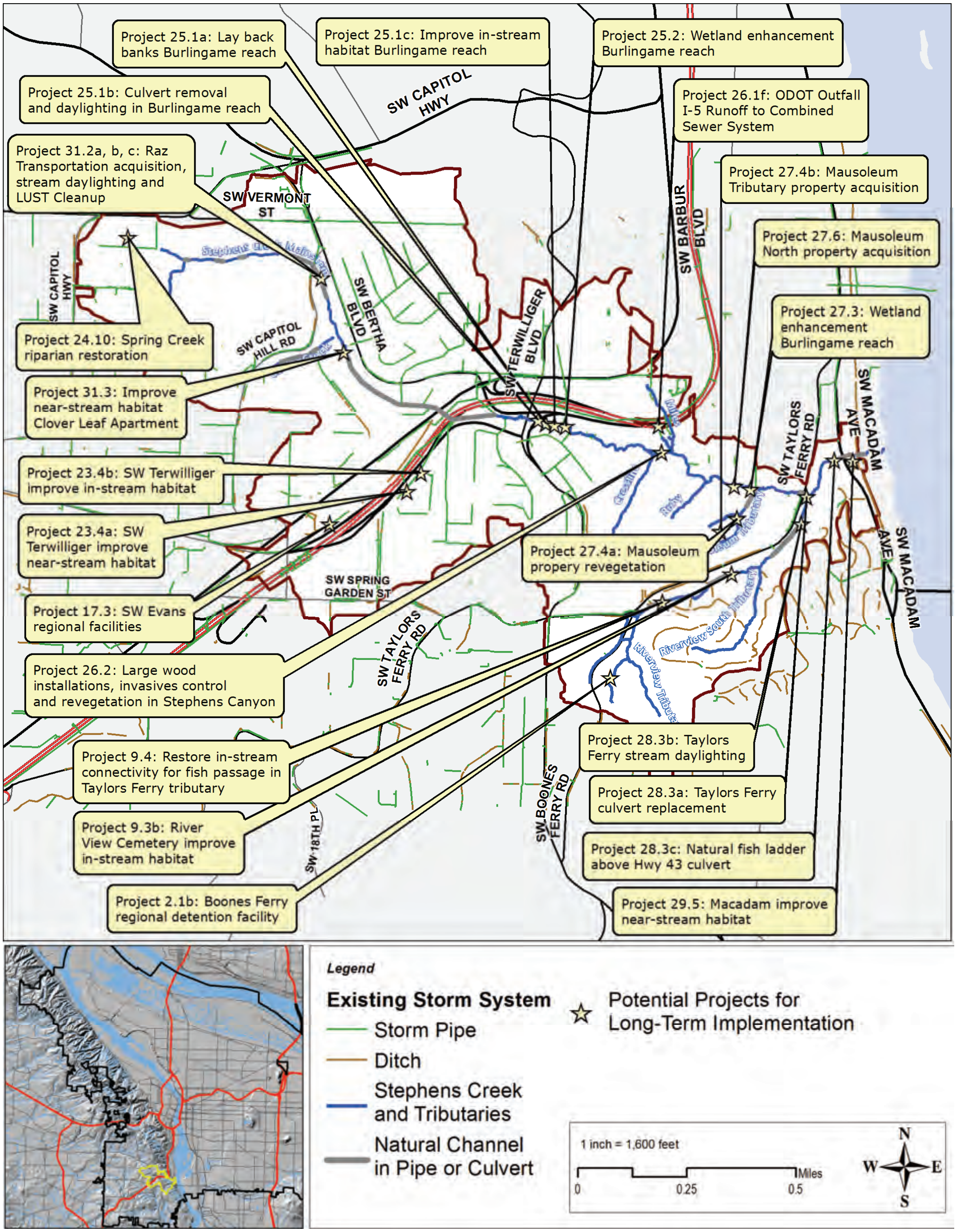

Figure 4-9
Potential Projects for Long-Term Implementation

CHAPTER 5

Program Recommendations

ENVIRONMENTAL SERVICES
CITY OF PORTLAND
working for clean rivers

5 Program Recommendations

From the beginning of this planning effort, project management stakeholders acknowledged the importance of assessing the results of the effort to inform future stormwater system planning. This chapter assesses the results, both in terms of the process and the technical products. It examines the successes and the limitations of the Stephens Creek Stormwater System Plan pilot effort and formulates recommendations for a future Stormwater System Program.

5.1 Pilot Successes

This section presents an overview of the system planning process as applied to the Stephens Creek watershed, with an emphasis on the elements of the process that the project team considered most successful.

5.1.1 Integration

Tasked with integrating Engineering Services and Watershed Services goals into one stormwater system plan, the project successfully established shared ownership and workload responsibilities. With dedicated staff from both Watershed Services and Engineering Services the task assignments were evenly distributed across both work groups. Team members were asked to both lead certain efforts as well as support other team members as necessary. The project also benefited from a project manager not vested in any one technical group, and who actively facilitated a work flow process that was committed to creating a working environment of trust, collaboration, and transparency.

5.1.2 Technical Levels of Services and Performance Targets

The initial development and agreement on LOS and performance targets was time consuming, but the effort resulted in obtaining a wide range of technical concerns and thorough feedback from the participating work groups. The effort outlined potential interests in stormwater system planning, which ultimately provided the content necessary to successfully define the plan's technical goals and objectives.

5.1.3 Characterization

Because Watershed Services had previously conducted a substantial amount of analysis in Stephens Creek, the plan area was well-understood and a majority of the necessary watershed related information was readily available. This made the characterization phase of the project go smoothly. Project stakeholders reported they gained a comprehensive understanding of the system function and the issues present, especially the state of the existing infrastructure and the biological aspects of the stream. The GIS analysis and structure established for mapping was also highly successful. It was essential for presentations and supported the decision making through the course of the project.

5.1.4 Alternatives Development and Evaluation

Although MUA has short-comings in terms of creating consistency across BES projects (the objectives, scores, and ranking are recreated for each project with different stakeholders), the method provided a predictable and executable alternative evaluation process that successfully tied alternative evaluation directly to project goals and objectives.

Furthermore, the development of alternative refinement principles (see Section 3.4.1) provided an opportunity to go beyond the limitations of project scoring and discuss the priorities and tradeoffs in a transparent and inclusive manner. This discussion emphasized the importance of moving beyond current design standards to consider new, context-sensitive stormwater conveyance to shared neighborhood-scale pollution reduction and detention facilities. It recognized that BES does not own and control the entire stormwater system, and that we must rely on partnerships with ODOT, PBOT, PP&R, and private property owners to address the system deficiencies. It highlighted the need to phase the capital work to ensure water quality and hydrology issues are integrated with in-stream restoration work. It also highlighted the importance of committing to program, policy, and other operating activities in order to support the capital recommendations. Providing this mixture of recommendations illustrated to decision makers that how BES acts is just as important as what it constructs.

5.1.5 Recommended Plan

The result of this effort is a suite of program, policy and operating recommendations that are integrated with capital recommendations, all of which received broad approval from the team members and a diverse group of stakeholders. In spite of a steep learning curve and tough decisions to defer work in order to meet the schedule, the recommended plan resulted in a vision for future stormwater management practices in southwest Portland, and laid the groundwork for subsequent iterations of the stormwater system plan.

The recommended plan includes approximately $14 million of capital improvements over a 10-year period. These improvements were broadly accepted by the project advisory and management teams and set in place a process to update the SWMM to allow for new, collaborative, and cost-effective approaches to stormwater management and conveyance utilizing shared neighborhood-scale facilities. The recommendations provide a way forward to address unimproved and sub-standard streets in southwest Portland that is consistent with the citywide Street by Street initiative led by PBOT. Although there will be a continued reliance on the standard LID improvement process, this recommended plan acknowledges new and innovative design approaches and identifies the need to share costs as redevelopment occurs.

5.2 Pilot Limitations

Limitations of the pilot effort are identified and discussed here. These limitation were developed via several project retrospective meetings held with the technical team, the advisory team, and various outside stakeholders.

5.2.1 Scope and Schedule

This effort took close to 3 years to complete. Even considering that much time was spent clarifying and agreeing upon the scope, building working relationships, and developing a common understanding of what an integrated watershed and engineering plan included, this pilot project constituted a huge level of effort for a relatively small planning area.

Although stormwater system planning will likely become easier over time, efficiencies and consistent definitions regarding the level of effort must be established to shorten the planning cycle and make most efficient use of staff time. Clear distinctions must be made regarding how far each subsequent effort will delve into predesign-type work, including but not limited to the level of effort to identify potential projects and determining a reasonable number of projects to work with.

In the absence of a citywide stormwater master plan, this pilot project attempted to create both a conceptual plan that set the overall design direction for the Stephens Creek system improvements and the beginnings of a predesign that looked more closely at the feasibility of individual projects. Initially, the project team tried to accommodate expectations for both without a clear distinction between the two. In the end, the team recognized the results needed to land closer to a concept plan that laid out an overall direction for the basin and forwarded the predesign analysis into the next phase of work.

5.2.2 Asset Management

Although a wide range of technical LOS and targets were developed for the Stephens Creek watershed, they were not written from an asset management-based risk assessment, and the relative value of the stormwater system risk was not established. A small working group was created to do this work and a draft work plan was prepared, but because it could not be completed within the timeframe of the pilot project schedule, it was deferred to a later date. Refining LOS and targets to reflect stormwater system risks and developing alternatives to limit or mitigate BES's exposure to risk will likely result in a more refined alternative development and evaluation process, which will ultimately lead to higher confidence regarding how bureau dollars are spent to match actual customer service needs.

5.2.3 Scale and Resolution

Although parallels to Stephens Creek could be drawn for much of southwest Portland, this study is limited to the conditions in one basin, and it does not provide a complete citywide perspective on stormwater system planning. The stormwater LOS developed in this pilot will need to be broadened and refined over time to serve a citywide application. It is also likely that that each plan area will have unique characteristics and issues that require a unique approach.

Furthermore, planning-level analysis must be conducted at a scale and resolution that does not have overly burdensome data needs yet it must provide a sound basis for decision making. In this SCSWSP effort, a wealth of watershed information was readily available in large part due to the existing *Stephens Creek Subwatershed Improvement Strategies Plan* (BES, 2009a). This previous planning effort took a broad and holistic view of watershed health issues, assessed stream conditions and inventoried over 100 potential watershed improvement projects, including many stormwater improvements. In contrast, analysis of the existing stormwater conveyance and management system relied on gathering detailed field data and running complex models to answer very specific engineering questions about system hydrology and hydraulics (i.e., can the system convey the 10-year design storm?). Integration of these two distinct perspectives was challenging and insightful as it produced a more complete view of the stormwater system, but critical questions regarding the condition and function of the stormwater system remain.

Short of a site-by-site assessment, a pragmatic approach is needed to collect and categorize on-the-ground stormwater system conditions including but not limited to ownership and configuration of existing assets. Future stormwater system planning will need to continue to seek a balance between planning level analysis and detailed engineering in order to determine system deficiencies and prioritize recommendations accordingly.

5.2.4 Approvable Discharge Point Methodology

Analysis of approvable discharge points was limited to determining which properties lacked an adjacent right-of-way with stormwater service (curb, ditch, or pipe). Additional analysis should take Oregon Drainage Law into consideration. For example, explicitly documenting easements, drainageways, and ownership, and further refining the limitations, opportunities, and requirements to providing approvable discharge points for new development and redevelopment. Some properties must drain across adjacent properties rather than to a right-of-way. For example, it is not possible to drain to an adjacent right-of-way when that right-of-way is upslope from a property.

Customer complaints and other knowledge of stormwater drainage problems are not housed in a central location that facilitates systematic analysis of deficiencies. Mapped complaints could be useful in finding and validating service deficiencies.

5.2.5 Project Identification

Building on previous project identification work from the *Stephens Creek Subwatershed Improvement Strategies Report* (BES, 2009a), and continuing through project brain-storming sessions, over 100 projects were identified to address system deficiencies. While the team screened out projects that did not meet the system plan objectives, a few project advisors suggested that a preliminary screen for constructability would be useful before developing the project in more detail. Advisors also noted that proposed project solutions did not always appear to match identified problems and that the pre-identified watershed projects did not always correspond with systems-focused needs. The structure and presentation of the objectives could also be refined to provide clearer justification for project selection.

Project development was conducted by first dividing the watershed into 33 smaller areas. Individuals were then assigned to develop projects for each area. Different people on the project development team proposed projects at different levels of detail, used different tools or project types to solve similar problems, and combined or separated projects differently. In some cases, multiple approaches to solving one problem were offered as different alternatives, while in other project areas, the alternatives were whether to solve a problem or not. Given the number of people involved and the number of projects identified, the project identification process would have benefited from a final evaluation step to confirm the projects identified clearly addressed the stated problems.

Advisors also noted that this pilot followed a general BES tendency to identify commercial-scale stormwater projects over residential-scale solutions (i.e., rain gardens) and it was noted this assumption should be challenged because the residential properties are more cost effective and involve a wider variety of community engagement options.

5.2.6 Alternatives Development

Once site-specific projects were identified, the team found it difficult to group the projects into a logical or discrete range of alternatives. Part of the difficulty was related to how to package the watershed health improvements with the stormwater quantity and quality improvements since there were not always direct correlations between the two. In the end, two "bookend" alternatives were formed to frame the conversation and express the upper and lower limit of both watershed and infrastructure improvements. Although it was not expected that either of these alternatives would be chosen as the preferred alternative, they were included to frame the range of potential outcomes. Within this frame, two intermediate alternatives were developed to represent localized stormwater management that relies mostly on current practices or regionalized stormwater management that relies on new standards and policies.

Although these alternatives formed a reasonable basis for evaluating system outcomes, the component projects targeted for watershed health enhancement and those targeted for stormwater conveyance system improvement were grouped somewhat arbitrarily. The resulting alternatives shed light on how best to develop stormwater conveyance system improvements, but not on how to determine the appropriate order or priority of watershed enhancement projects. This short-coming was addressed later using the project refinement principles (see Section 3.4.1).

5.2.7 Cost Estimating

The cost sharing assumptions for public-private partnerships (30% and 70%) were selected as a reasonable means to explore the potential system-wide outcome of widespread BES partnership with private institutions. If a similar methodology is used on future stormwater system plans, a sensitivity analysis should be conducted to refine and gain greater consensus on these percentages. In other words, the difference between the system perspective and BES perspective should be reconciled. Although current decision making is generally based on a BES perspective, if the score-to-cost ratio is similar, the system-wide solution should also be considered.

5.2.8 Alternatives Evaluation

The project team agreed to reorganize the LOS in order to use them in the MUA process for alternatives evaluation. After referencing other recent planning and design projects, the team added additional objectives and restructured the LOS with restated goals. Although the MUA process proved to be highly successful, the conversion of LOS to goals and objectives was awkward and somewhat confusing for project participants.

It is also worth noting that both the management team and the project team ranked and weighted the project objectives. The management team was assigned the responsibility of creating the official ranking and weighting of project objectives, whereas the project team ranking and weighting was used for comparison and to explore the MUA process.

A few project team members suggested it would be more appropriate for the technical staff who prepared the analysis to provide the initial ranking and weighting of the objectives, and then forward these recommendations to the management team. The expectation is that this would keep the project priorities focused on the problems that need to be solved for that basin, not on BES-wide priorities. Note that the project team ranking and weighting differed somewhat from that of the management team, but that overall the outcome was similar; thus, building confidence in the MUA process.

Performance targets were created for the Stephens Creek LOS, but it was difficult to incorporate them into the alternative evaluation process. This hindered the team's ability to quantify how well the proposed alternatives minimized system risk. It also made it difficult to establish a tracking and monitoring program to gauge the success of implemented projects. Project staff suggested conducting some form of a sensitivity analysis to test the assumptions behind the draft targets, but the project schedule did not accommodate this unplanned work. Future work should ensure that LOS are risk-based and incorporate appropriate performance targets that can be readily analyzed and scored at the planning level, and measured over time after project implementation.

5.2.9 Responding to Private Property Needs

This SCSWSP acknowledged that the stormwater system in southwest Portland is not owned and managed exclusively by BES. There are many stakeholders who share responsibility for the management and conveyance of stormwater, including private property owners and outside agencies and institutions. A key decision in this process was to analyze the entire stormwater system, including natural streams and drainageways that are not owned by BES. Projects were developed and evaluated to achieve stormwater management objectives regardless of which entity owned the project site, drainage area or conveyance channel. In some cases it may be cost-effective for BES to invest in projects or actions that are not in BES's traditional or exclusive domain.

In this basin, the greatest infrastructure deficiencies exist at the local service level. Although this plan identifies projects to provide new conveyance infrastructure to the unserved areas, it does not recommend widespread capital investment to provide service. The areas of need are too great and the solutions involve more than just stormwater conveyance, so a broader program approach is needed. Local conveyance solutions rely on partnerships with PBOT and private property owners as well as new design tools and development standards.

Stormwater system planning needs to more actively inform the direction of system development on private property. This pilot project tried to address some of the stormwater system conveyance and management details needed to address various development scenarios, but these types of recommendations require site-specific analysis and design work that fall well outside the scope of the Stephens Creek Pilot Project. Also, it is often problematic to invest CIP dollars on private property; for cases where cost-effective risk mitigation strategies are located on private property, funding strategies, and policy and program initiatives are needed to facilitate capital investment on property which are currently be privately owned.

5.2.10 Stakeholder Involvement and Outreach

Stakeholder involvement was sought from across BES, but it lacked involvement of key regulatory staff. Although representatives from Science, Fish and Wildlife and Portland Harbor participated on the project Advisory Team, representatives from Pollution

Prevention were not included and are necessary in all future stormwater system planning efforts to ensure compliance with MS4, UIC, and TMDL requirements.

Given the emphasis on internal coordination and collaboration and that the results of the effort were uncertain at the beginning of the process, this project incorporated only limited public outreach and involvement. Stakeholder efforts focused on internal city work groups, including discussions with PBOT and PP&R representatives. General project overviews were provided to two transportation-related citizen committees during the alternatives development phase and BES committed to following up with more complete outreach once the results were available.

5.3 Future Stormwater System Planning

Based on the project assessment summarized in Sections 5.1 and 5.2, this section looks forward and provides recommendations for future work. It outlines a program structure and process to stormwater system planning that will be executed at several scales and formally tied to existing stormwater programs— the Citywide Stormwater System Plan, concept and predesign plans, and the SWMM—and outlines next steps to address to implement this program. This section also includes technical recommendations to improve the quality of the program deliverables regarding asset management and stakeholder involvement and outreach.

5.3.1 Program Structure and Process

Stormwater system planning relies on analysis of both natural and engineered systems, and responsibility spans many work groups, projects, and programs. Although shared and distributed ownership brings many benefits, the work is currently distributed broadly with no clear center for policy and strategic direction. Coordination among projects and programs is challenging and dependent on individual methods and interpretation of needs. This SCSWSP recommends creating a program nucleus that will utilize existing staff currently responsible for the work (or some portion of the work) and reposition them into an organizational structure that has the scope and authority to address the work programmatically. However, this does not mean centralization of all stormwater related activities. This program approach acknowledges the need to support and maintain the current distribution of stormwater responsibilities throughout BES in order to continue to foster wide-spread ownership and innovation.

Potential program goals include:

- Serve as a nucleus to coordinate and prioritize stormwater infrastructure policy and planning work around agreed upon LOS.
- Serve as a subset of the Portland Watershed Management Plan (PWMP) to provide policy, capital, and operational recommendations to address stormwater system capacity, stormwater quality, surface water drainage, and condition problems in natural and manmade stormwater conveyance systems.
- Serve the development community by providing clear and consistent responses to development proposals for both on-site and stormwater system requirements.

- Serve as a clearinghouse for stormwater issues, specifically as they relate to public infrastructure needs and systems planning, as well as providing a process for conflict resolution and consensus building.
- Assist to develop more integrated responses to regulatory requirements, in particular the MS4 permit, UIC permit, TMDL requirements, ESA Recovery Planning, Superfund Program, and other relevant programs.
- Address system conditions, strategies, and actions more completely in a variety of city planning and investment efforts.
- Build leadership, capacity, and improved organizational relationships by committing to support the BES Strategic Plan and Asset Management Plan including performance monitoring, reporting, and continual improvement.

Based on applicable City of Portland policy and planning standards, the program will update stormwater policy, planning procedures, and design standards, and provide the following deliverables:

- Citywide Stormwater System Plan based on coordination with Comprehensive Plan and Public Facility Plan work.
- Concept and/or predesign level plans for priority plan areas as appropriate.
- Updated SWMM that incorporates system planning principles and guidelines.

Citywide Stormwater System Plan

The Citywide Stormwater System Plan will provide a long-term, big picture look at the entire city. This plan is presented at the lowest resolution and generally characterizes the conditions and constraints of the three regulated stormwater systems (CSO, UIC, and MS4) as well as a range of institutional and private systems. It will be based on the current work of both Bureau of Planning and Sustainability (BPS) and BES to update the City's Comprehensive Plan and BES's Public Facility Plan. It will include high-level LOS for stormwater system performance and describe how designated areas of the city measure up to those services. As a result, the Citywide Stormwater System Plan will highlight priority areas and their associated risks and recommend which areas are in need of further study with a concept or predesign plan.

Concept and Predesign Plans

In consultation with stakeholders, the program management team will agree to a work plan that commits to more in-depth study and planning of priority areas. Depending on the resolution of information available and questions that need to be answered, program staff will either prepare a concept plan or predesign plan for priority areas. Concept plans might answer questions such as "What type of risk is present and how great is the risk?" and "What options should be considered?". Basin predesign studies will include alternative development and evaluation and triple-bottom-line analysis. Predesign analysis explores the potential solutions and potential impacts and recommends specific direction to take into the next phase of design.

The program will also establish general standards and criteria to apply a more systematic approach to the characterization and alternative analysis. This process will address basin-wide deficiencies, such as underserved taxlots, lack of street improvements, etc. Once areas are characterized and categorized, and the potential approaches are defined, the project selection process will focus on addressing the specified deficiencies. Also, a preliminary feasibility review could be conducted earlier, as part of characterization.

Stormwater Management Manual Update

The SWMM has, by default, become the depository for much of BES's stormwater policy, but it falls short of addressing system needs. In addition, it combines stormwater policy with technical design guidelines, which complicates the SWMM revision process. A number of suggestions for improving both the policy and technical guidelines were collected during the Stephens Creek Pilot Project and this SCSWSP recommends restructuring and updating the SWMM within a stormwater system program approach.

Program Implementation

To produce the deliverables described above, program staff will need to develop clear pathways to implement stormwater system recommendations. New tools and products are needed to share information about where facilities are located and planned, and how the development community is expected to interface with this information. New tools should be explored and evaluated as case studies.

A process for funding and cost-sharing must also be established. Currently, private property is not eligible for CIP funding. Perhaps O&M agreements or bond covenants could address concerns, but mechanisms to work on private property and/or with private property owners need to be more clearly established. For example, acquiring easements on drainageways might provide an approvable discharge point for new development or allow capital improvements to be made to "infrastructure" that is currently private.

5.3.2 Asset Management

Stormwater system planning must be closely aligned with BES's Asset Management Program. While the LOS established for Stephens Creek provide a good starting point, stormwater system LOS must be refined and tied back to BES-wide LOS. The refined LOS must be formulated from a risk perspective and structured in such a way that estimating a dollar value for the risk is feasible. The LOS can then become the basis for program decision making.

Asset management also provides the structure to monitor program progress. With performance measures and targets for every LOS, work will be assessed and adjusted as necessary.

5.3.3 Stakeholder Involvement and Outreach

Future stormwater system planning work needs strategic public outreach that highlights system needs and the role of private property in the conveyance and stormwater management network. Many property owners are highly aware of stormwater issues and a more detailed and comprehensive public involvement plan is necessary to adequately respond to concerns.

Program support is also necessary to find the most efficient ways to collaborate and coordinate across work groups within BES as well as continuing to strengthen working relationship with PBOT, ODOT, and PP&R. Staff time is very limited within these institutions and new, cost-effective ways of sharing information is necessary.

Due to 2011 NPDES MS4 Discharge Permit requirements for completion of a hydromodification assessment and development of a retrofit plan, coordination with regulatory staff from the MS4 Program is imperative. UIC Program staff should also be involved.

Outreach tools must also be developed to communicate how the proposed program will be managed. Suggestions include a master timeline with tasks and definitions that show the whole program picture.

5.4 Conclusions

Overall, the SCSWSP project was considered to be a success by the team members and stakeholders. Watershed Services and Engineering Services stormwater goals were successfully integrated, resulting in an agreed-upon approach to integrated CIP and policy, program, and operating activities related to stormwater.

More work is needed to develop a program approach and refine the ideas and recommendations developed within this SCSWSP. Efficiencies must be found to organize the work flow and make it easier to understand and be more predictable. Also, there are unanswered questions regarding implementation that need to be explored. The program will need to continue to pilot approaches as it works more collaboratively with a broad range of system owners. Ultimately, stormwater system planning requires the expertise and buy-in of many stakeholders to create a whole that is greater than the sum of its parts.

CHAPTER 6

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