PORTLAND INTERNATIONAL AIRPORT
STORMWATER MASTER PLAN
JUNE 2015

GS&P

GRESHAM SMITH AND PARTNERS

In collaboration with:

HDR

Geosyntec consultants

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Port of Portland Project Team

Susan Aha, Water Quality Manager (Project Manager)
Ken Anderton, Industrial Development Program Manager
Nick Atwell, Aviation Wildlife Hazard Manager
Jamey Berg, Environmental Planner
Terri Burk, Planning and Development Manager
Brian Freeman, Civil PE Lead Engineer (Project Technical Lead)
Jason Gately, Planner II
Danny Garcia, Airside Operations Manager
Dan Gilkison, Engineering Project Manager (Project Technical Lead)
Dana Green, Natural Resource Manager
Danelle Peterson, Senior Water Quality Specialist
Andy Priebe, Asset Program Manager
Phil Ralston, General Manager, Environmental Operations (Project Sponsor)
George Seaman, Engineering Project Manager
Andy Sowders, Maintenance Superintendent II
Dorothy Sperry, Environmental Affairs Manager
Art Spillman, Senior Facilities and Asset Manager
Julie Thiessen, Development Manager III
Craig Thompson, Development Manager II
Richard Vincent, Senior Environmental Planner

Consultant Project Team

Gresham, Smith and Partners

Tim Arendt, PE — *Tom Dietrich, PE* — *Elizabeth Fisher, EI*
Brittnee Halpin — *Melanie Knecht, PE* — *Holly Lorton, EI*
Devon Seal, PE

Geosyntec Consultants, Inc.

Jim Howell, PE — *Marc Leisenring, PE* — *Adam McGuire, EIT*
Dan Pankani, PE — *Eric Strecker, PE*

HDR Engineering, Inc.

Shane Cline, PE — *Ryan Sheean, EIT* — *Paul Woerrlein, PE*

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APPENDICES

ACRONYMS AND ABBREVIATIONS

AC	advisory circulars (regulatory guidance document released by FAA)
ALP	Airport Layout Plan
AMP	Asset Management Planning Team
AOA	Air Operations Area
ARFF	Aircraft Rescue and Fire Fighting
BDS	Bureau of Development Services (City of Portland)
BES	Bureau of Environmental Services (City of Portland)
BMP	Best Management Practice
BOD	biochemical oxygen demand
BMP SA	BMP Strategy Area
CAD	computer aided design
CCTV	closed circuit television
CDF	controlled density fill
CIPP	cured-in-place pipe
City	City of Portland
CMP	corrugated metal pipe
COF	consequence of failure
CQB	Central Quiescent Basin
CST	Concentrate Storage Tanks
CWA	Clean Water Act
DDB	Dilute Detention Basin
DEQ	Department of Environmental Quality
DSM	Port of Portland Stormwater Design Standards Manual
DST	Dilute Storage Tanks
EDB	East Detention Basin
EQB	East Quiescent Basin
FAA	Federal Aviation Administration
FEMA	Federal Emergency Management Agency
GA	general aviation
GIS	Geographic Information System
GlyCAST™	Proprietary deicer management model
GS&P	Gresham, Smith and Partners

ACRONYMS AND ABBREVIATIONS

HDPE	high density polyethylene
HUC	hydrologic unit code
LID	Low Impact Development
LiDAR	light detection and ranging
LOF	likelihood of failure
MCDD	Multnomah County Drainage District
MS4 Permit	Municipal Separate Storm Sewer System (MS4) Permit No. 101314
NASSCO	National Association of Sewer Service Companies
NAVD88	North American Vertical Datum of 1988
NE	northeast (prefix for roads in Northeast Portland)
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NPDES	National Pollutant Discharge Elimination System
NREX	North Runway Extension Project
NRCS	Natural Resource Conservation Service
O&M	Operations and Maintenance
ODOT	Oregon Department of Transportation
OFA	Object Free Area
OFZ	Obstacle Free Zone
ORANG	Oregon Air National Guard
PACP	Pipeline Assessment & Certification Program
PDC	Portland Development Commission
PDX	Portland International Airport
PE	Professional Engineer or Port of Portland Project Engineer
PIC	Portland International Center
PLC	Programmable Logic Controller
Port	Port of Portland
PS	pump station
QTA	Quick Turn Around
RACI	Responsible, Accountable, Consult, Inform
RCP	reinforced concrete pipe
RFP	request for proposal

ACRONYMS AND ABBREVIATIONS

RFQ	request for quotation
ROFA	Runway Object Free Area
ROW	right-of-way
RSA	Runway Safety Area
SCADA	Supervisory Control and Data Acquisition
SPCC	Spill Prevention, Control and Countermeasure
SSA	Autodesk Storm and Sanitary Analysis
SSF	subsurface flow
State	State of Oregon
SWM	Stormwater Management
SWMM	Stormwater Management Model
SWMP	Stormwater Master Plan
SWPCP	Stormwater Pollution Control Plan
TACAN	Tactical Air Navigation System
TMDLs	Total Maximum Daily Loads
TOC	total organic carbon
TRC	Technical Reference Center
TSA	Taxiway Safety Area / Transportation Security Administration
TSS	total suspended solids
USGS	U.S. Geologic Survey
UST	underground storage tank
WDB	West Detention Basin
WHMP	Wildlife Hazard Management Plan
WHPA	Wellhead Protection Area
WLA	wasteload allocation
WQB	West Quiescent Basin
WQ_V	water quality volume
WQ_F	water quality flow

DEFINITION OF UNITS

ac	acre
cfs	cubic feet per second
CY	cubic yards
ft	foot (feet)
LF	linear feet
mg/L	milligrams per liter
sq ft	square feet

EXECUTIVE SUMMARY

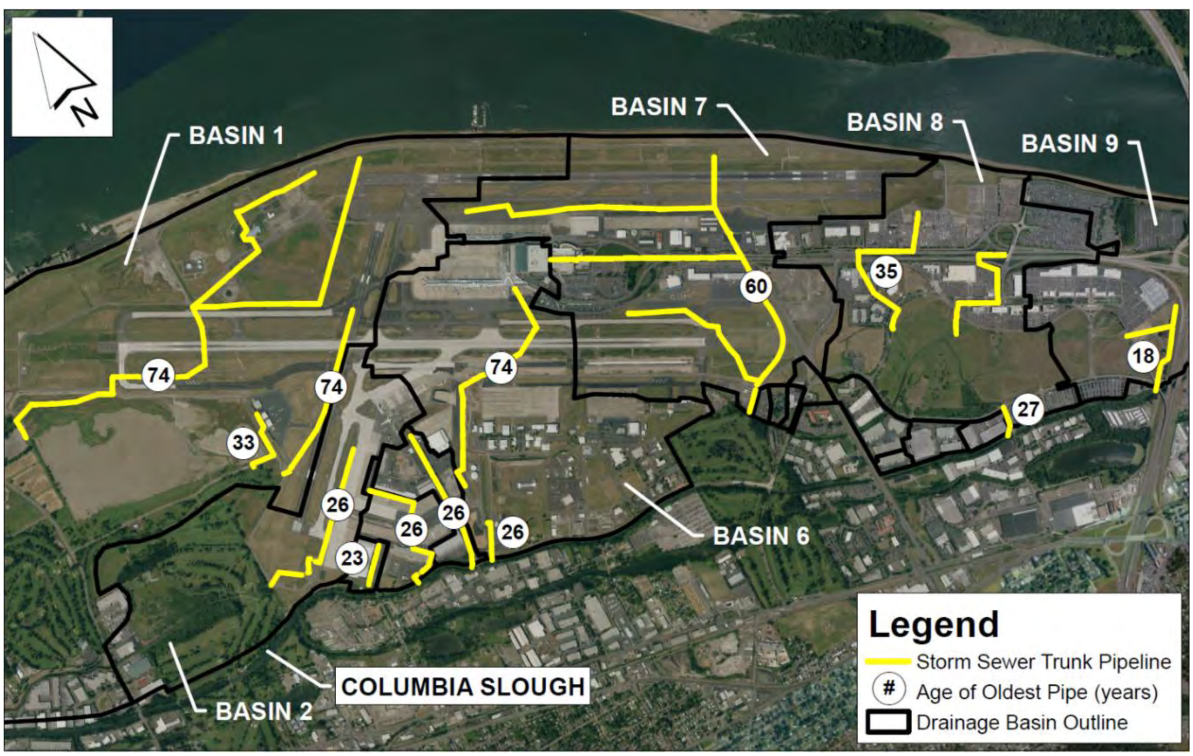
Purpose of the PDX Stormwater Master Plan

The PDX Stormwater Master Plan (SWMP) identifies critical stormwater management issues that the Port needs to address, and recommends planning-level solutions to remedy them. Critical issues at PDX include the need for treatment facilities to meet current and future water quality regulations, ponding driven by hydraulic capacity limitations, and stormwater asset failure risks associated with asset age and condition. This plan provides guidance to Port decision makers on how to address new regulatory requirements, plan for the replacement of aging and inadequate infrastructure, and ensure that airport development can be implemented as planned. While some specific details of the plan may change (such as the exact timing and extents of individual projects within affected drainage basins) the overall call to action is clear:

- New facilities must be built to retain and treat stormwater to comply with current regulations.
- Some of the airport drainage infrastructure is well past its useful life and projects should be planned its renewal/replacement.
- Some basins will require more urgent action than others due to the number of pending projects that are subject to new stormwater management standards.

Background

The Port of Portland (Port) has been managing stormwater at the Portland International Airport (PDX) site since initial airport construction in the early 1940s. The oldest stormwater pipes on the airport today date back to that construction (see figure below for ages of critical trunk lines).



Main Storm Sewer Trunk Lines with Current Pipe Age

Over the last 70 years, a significant amount of development has occurred at PDX, with the expansion of the airfield as well as supporting facilities and infrastructure. The drainage infrastructure serving these areas has also changed significantly over time, growing from a few pipes to a highly complex network with nearly 600,000 feet of pipe and over 1,000 drainage structures situated in nine main drainage basins. The drainage basins are served by large storm sewer “trunk” lines that collect drainage from smaller pipes and range in diameter from 3 feet to nearly 7 feet. While managing a set of assets of this size and complexity is a significant undertaking in itself, several features unique to PDX exacerbate the challenge:

- The storm sewer trunk lines (shown above) include some of the oldest pipes at PDX (60 to 74 years old). The largest and longest of these pipes exceed their expected useful life, meaning replacement may need to be imminent.

- Despite the expansion of the airport over time, critical portions of the drainage infrastructure have remained unchanged since the original construction. More stormwater runoff is draining to major storm sewer trunk lines than they were designed to handle, creating ponding on the surface during large rain events.

- The management of flow in the Columbia Slough causes water to back up in the airport storm sewers, which contributes to the ponding problem.

- Regulations governing stormwater have become more stringent over time. For example, the Port now must treat stormwater runoff from newly developed and redeveloped areas to comply with the Port Stormwater Design Standards Manual (DSM), in accordance with the Port’s municipal separate storm sewer system (MS4) permit.

- Until recently, neither the right tools for characterizing PDX stormwater nor consistent standards for design of stormwater infrastructure were available.

- Years of adding drainage infrastructure on a project-by-project basis without an overarching plan have created system capacity limitations and led to missed opportunities to cost-effectively address capacity, routing, and asset renewal issues.

The cumulative effect of these challenges is the unintentional creation of safety, operations, infrastructure, and regulatory compliance risks along with obvious and hidden unnecessary costs to Port. Understanding that the need to address these risks had reached a tipping point, the Port commissioned a stormwater master planning effort for PDX that concluded in 2015 with the development of this document. The PDX SWMP has the potential to address the identified stormwater management risks, improve coordination between Port departments, and, in the long run, reduce unnecessary expenditures.

Stormwater Master Planning Approach

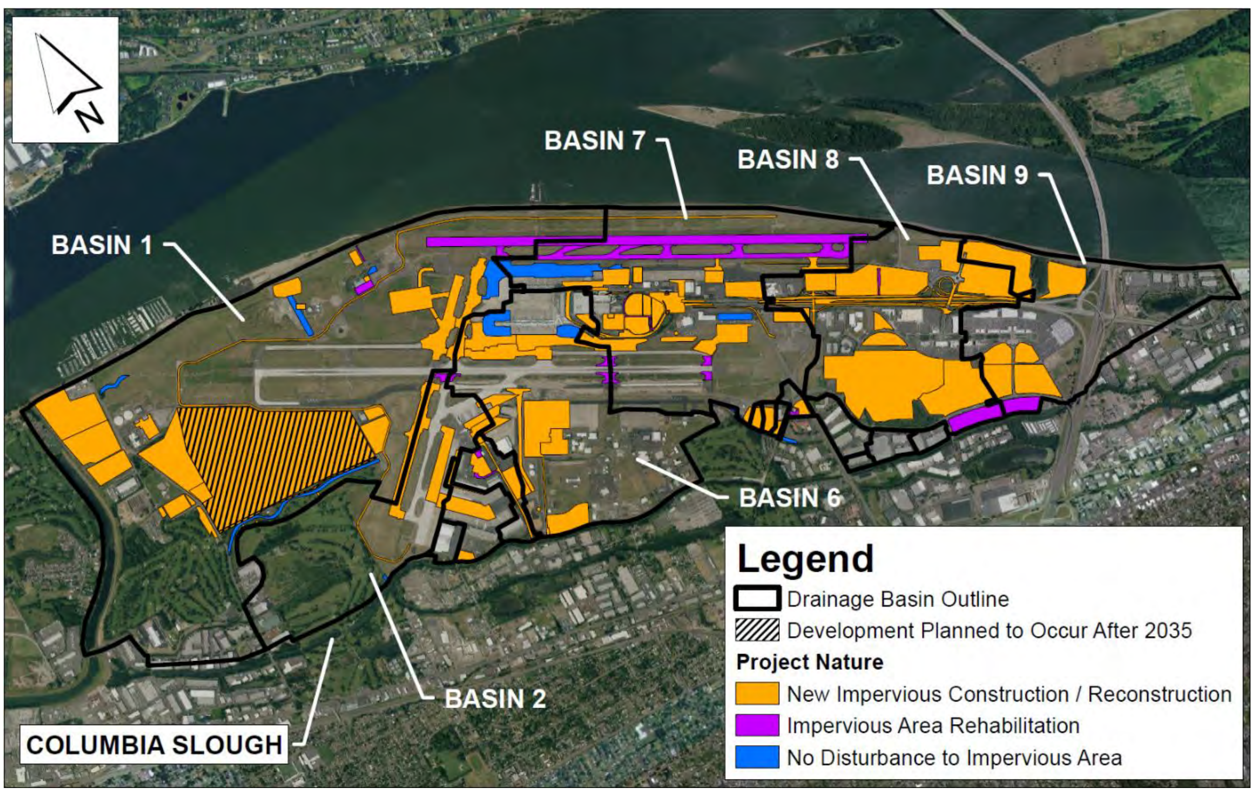
The PDX SWMP represents a major effort to identify the ways in which the Port can comply with stormwater regulations, improve regional water quality, reduce stormwater backups and ponding, and update aging infrastructure all while documenting how these improvements relate to the other capital project needs of the airside and landside areas of the airport. The effort included extensive contributions from a wide range of Port departments, resulting in a strong consensus on issues that require resolution, and stormwater management solutions that are best suited to address the issues. The objective of the PDX stormwater master planning process was to provide project-specific guidance for developing airside and landside areas of the airport, mitigate risks and meet the Port's regulatory obligations to manage stormwater. The PDX stormwater master planning process was based on the following strategy:

Stormwater Master Plan Strategy

Identify risks to the Port created by critical stormwater management issues that need to be addressed

Develop planning-level stormwater management solutions to mitigate those risks

A systematic application of this method over a two year period from 2013 to 2015 led to the identification of stormwater management issues associated with significant risks in 20 areas (both airside and landside). Stormwater management needs were evaluated based on currently planned development through the year 2035, as shown on the following figure. Identified needs included hydraulic capacity issues, stormwater asset failure risks, and stormwater controls required by the Port's Stormwater Design Standards Manual. Over 100 new construction and reconstruction projects (shown in orange) will require stormwater controls.



Development and Redevelopment Map for PDX 2015 Through 2035

Proposed Stormwater Management Solutions

The SWMP proposes a total of 38 solutions to address the identified stormwater management needs, which fall into the following three categories:

- New or modified infrastructure – These 22 solutions involve the construction of:
  - Drainage infrastructure to address ponding or stormwater asset risks (10 solutions), and
  - Regional stormwater controls to address treatment requirements (12 solutions).
- Operational change – One solution involves the year-round operation of an existing deicing pump station to address a ponding issue.
- Future planning considerations – These 15 solutions provide high-level drainage and stormwater control planning recommendations for areas of significant new development.

Stormwater management solutions recommended in this plan require refinement through site-specific planning and design. The SWMP includes a stormwater management fact sheet for each solution, providing information useful for developing project charters and business cases. Each solution fact sheet includes a planning-level opinion of probable cost and potential implementation timeframe, in addition to implementation guidance for project planning, design, construction, and post-construction. Each solution fact sheet also refers to stormwater management need fact sheets that describe the stormwater management needs addressed by the solution, including risks needing to be mitigated.

At this time, it is estimated that over 60% of these solutions may need to be implemented within the next five years, based on the timeframes currently planned for related development projects. Although all of the solutions were developed to address a critical issue identified by the Port, it may be necessary to prioritize the most critical solutions for implementation due to limitations in funding, staffing, or other Port resources. The Port routinely reviews the project planning forecast which will change the prioritization of the capital projects as well.

Although the stormwater management needs and solutions in this SWMP are representative of long-term trends, the specific analyses are based on a snapshot in time. Conditions are ever-evolving, and thus the following situations may require certain stormwater management needs and solutions to be updated:

- Additional information on stormwater drainage conditions, such as groundwater extents
- Additional information on stormwater asset condition
- Changes in the planned development projects compared to what is assumed in this document
- Changes in regulatory requirements, such as stricter discharge limits, more specific regulatory timeframes for controls implementation, or requirements from regulatory agencies associated with specific development projects
- Development project-specific stormwater drainage plans which may or may not align with the facility-wide stormwater management plans in this SWMP

Conclusion

The SWMP provides a great deal of information to support ongoing effective and efficient management of stormwater and implementation of stormwater management solutions. Integration of the SWMP findings into the Port's planning, properties management, engineering, environmental, and asset management processes is essential for maximizing the value of the SWMP.

While implementation of the SWMP findings will be challenging due to the extent of issues, evolving conditions, and the number of stakeholders, successful implementation will reduce the Port's risk and reduce long-term costs through efficient integration of the work into development projects, reductions in rework, and avoidance of emergency response measures. Timely action upon these findings is essential to gain value from the SWMP effort. Unnecessary delays may result in lost opportunities, increasing costs and potentially undermining the basis for analyses of the proposed solutions.

1 INTRODUCTION TO THE SWMP

1.1 Overview

The PDX Stormwater Master Plan (SWMP) documents the findings of the 2013-2015 "Integrated Stormwater Master Planning Services for Port of Portland Facilities," pertaining to the Portland International Airport (PDX). This plan provides an overview of the drivers for stormwater management at PDX, critical stormwater management needs defined based on those drivers, and stormwater management solutions that have been identified to address the needs. The contents of the plan incorporate the results from a variety of stormwater management analyses specific to PDX, including hydraulic modeling of the drainage system, water quality assessments, and asset management data analysis. Findings of the SWMP reflect recommendations for existing (2015) development conditions, as well as long-term considerations for future development projected through 2035.

1.2 Background on the Port of Portland and Portland International Airport

PDX is owned and operated by the Port of Portland (Port), which is a regional government agency authorized by the State of Oregon. The Port operates marine, airport, and industrial facilities under the direction of commissioners appointed by the Oregon Governor and confirmed by the legislature. The mission of the Port is to enhance the region's economy and quality of life by providing efficient cargo and air passenger access to national and global markets.

PDX supports commercial, cargo, and general aviation aircraft operations and hosts the Portland Air National Guard Base for the Oregon Air National Guard (ORANG). A variety of "airside" facilities and operations reside inside within the PDX Air Operations Area (AOA) security fence. The Port also owns "landside" properties (outside the AOA fence) contiguous with the airport that are operated by the Port or tenants. Landside properties include Port-owned and operated facilities, as well as Port properties leased to tenants for light industrial and commercial use such as rental car facilities, hotels, restaurants, business parks, and retail, including Cascade Station and Portland International Center (PIC). Airside and landside Port property at PDX is illustrated on Figure 1-1.

1.3 Inception of the PDX Stormwater Master Plan

Since the original development of the airport, an extensive system for the management of stormwater has evolved. The core of the PDX stormwater management system is the stormwater drainage infrastructure underlying the surface, including pipes, channels, structures, and pump stations. The drainage system is supplemented by a variety of additional stormwater management features that are used to monitor, divert, treat, and discharge stormwater to surface waters in accordance with various stormwater-related regulatory permits. Historically, the planning, design, construction, and management of stormwater assets at PDX has occurred on an as-needed basis. In the last decade, the Port has progressively moved toward a more comprehensive, integrated, and forward-looking program for the management of stormwater.

During 2008 to 2009 the Port evaluated existing storm system infrastructure data and identified data gaps. During 2012 the Port began development of a hydraulic model for PDX based on existing conditions. The progression was advanced with the "Integrated Stormwater Master Planning Services for Port of Portland Facilities" project in early 2013. Execution of the project was led by Port Environmental and Engineering staff with support from Port staff from Planning and Development, Construction, Operations, Maintenance, Asset Management, Facilities, Properties, Finance, and Legal departments. Technical work and document development was provided by a consultant team led by Gresham, Smith and Partners (GS&P) that included significant contributions from Geosyntec Consultants and HDR.

The PDX Stormwater Master Plan (SWMP) is the culmination of the stormwater master planning services project for PDX. It provides master planning guidance to address anticipated long-term stormwater management needs at PDX.

1.4 Objectives of the PDX Stormwater Master Plan

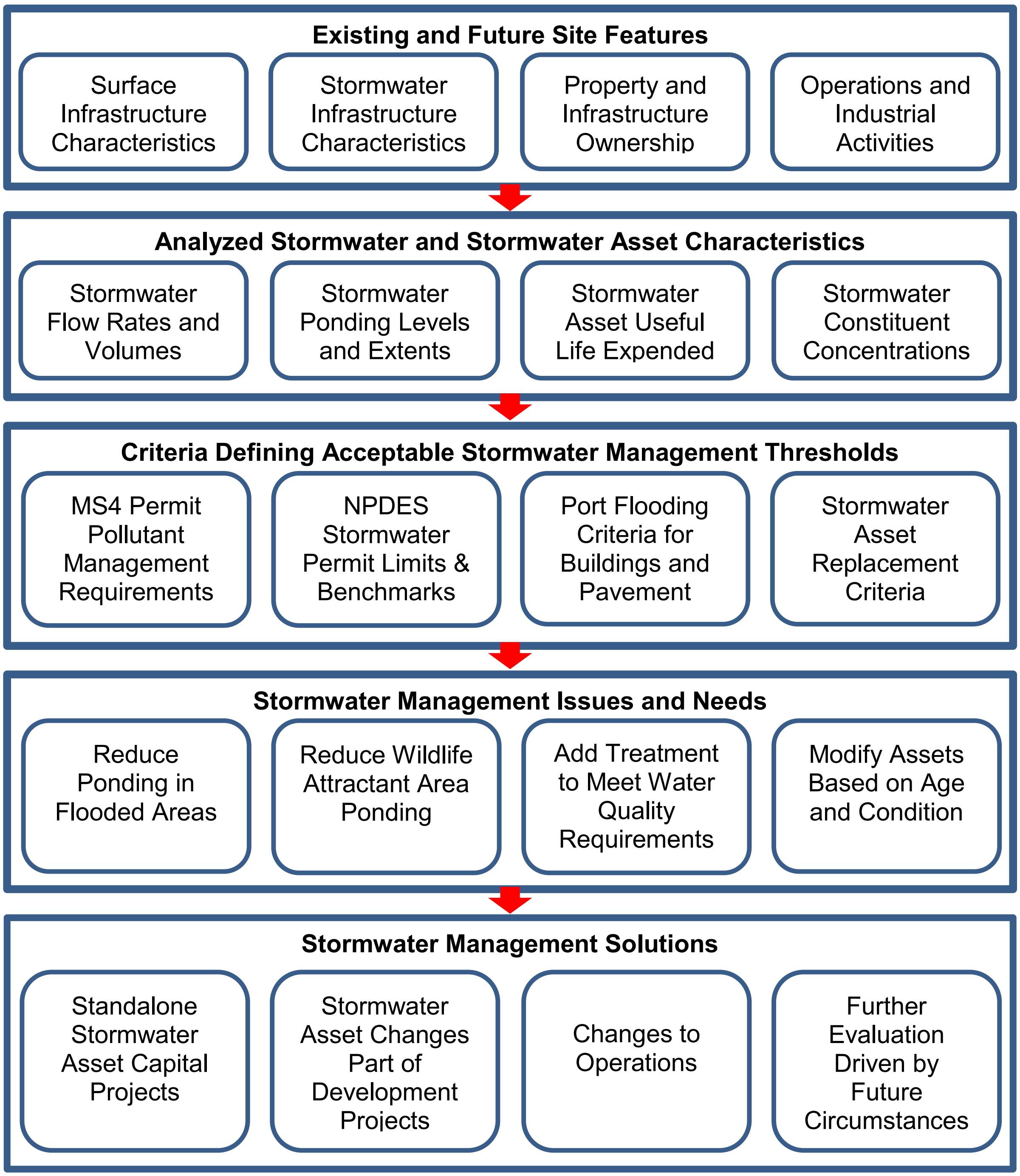
The PDX SWMP provides documentation of the findings and recommendations from the stormwater master planning project. The SWMP is intended to be a key component of the Port's overall stormwater management program at PDX. With the completion of the PDX SWMP, a key function of the PDX stormwater management program will be to evaluate and implement the recommendations of the SWMP. The SWMP is expected to foster a culture of proactive planning for stormwater management infrastructure, with the following objectives:

- Facility-wide and long-term perspective for stormwater management
- Improved awareness of the drivers for stormwater management needs at PDX, including regulatory requirements and risks to operations, safety, and future development.
- Understanding of long-term stormwater management needs and constraints associated with future development projects, and planning recommendations to address the needs
- Identification of stormwater solutions that stack stormwater management objectives to achieve financial savings and meet regulatory requirements as well as stormwater management needs
- Broader awareness of long-term regional stormwater management solutions, to facilitate integrating portions of solutions into ongoing development projects, where appropriate
- Improved access to stormwater-related data to establish a consistent basis for stormwater management decisions
- Improved communication on stormwater issues, needs, and solutions among parties that may affect or are affected by stormwater
- Access to conceptual-level budgetary and schedule guidance on potential stormwater solutions to support early planning in advance of when the projects may be required
- Improved ability to understand and apply Port Stormwater Design Standards Manual (DSM) on all applicable design projects
- Facilitation of stormwater management decisions through the Stormwater Asset Management Planning Team

1.5 PDX Stormwater Master Planning Process

The content of this SWMP document was derived from a systematic evaluation of some of the key physical infrastructure, stormwater characteristics, operational needs, regulatory requirements, and future development plans at PDX. The principal components of the master planning process and the sequence of tasks are illustrated in Exhibit 1.

Exhibit 1 – Evaluation Process for PDX Stormwater Master Plan



As introduced in Exhibit 1, the stormwater master planning process at PDX involved characterizing stormwater management issues (e.g., ponding), identifying needs for changes in stormwater management associated with those issues (e.g., reduce ponding to below drainage inlets for a 10-year, 24-hour storm), and developing concepts for specific stormwater management solutions to address the needs (e.g., modify piping to increase drainage capacity). The identified stormwater issues were reviewed with the Port to discuss potential risks to Port operations, safety, or infrastructure. Issues presenting significant risks or affecting critical areas or facilities at the airport were identified as critical and were elevated to stormwater management needs. Stormwater management solutions were then identified that will address the identified needs and mitigate the identified risks to acceptable levels. At some locations, the presence of an issue (e.g., ponding) was deemed to be non-critical based on an acceptable level of risk. In these areas, issues were not classified as needs, and solutions were also not evaluated.

1.6 Key Terms in the SWMP

The SWMP frequently uses a variety of terms that are relevant to stormwater management at PDX. These terms are defined below to facilitate a common understanding among potential SWMP users.

- ***Best Management Practice (BMP)*** – The term BMP can be used to refer to a variety of techniques, measures, and structural controls used to manage the stormwater quantity and improve the quality of stormwater runoff prior to discharge to surface waters. For purposes of this SWMP, the use of the term BMP (except where otherwise noted) refers to a structural stormwater control that is implemented to provide stormwater quality treatment in accordance with regulatory requirements, for example the post-construction water quality requirements in the Port's DSM.

- ***Stormwater Asset*** – Physical structures that comprise the PDX stormwater management system. Includes gravity and force main piping, conveyance ditches, detention ponds, quiescent ponds, catch basins, manholes, diversion structures, junction boxes, storage tanks, pump stations, stormwater monitoring equipment and instruments, as well as treatment and BMP structures. In the context of the PDX SWMP, stormwater "asset" is considered synonymous with stormwater "infrastructure".

- ***Ponding*** – The pooling of stormwater aboveground. Ponding can occur upstream of drainage structure inlets or in low spots without drainage infrastructure. Ponding in critical areas is generally considered to be a stormwater management issue by the Port. Excessive ponding is generally considered synonymous with the term "flooding". Specific circumstances of ponding considered in the SWMP include:

    - Ponding on critical pavement surfaces for the 10-year, 24-hour storm event
    - Ponding above the finished floor of buildings for the 100-year, 24-hour storm event
    - Ponding in critical hazardous wildlife attractant areas
    - Ponding in locations where new development is planned

- ***Stormwater Management Risk*** – A probability or threat of damage, operational interference, injury, access, liability, loss, or any other negative occurrence caused by vulnerabilities in the stormwater management system, that may be avoided through preemptive action. Risk management can reduce threats to: safety of aircraft and ground vehicle passengers; safety of individuals and ground crews not in vehicles; limits in movement of aircraft; limits in movement of ground vehicles including emergency response vehicles; damage to existing buildings, equipment, or infrastructure; noncompliance with environmental permits and regulations; and constraints on the ability to develop land parcels.

- ***Stormwater Management Driver*** – The impetus for stormwater management actions to resolve an identified stormwater management issue (see below). Examples of drivers include:
  - Regulatory requirements (e.g., FAA, EPA, NMFS, DEQ, City of Portland)
  - Criteria in the DSM for operations, safety, and asset management
  - Unacceptable risks posed by an issue, such as ponding, that need to be mitigated

- ***Stormwater Management Issue*** – A stormwater management issue is a condition identified through the SWMP process as a potential concern to the Port. Examples of stormwater management issues include:
  - Ponding on pavement that might affect operations or infrastructure
  - Ponding in infield areas that might increase the risk of attracting wildlife
  - Stormwater asset exceeding its useful life
  - Development projects that trigger the need for water quality BMPs

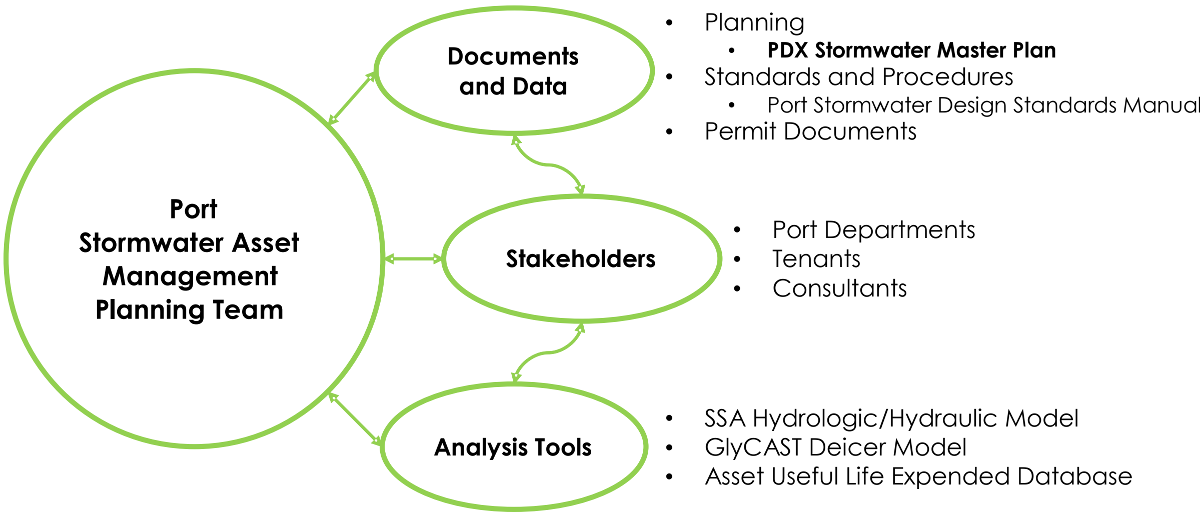
- ***Stormwater Management Need*** – A stormwater management (SWM) need is an actionable item for issues that the Port has determined present a significant risk to operations, safety, infrastructure, or regulatory compliance. A stormwater management need is therefore specific to a critical area. It describes the extent to which the issue is to be addressed to sufficiently reduce the risk. Examples of stormwater management needs include:
  - Reducing ponding in critical pavement areas such that no ponding occurs for a 10-year, 24-hour storm event
  - Reducing ponding in hazardous wildlife attractant areas such that no ponding above a catch basin inlet occurs for a 10-year, 24-hour storm event
  - Constructing a water quality BMP to comply with regulatory or DSM criteria

- ***Stormwater Management Solution*** – A stormwater management (SWM) solution is a site-specific plan for addressing one or more stormwater management needs. The solution includes identification of system components, process flow, asset sizes, footprint, and location. Stormwater management solutions can include:
  - New stormwater infrastructure in a standalone project
  - New or modified stormwater infrastructure that is part of planned development project
  - Modifications to current operational protocols
  - Recommendations for future action driven by additional data collection, studies, or evolving circumstances

1.7 Value of the SWMP Document

The PDX SWMP is intended to be a significant component the overall stormwater management program at PDX. Exhibit 2 illustrates the relationship of the SWMP to the overall stormwater management program. As shown, the PDX SWMP, Port DSM, and regulatory requirements are information the Port Stormwater Asset Management Planning (AMP) Team will use to review, coordinate, and implement stormwater management activities with stakeholders.

Exhibit 2 – Function of PDX SWMP within Port's Stormwater Management Program



The PDX SWMP distills the results from a significant amount of detailed analyses (e.g., hydraulics, water quality, and asset management) and how those characteristics may need to be modified to reduce risks for operations, safety, assets, and regulatory non-compliance. In an effort to promote usability, the SWMP details the results of a variety of stormwater analyses, in the forms of the stormwater management needs and solutions, but does not detail the analyses themselves. Specific analyses are detailed in separate files, which are listed for reference purposes in Appendix C. The information that is included in the SWMP document should support project and long-range planning and broad-based decision-making related to stormwater management. As potential stormwater management solutions progress toward design and implementation, it is recommended that the detailed technical basis and assumptions associated with the proposed solutions be revisited to verify their accuracy and relevancy (see Appendix D for general project assumptions and individual stormwater management fact sheets at the end of the SWMP).

It is anticipated that the SWMP may be used to support a variety of Port functions and activities. Potential uses of the SWMP by Port staff in various project roles and departments are described in Table 1.

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Table 1 – Potential SWMP Uses by Various Port User Groups

Port User Group	Potential SWMP Uses
Stormwater AMP Team	• Facilitate access to data acquired in the SWMP process by other users • Provide guidance for stakeholders and subject matter experts to make coherent recommendations about projects where stormwater quality and quantity are an issue • Provide a starting point for a stormwater asset management data management strategy to build upon over time. • Apply the plan to identify opportunities to address multiple, coordinated objectives which include not only stormwater management but other facility development and renewal projects as well.
Planning and Development	• Coordinate updates to the SWMP or supporting files based on new stormwater information • Use information to support preparation of Charters and Business Cases • Integrate stormwater master planning findings into the next Airport Master Plan • Understand budgets needed to address identified stormwater management issues • Use information to support integration of storm system modifications into capital projects or as stand-alone projects. • Use information to sequence and schedule stormwater projects • Identify and reserve airport parcels that need to be allocated to stormwater BMPs and other control measures
Environmental	• Identify permits and permit changes that may be needed to implement stormwater management solutions • Inform the decision-making for BMPs that are proposed to meet MS4 permit post-construction treatment requirements • Access information on the potential integration of spill control mechanisms with stormwater conveyance and treatment
Engineering	• Access estimated costs for potential stormwater management projects, including identification of costs included and excluded from those estimates • Understand the basis for proposed stormwater infrastructure changes • Identify design disciplines needed for implementation of the various stormwater management solutions • Utilize stormwater hydraulic model to support future planning and design efforts
Project Managers for New Capital Projects	• Identify stormwater management solutions that could be implemented in concert with the development and redevelopment projects and conceptual-level costs • Understand stormwater-related services that may need to be included in consultant RFQs and RFPs
Maintenance	• Identify operational changes that may affect the deicing system • Plan for maintenance needs associated with new structures and infrastructure • Understand problem areas with respect to ponding and asset management

Port User Group	Potential SWMP Uses
Wildlife Management	• Identify and advocate for stormwater management solutions intended to reduce the risk of hazardous wildlife attractants
Asset Management	• Use information to plan and prioritize infrastructure replacement and condition inspections • Use guidance on asset management to set up system for standardized coding of findings of pipe and structure inspections • Use information on existing pipes to help determine the extent to which information on stormwater asset data gaps and conflicts should be addressed • Use findings to determine if means for accessing stormwater asset data needs to be modified
Properties	• Understand which proposed stormwater solution projects involves work on Port and non-Port parcels • Understand land commitment needed for treatment structures • Understand development constraints associated with storm system infrastructure
Finance	• Use stormwater data to set rates for users of the stormwater system

1.8 Limitations of the SWMP

While the stormwater master planning effort was wide-ranging, there were inherent limitations in the scope of analyses, as described in the subsections below.

1.8.1 Stormwater Assets Evaluated

The PDX stormwater drainage system includes over 10,000 individual pipe segments and thousands of structures such as catch basins and manholes. Given the scope and budget of the project, the GS&P Team focused primarily on stormwater conveyance pipes with a diameter of 18 inches and larger from an asset management standpoint, and 24 inches and larger from a stormwater hydraulic modeling standpoint (with the addition of smaller pipes serving areas that were critical to include), as explained in Section 4. Pipes smaller than these sizes were excluded from the analyses to help manage the level of detail, as they were less critical to system performance and had significant data gaps.

1.8.2 Resolution of Deficiencies in Stormwater Asset Information

In 2008-2009, GS&P evaluated the existing state of stormwater asset information in the Port GIS and in paper records kept by the Port maintenance department in an effort to identify missing information, gaps, and conflicting data on pipe and drainage structure data. These deficiencies in information were not further assessed in the work associated with this SWMP.

1.8.3 Characterization of Stormwater Asset Condition

The stormwater master plan work included an assessment of the useful life expended of stormwater pipes based on age, as well as a review of existing stormwater asset condition inspection data. The review of inspection data reflected a snapshot in time, and generally does not reflect inspections performed after 2014. The Port conducts periodic condition inspections of select infrastructure on as needed basis to assess actual asset condition and the need to repair, rehabilitate, or replace existing compromised assets. As additional inspections are completed, the findings should be factored into the assessment of likelihood of asset failure.

1.8.4 Impact of Groundwater on Stormwater Characteristics

Groundwater at PDX likely has some interaction with the stormwater management system because of the influence of the Columbia River, the management of the Columbia Slough by MCDD, historical activities, and inherent hydrogeological characteristics of the PDX area. Groundwater impacts may include contribution of flow, contribution of pollutants, influence on stormwater infiltration rates, and direct creation of ponding/wet areas. Because of the vast area of PDX, seasonally fluctuating groundwater elevations, and varying soil conditions associated with historic airport construction, the Port has not characterized typical infiltration rates across the airport, or seasonally varying groundwater elevations. For purposes of stormwater quantity modeling performed as part of the stormwater master planning effort, typical infiltration rates were assumed based on select soil boring data, and groundwater infiltration into pipes was characterized based on monitored base flows. Because of questions about groundwater levels, the Port initiated an evaluation of groundwater elevations in Drainage Basins 1 and 2 in 2014. When findings from this study are available, it is recommended that the findings be reviewed and assessed for compatibility with modeling assumptions. Depending upon the findings, some aspects of the stormwater hydraulic model may need to be updated. In particular, the impact of groundwater on proposed stormwater management solutions should be assessed to determine if changes in concept or sizing are necessary.

1.8.5 Development Projections

A key part of the SWMP was defining the existing PDX layout and the future development plans for PDX. The "existing" site, defined as PDX development conditions in 2015, was compiled from information collected from 2012 – 2015 (as described in Appendix D). Because some of the data was collected prior to 2015, there may be slight differences in what is represented in the SWMP as "PDX 2015" and the actual PDX layout at this time. The year 2035 was selected as the end point for the planning horizon. Potential development projects that may occur between 2015 and 2035 were compiled in a detailed analysis by Port staff. However, the analysis reflects a snapshot in time and actual development will differ in terms of the specific projects implemented, their location, and their extent. Therefore, users should also utilize the SWMP information and recommendations with a recognition that actual development conditions may affect the SWMP findings.

1.8.6 Developing Solutions for Issues Not Determined to Pose a Significant Risk

The SWMP identified numerous potential stormwater issues; however, some of the issues were not significant enough or in critical areas to pose a risk to Port infrastructure, operations, safety, or regulatory compliance. Therefore, the SWMP does not provide stormwater management solutions for issues that were not determined to pose a significant risk.

1.9 Contents and Organization of the SWMP

The PDX SWMP is organized in a series of five sections that describe varying aspects of characteristics and planning considerations for stormwater management at PDX. The SWMP organization is intended to assist users with accessing essential SWMP findings and recommendations while providing external references details supporting the findings. The electronic version of the document contains hyperlinks for easy navigation. The summary below explains the contents and purpose of the major sections of the PDX SWMP, and serves as a guide for finding particular types of stormwater management information.

Section 1 – Introduction to the SWMP: This section provides an introduction to the SWMP and explains key terms, SWMP objectives, considerations for SWMP use, and an overview of SWMP content.

Section 2 – PDX Stormwater Management Program: The SWMP is an integral part of the overall stormwater planning and management program at PDX. Section 2 describes the Port's stormwater management strategy at PDX, the elements of the stormwater management program, and the regulatory basis for stormwater management at PDX.

Section 3 – PDX Stormwater Management System: Section 3 contains a summary of the information and technical basis for the SWMP, including characteristics of physical features (stormwater assets, drainage basins), stormwater characteristics (water quality, ponding, and flows), and existing stormwater controls.

Section 4 – Stormwater Management Issues and Drivers: Section 4 describes the drivers triggering the need to manage stormwater, and general stormwater management issues that have been identified at PDX during the course of SWMP analyses.

Section 5 – Overview of Stormwater Management Needs and Solutions: Section 5 provides an overview of the stormwater management needs and solutions that have been identified at PDX, as well as guidance for using the related stormwater management fact sheets.

Section 6 – Section 6 provides recommendations for next steps in implementing the SWMP, including further characterizing needs, refining and implementing solutions, and general SWMP implementation steps.

Figures – The SWMP includes a Figures section that provides further detail on the PDX stormwater management system, issues, and solutions. The figures are listed in the Table of Contents.

Fact Sheet Sections – (Basin-Specific) Stormwater Management Fact Sheets: These sections provide summary fact sheets for the stormwater management needs that have been identified by the Port, as well as stormwater management solutions identified to address those needs. In general, each section includes both needs and solutions fact sheets associated with a unique drainage basin or set of drainage basins, but the first section provides a fact sheet that is applicable airport-wide.

Appendices – The appendices provide additional details primarily supporting the technical basis for the findings, conclusions, recommendations in the PDX SWMP. Individual appendices are listed in the Table of Contents.

2 PDX STORMWATER MANAGEMENT PROGRAM

2.1 Introduction

Section 2 provides an overview of the Port's stormwater management program at PDX, as applicable to implementation of the SWMP. A variety of Port departments and staff are involved in short-term and long-term stormwater management activities at PDX. Short-term activities include daily operations and maintenance of stormwater infrastructure and controls, infrastructure data management, wildlife hazard management, flow management, and regulatory compliance activities. Long-term activities include planning and implementation of new infrastructure and controls, as well as replacement and repair of aging infrastructure. When not adequately planned, implemented, or maintained, stormwater management infrastructure and controls can fail to perform as designed, and can lead to significant impacts to airport operations, safety, compliance, and other airport assets. The Port recognizes the need for a proactive and coordinated approach to stormwater management across Port departments and in conjunction with tenants, and consultants. Such an approach will allow the Port to better anticipate potential stormwater issues and identify solutions that are cost-efficient and integrated with planned development to minimize impacts to airport operations and facilities.

The content of this section reflects refinements in the Port's approach to stormwater management that have evolved throughout the stormwater master planning process. The section provides an overview of identified roles and responsibilities for Port staff teams and departments, required stormwater management functions, regulatory requirements driving the stormwater management program, recommendations for ongoing program implementation, and available resources to facilitate PDX stormwater management activities.

2.2 Port Stormwater Management Program Structure for PDX

As previously described, Port staff and departments interact on a variety of PDX stormwater management functions. The Port has developed a "Responsible, Accountable, Consult and Inform" (RACI) chart (Appendix E – "SWMP RACI Chart") to describe the process for implementing the SWMP and managing stormwater projects at PDX across a variety of Port departments. The following subsections summarize key stormwater management tasks, roles, and responsibilities that are included under the umbrella of the PDX stormwater management program.

2.2.1 Stormwater AMP Team

The Port has a number of standing work teams who are dedicated to the collection of data about specific assets, facilities, and systems, as well as the application of that data to the task of planning for their renewal and replacement. These are known as the Asset Management Planning (AMP) Teams. During the course of the SWMP development, the Port established the Stormwater AMP Team under the sponsorship of the Planning and Development Manager. With the creation of the Stormwater AMP Team, the Port acknowledged and recognized the importance of stormwater infrastructure as Port assets and the value in proactively managing these assets to support multiple stormwater management drivers. The Stormwater AMP Team will coordinate a variety of stormwater-related functions, serve as a technical resource for stormwater management issues, and facilitate decision-making.

The Stormwater AMP Team includes members of the following Port departments:

- Asset Management
- Engineering
- Environmental
- Maintenance (Marine and Aviation)
- Development Management

Additionally, members of other Port departments, including those listed below, will be invited to participate in Stormwater AMP Team activities on an as-needed basis:

- Environmental Affairs
- Construction Services
- Business and Properties
- Community Affairs
- Long-Range Planning

Primary objectives of the Stormwater AMP Team include:

- Provide coordination of the processes, tools, documents, and data associated with implementation of the findings of the stormwater master plan.

- Provide technical input and recommendations on modifications to stormwater infrastructure.

- Act as a technical resource on stormwater and support the stormwater project implementation process, including charters, business cases, project prioritization and sequencing.

- Provide consultation on conformance of development projects with the DSM.

- Provide consultation on local vs. regional best management practice (BMP) facilities to provide required water quality treatment for stormwater runoff.

- Assist Asset Management with creating a coherent list of stormwater assets, with a means of identifying them that is consistent with the Port's Asset Registry and Masterworks project management system.

- Help to objectively describe the condition, remaining life and replacement cost of existing stormwater assets and to recommend detailed condition assessments of important stormwater infrastructure.

- Recommend and/or evaluate capital projects for replacement or renewal of existing stormwater assets or the creation of major new infrastructure such as pre-treatment and storage facilities.

2.2.3 Other Port Personnel Involved in Stormwater Management Activities

Outside of the AMP Team, Port project roles and departments that have responsibilities for stormwater management (based on the SWMP RACI Chart in Appendix E) include the following:

- Port staff roles:
  - Stormwater Asset Management Planning (AMP) Team
  - Project Sponsor
  - Development Manager
  - Business Line Manager
  - Project Manager
  - Engineers (Project, Civil, Facilities)
  - Tenant Permit Coordinator
  - Property Manager
- Port departments:
  - Planning and Development
  - Project Portfolio Office
  - Asset Management
  - Engineering
  - Construction
  - Operations
  - Maintenance
  - Environmental
  - Finance

2.2.4 PDX Stormwater Management Program Functions

The PDX stormwater management program encompasses stormwater-related functions and decision-making performed in the course of designing and implementing new and redevelopment projects, as well as those pertaining to long-term planning, compliance, asset management, operations and maintenance, and engineering functions. In general, implementation of the SWMP will be led by the Stormwater AMP Team with the participation of internal stakeholders including planning, environmental, maintenance, engineering, finance and the Project Portfolio Office (PPO). Key stormwater management activities and decisions, as identified in the SWMP RACI Chart (Appendix E), are summarized in Table 2.

Table 2 – Key Tasks and Functions from SWMP RACI Chart

Task	Key Functions
Stormwater Management Planning	• Master plan provides processes, tools, and documents. • Ongoing tasks coordinated by AMP Team • AMP team is technical resource for planning/recommending stormwater infrastructure for new and redevelopment projects • AMP team is technical resource for stormwater issues, recommend project prioritization and sequencing, and conformance to the DSM
Port Capital Projects – Initiation (Charter Development and Business Case Development)	• Use SWMP recommended projects as basis for charters, both standalone and those combined with capital projects • Provide information on environmental, hydraulic, treatment, and asset impacts at charter and business case level • Assess changes in scope/schedule/budget • Prioritize, sequence, and schedule projects
Port Capital Projects – Design	• Design stormwater projects per the DSM • Approve technical basis of design • Assess drainage/ponding impacts with stormwater hydraulic model • Coordinate treatment requirements
Port Capital Projects – Closeout	• Update stormwater model at project closeout • Transition project to operations and maintenance
Maintain Tools and Documents	• Update documents like the DSM, SWMP, and intergovernmental agreements • Maintain tools like stormwater model, water quality model, BMP tracking tool
Operations	• Assess asset condition, track asset data and changes • Allocate operations and maintenance (O&M) costs of regional BMPs
Tenant Processes	• Identify stormwater system infrastructure issues for property transactions and tenant development
Financial	• Establish and apply stormwater facility charges • Fund regional BMPs

2.3 Stormwater Management Program Resources

The Port has a series of additional technical resources, reference documents, and tools to assist with stormwater management program decision-making and operations. Use of these resources may facilitate implementation of SWMP recommendations. The following subsections provide an overview of these resources, as well as a comparison of their content with the content of the SWMP.

2.3.1 Regulatory Requirements for Stormwater Management

A variety of regulations and permit programs drive stormwater management functions at PDX, including the need for post-construction stormwater quality treatment controls (i.e., BMPs), as well as quantity and quality limitations on discharges to receiving waters. Key regulatory requirements affecting stormwater management at PDX are summarized in Appendix F. Summary documents of applicable permit requirements were created as part of the master plan process.

2.3.2 SWMP Tools for Stormwater Analysis and Design Support

Various stormwater management tools specific to PDX were used to perform stormwater management analyses in support of SWMP development, as identified in Table 3. It is anticipated that the stormwater hydraulic model will be used primarily by Port Engineering and Environmental, with consultant support as appropriate, in the process of selecting and designing stormwater infrastructure changes. The PDX infrastructure databases will be used by Asset Management and Port Engineering, while the 2035 development map can be used by Planning and Development, as well as the Stormwater AMP Team.

Table 3 – Tools Used or Developed in SWMP Process

Tool	Function, Capabilities, and Limitations
Stormwater Hydraulic Model (Storm and Sanitary Analysis Software from Autodesk, developed by GS&P)	• Covers PDX Drainage Basins 1-9 • Produces flow rates and flow volumes throughout drainage system based on precipitation inputs • Used to establish ponding levels • Primarily includes conveyance pipes 24-inches in diameter or greater, with smaller pipes represented in targeted locations • Calibrated to flow data (calibration data for Basins 1 North and 6 may be suspect due to questionable flow meter readings) • Results may be influenced by influence of groundwater on infiltration rates
Pollutant Loading Model (EPA SWMM model, developed by Geosyntec Consultants)	• Covers PDX Drainage Basins 1-9 • Produces pollutant mass loading rates at PDX outfalls • Used to establish data needed for MS4 Permit compliance work • Used statistical analysis of outfall pollutant data to fine tune model output
Deicing System Model (Propriety GlyCAST™ software from GS&P)	• Model of PDX Drainage Basins 1, 4, 5, 6, and 7 • Includes functional representation of deicing system, including collection, storage, and treatment • Includes hydrologic and water quality components • Used to assess pollutant loads and stormwater flows from deicer • Used to size deicing system components and assess percentage risk of non-compliance with deicing National Pollutant Discharge Elimination System (NPDES) permit
PDX Integrated Stormwater Infrastructure Database (Excel spreadsheet, developed by GS&P)	• Database of drainage structures and conveyance piping developed in 2008-2009 • Developed from GIS data and paper maintenance records • Used to identify data gaps and conflicts in basic infrastructure data • Data gaps and conflicts not resolved
Database of Stormwater Pipe Asset Characteristics, Age, and % Useful Life Expended (Excel database, developed by GS&P)	• Includes pipe Asset ID, pipe diameter, pipe installation date, pipe material, pipe age, % useful life expended (based on age)
PDX Future Development Plan Map and Database (GIS mapping, Excel database developed by GS&P, with projects determined by Port)	• Representation of planned development projects to be implemented by 2035 at PDX, as envisioned in 2015 • Includes project location; anticipated timeframe for construction; impervious construction / reconstruction areas requiring a BMP or assigned a BMP; impervious areas being rehabilitated that do not require a BMP; project areas with no BMP required because of no disturbance to impervious area

2.3.3 Port of Portland Stormwater Design Standards Manual (DSM)

The Port developed a Stormwater Design Standards Manual (DSM) to enforce post-construction stormwater management requirements for applicable development occurring after January 1, 2014, in accordance with the requirements of the Port's MS4 permit. Compliance with the DSM is triggered on new development and redevelopment projects exceeding a defined disturbance area threshold and falling within defined applicability areas at PDX. DSM requirements include design standards for stormwater drainage infrastructure, as well as sizing and selection criteria for structural best management practices (BMPs) or post-construction stormwater quality controls. A brief comparison of the relevant features of the PDX SWMP and DSM is provided in Exhibit 3.

Exhibit 3 – Comparison of PDX SWMP and DSM

PDX Stormwater Master Plan	Port Stormwater Design Standards Manual
Emphasizes regional solutions with some development project-specific considerations	Defines stormwater standards to be met on individual development projects
Intended for use by Port staff	Intended for use by Port staff, tenants, and consultants
Defines location and type of stormwater issue	Provides design standards and BMP sizing criteria for development
Includes recommendations for specific regional and sub-regional BMPs	Includes guidance on BMP selection and design
Provides guidance on planning process for future stormwater management	States requirements for submittal of stormwater documents for Port approval

As part of the analyses supporting the SWMP, the GS&P Team evaluated future stormwater control requirements for development projects planned at PDX through 2035 that are expected to trigger DSM compliance. DSM stormwater control requirements pertaining to planned development were classified as stormwater management needs in the SWMP (see Section 4 and stormwater management need fact sheet 0-1). The SWMP analyses also included the identification of BMP solutions sized to address the identified needs. Needs and solutions pertaining to DSM-required stormwater controls are generally described in Section 5 and detailed in the fact sheets at the end of the SWMP (prior to the appendices).

The DSM also requires that drainage designs for new and redevelopment projects be evaluated using the PDX stormwater hydraulic model to account for downstream drainage restrictions and to characterize the impacts of development on ponding. The SWMP identifies stormwater management solutions for ponding-related stormwater management needs based on the assessment of future development conditions (through 2035) using the stormwater hydraulic model, in accordance with DSM standards. As future projects are implemented in accordance with the DSM, they should make use of the stormwater hydraulic model to verify that identified long-term solutions are compatible with planned development.

2.3.4 Additional Port Stormwater Management Resources

The following additional resources include information that may support stormwater management planning, design, and analysis.

- Port Stormwater Asset Data Management Systems – The Port stores and updates various Geographic Information Systems (GIS) data that relate to select stormwater assets (e.g., structures, pipes and BMPs). There is also data on GIS impervious areas and drainage basins. In addition to the Port GIS, designers may also look to the City and Metro GIS databases to obtain information on zoning and floodplains

- Port-wide Stormwater Management Plan – Plan demonstrates Port compliance with the requirements of the Port-wide MS4 (municipal separate storm sewer system) NPDES permit covering all Port-owned facilities within the City of Portland Urban Services Boundary (USB), including PDX. One requirement of the MS4 permit was the development of the DSM and establishment of post-construction water quality control criteria, as described in the previous subsection.

- PDX Stormwater Pollution Control Plan – Plan demonstrates PDX compliance with the requirements of the 1200-COLS general NPDES permit for PDX stormwater discharges to the Columbia Slough. This plan includes potential pollutant sources associated with industrial activities at PDX, as well as existing structural and non-structural BMPs to control pollutants.

- Management Plan – Deicing System Standard Operating Procedures – Plan describes the features and operations of the PDX deicing system, which is used to control discharges of stormwater entrained with aircraft and pavement deicing materials, in accordance with PDX Individual NPDES permit #101647 (“deicing NPDES permit”).

- PDX Spill Prevention, Control, and Countermeasures (SPCC) Plan – Plan demonstrates PDX compliance with the requirements of the Oil Pollution Act and underground storage tank (UST) regulations. This plan describes PDX oil storage locations and quantities, as well as controls and spill response procedures.

- Port Technical Reference Center (TRC): The Port’s TRC stores project record information as well as geotechnical and site data and reports.

- Port Design Consultant Manual: The Port has detailed requirements for design drawings, specifications, and other electronic files. Designers are required to follow the standards set within the Design Consultant Manual for all design submittals.

- Standard CAD Drawings: Coordinate with the Port on available drawing templates and standard drawings to be incorporated into design submittals.

- Standard Design Specifications: Coordinate with the Port on available specification templates and standard specifications to be incorporated into design submittals.

- PDX Wildlife Hazard Management Plan (WHMP): The Port maintains a copy of the WHMP to document practices and standards that the Port takes at PDX to manage wildlife hazards.

3 PDX STORMWATER MANAGEMENT SYSTEM

3.1 Introduction

Section 3 provides a summary of the PDX stormwater management system features and functions for reference purposes, including general drainage patterns, drainage system (conveyance) features and infrastructure, storage facilities and best management practices, and assumed development conditions driving stormwater runoff. This information is included to document conditions at the time of the SWMP analysis that supported the analysis and characterization of stormwater management issues. It also is provided to facilitate the understanding of individual stormwater management needs and solutions, as described in the stormwater management fact sheets (provided at the end of the SWMP, prior to the appendices).

PDX is located approximately 9.5 miles northeast of downtown Portland, and falls within the City of Portland USB. The site is generally bounded by the Columbia River to the north, the Columbia Slough to the south, the Peninsula Canal to the west, and Interstate 205 to the east. Along these boundaries, Port property interfaces with non-Port property, and the PDX stormwater management system interacts with stormwater runoff and stormwater infrastructure managed by the City, MCDD, ODOT, and private property owners. As such, the PDX stormwater management system is subject to impacts from discharges of stormwater runoff from non-Port properties into the PDX system, as well as from the performance of downstream non-Port drainage infrastructure that receive flows from PDX. For purposes of characterizing the effects of these interactions on the performance of the PDX stormwater management system, SWMP analyses encompassed select adjacent non-Port properties and infrastructure.

3.2 PDX Stormwater Drainage System Overview

This section provides an overview of the existing PDX drainage system and drainage patterns, including PDX receiving waters and drainage infrastructure used to convey flows to them.

3.2.1 PDX Watersheds and Receiving Waters

PDX (including Cascade Station and Portland International Center), is located between the Columbia Slough and Columbia River, east of the Willamette River. Other than the PDX deicing outfall to the Columbia River, all stormwater outfalls from PDX discharge to the Columbia Slough. The Columbia Slough drains into the Willamette River just upstream of its confluence with the Columbia River. Downstream of the Lower Willamette Subbasin, the Columbia River continues approximately 80 miles northwest before it discharges into the Pacific Ocean.

Historically, the Columbia Slough and the area where the airport is located were part of the Columbia River floodplain. The natural drainage pattern was altered over time as levees were installed along the River to provide flood control, and the floodplain area was filled with dredge material from the River to facilitate development. A system of manmade channels and levees were installed within the area to promote drainage toward the Columbia Slough and to provide flood control. Multnomah County Drainage District #1 (MCDD) provides flood control in the Columbia Slough and associated upstream channel systems through the operation of a series of pump stations that pump drainage across the levees into the Slough and also between segments of the Slough as it drains toward the Willamette River. PDX falls within the boundaries of the Columbia Slough Watershed, which has been assigned a 6th-level or 12-digit hydrologic unit code (HUC12 #170900120201) by the U.S. Geological Survey (USGS). This watershed falls within the larger Lower Willamette Subbasin (HUC8 #17090012), which consists of the area draining to the Columbia River northwest of Troutdale and southeast of St. Helens, including the entire Columbia Slough and the lower portion of the Willamette River upstream (southeast) of the Columbia River to Bolton.

3.2.2 Overview of PDX Drainage Basins

PDX is divided into fifteen drainage basins from west to east (Basins 1-6, 7a-7d, and 8-12), each corresponding to one or more outfalls at the Columbia Slough. The drainage basin boundaries are defined by topographical differences and individual networks of pipes and channels that drain to common points on the downstream ends of the basins. Of these basins, the stormwater modeling and analysis at PDX focused on the nine major drainage basins (Basins 1-6, 7, and 8-9), which represent 98% of the area found in Basins 1-12. The remaining basins (7b-7d, and 10-12) represent relatively limited areas draining by gravity to small, discrete outfalls along the Columbia Slough. Due to the small size of the areas, simplistic drainage systems, and limited availability of infrastructure data in these basins, they were not analyzed in detail using the stormwater model. Please refer to Figure 3-1 for a map of PDX drainage basins and drainage infrastructure, and Figure 1-1 for the drainage basin boundaries relative to Port property. Please refer to Section 3.4 for further details on each of the nine major drainage basins.

3.2.3 Stormwater Conveyance Facilities and Assets

Within the PDX drainage basins, stormwater is collected, conveyed, and discharged by a variety of drainage infrastructure and facilities, including the following types:

- Gravity pipes and structures
- Channels
- Pump stations and force mains

The above types of assets are described further in the following subsections. Existing stormwater controls at PDX, which are also managed as stormwater assets, are described in Section 3.3.

3.2.3.1 Gravity Pipes and Structures

As previously described, the airport site was originally served by a network of channels draining to the Columbia Slough. As PDX was constructed over time, portions of channels falling within development areas were realigned or replaced with pipe networks to drain the airfield and associated development areas. The Port currently owns and maintains over 10,000 individual gravity pipe segments at PDX. Other than isolated culverts in channels, these gravity pipes are connected by gravity drainage structures (including catch basins, manholes, and other structures and vaults) to form vast piping networks. Except in areas where there are data gaps, each pipe and each structure is generally assigned a unique identifier number to facilitate tracking as stormwater assets in the Port's GIS system. Due to the significant number of pipes, stormwater hydraulic modeling analyses performed for the SWMP focused on gravity pipes with diameters of at least 24 inches, to manage the level of detail in the model. Smaller pipes were incorporated in select areas where necessary to add further detail or represent potentially critical areas in the drainage system. Please refer to Figure 3-1 for stormwater gravity infrastructure at PDX, and Figure 3-2 for modeled stormwater infrastructure.

The Port tracks pipe age and material data, where available, in its GIS system, and these characteristics vary spatially across the airport. Based on available pipe installation years from the Port's review of data in the TRC, the oldest stormwater pipes currently in use at PDX were installed in 1941, giving them an age of 74 years, as of 2015. All pipes with this installation year are located west of the current Terminal Building. The available data indicate that no new pipes were installed at PDX between 1941 and 1952. The locations of various storm pipe ages and materials at PDX, based on data available in the Port's GIS system, are mapped out on Figure 3-3 and Figure 3-4. Due to significant gaps in pipe age data for the smallest pipes, asset management analyses for the SWMP focused on pipes 18 inches and larger. Please refer to Section 4.3 for more information on asset management analyses.

3.2.3.2 Channel Systems

Channels are located in all of the drainage basins at PDX, but are more prevalent in the drainage basins that have less congested development (Basins 1, 2, 8, and 9). All of the drainage basins at PDX include sporadic channels to collect overland flow runoff and route it to inlets connected to the piped drainage systems. As an example, the vegetated infield areas along runways and taxiways include channels that collect overland flow from the airfield and convey it to inlets on the piped drainage systems. Parking lots, aircraft aprons, and other large expanses of impervious development generally drain to inlets on the pavement and drain directly into the piped system without draining through channels first.

The four PDX drainage basins with less congested development (Basins 1, 2, 8, and 9) include significant channel networks to convey flows from airside and landside areas to the Columbia Slough. These channel networks are remnants of the levee and channel system that was originally constructed to facilitate development of the original Columbia River floodplain, as previously described. These remaining channel networks fall outside of the densest airport development, and are generally downstream of the piped systems. In Basin 1, channel systems also serve less densely-developed properties along NE 33rd Drive, west of the airfield. Water levels in these major channel systems are largely controlled by MCDD flood management operations, as discussed in the following subsection.

3.2.3.3 Pump Stations and Force Mains

A variety of stormwater pump stations are installed on and around the PDX site that influence the performance and operation of the PDX drainage system, as well as the routing of stormwater. These pump stations include facilities owned, operated, and maintained by MCDD to perform flood management operations, as well as facilities owned, operated, and maintained by the Port to perform deicing stormwater collection and discharge operations in accordance with the PDX deicing NPDES permit. The one exception is Pump Station 6 (PS-6), which operates as a deicing stormwater pump station during the deicing season (November 1st to May 31st each season), and operates as a stormwater pump station the remainder of the year.

As described above, MCDD manages flooding and water levels in the Columbia Slough watershed and upstream channel networks through their operation of a series of pump stations. In Basins 1 and 2, the channel water elevations are controlled directly by MCDD pump stations that pump water from the channels into the Columbia Slough (MCDD Pump Station #2 and Broadmoor Pump Station). The channel networks downstream of the developed areas in Basins 8 and 9 drain through gravity pipe outfalls into the Columbia Slough, but channel water levels are impacted by the MCDD-managed water levels in the Columbia Slough.

During the deicing season, stormwater flows in Basins 1, 2, 4, 6 and 7a are subject to potential collection by one or more deicer management pump stations within the dilute or concentrate portions of the PDX deicing system. When in collection mode, these pump stations divert flows toward storage tanks and ultimately to alternate discharge locations, including to the Columbia River outfall near the deicing treatment system, or to the sanitary sewer. These diversions reduce stormwater discharges to the stormwater outfalls along the Columbia Slough. See Section 3.3 for further information on the PDX deicing system.

3.3 PDX Stormwater Water Quality Controls

The Port has multiple regulatory obligations for stormwater which require water quality controls and water quality monitoring, as discussed in the regulatory summary in Appendix F. The primary relevant regulatory requirements at PDX are the 1200-COLS NPDES permit for stormwater discharges associated with industrial activities, the PDX deicing NPDES permit, and the MS4 NPDES permit. Other regulatory programs also drive the need for water quality controls, such as the Spill Prevention, Control, and Countermeasure (SPCC) rule. The following subsections describe the stormwater water quality controls the Port owns and maintains at PDX.

3.3.1 General Water Quality BMPs and Spill Control Devices

The Port and PDX tenants employ a variety of stormwater best management practices (BMPs) to protect the quality of PDX stormwater discharges and comply with applicable water quality regulatory criteria and permits. The following is a brief description of the structural stormwater BMPs implemented at PDX. Additional details on each BMP are provided in Section 3.4 within the corresponding drainage basin in which each BMP is located.

3.3.1.1 Detention Basins

The Port has constructed two detention basins at PDX outside of the deicer management system, which provide flood control and water quality treatment. Documentation of the design intent for the detention basins to provide these functions was not found during a search of Port records. It is noteworthy that the detention basins were constructed prior to the water quality requirements instituted by the MS4 permit. Detention basins at PDX include the following:

- East Detention Basin (Basin 6)
- West Detention Basin (Basin 2)

3.3.1.2 Spill Control BMPs

The Port has constructed several BMPs to mitigate the risks of releasing a spill off-site. These spill control BMPs are designed to isolate a potential spill and allow for cleanup operations. The quiescent basins listed below are regional spill control BMPs, providing function for the entire drainage basin. Oil water separators serve a smaller area, being located closer to operations where a potential spill might occur. The quiescent basins also provide some water quality treatment by acting as a settling basin for TSS. Spill control BMPs at PDX include the following:

- East Quiescent Basin (Basin 6)
- Central Quiescent Basin (Basin 4)
- West Quiescent Basin (Basin 2)
- Oil Water Separators (various locations)

3.3.1.3 Other BMPs

A variety of other structural stormwater BMPs have been implemented at PDX. These BMPs are targeted at providing post-construction stormwater water quality treatment. These BMPs are distributed controls, installed to address the runoff from specific projects with new or rehabilitated impervious surfaces. Distributed BMPs at PDX include the following:

- Manufactured Device BMPs (various locations)
  - Hydrodynamic Separators
  - Storm Filters
  - Sedimentation Manholes
- Sand Filters (along NE Cascades Parkway in Basins 8 and 9)
- Vegetated Swales (various locations)
- Rocky Swales (deicing treatment system)
- Filter Strips (various locations)

3.3.1.4 Source Controls/Non-Structural BMPs

Non-structural BMPs, also known as source controls, are implemented at PDX to address specific regulatory requirements for stormwater. These BMPs may be specific to particular location or operation or may apply across the entire PDX site. Non-structural BMPs at PDX include the following:

- PDX implements source controls for various activities such as storing fuel in order to comply with SPCC regulations. Examples include work instructions for fuel dispensing and leak monitoring.

- Other source controls are established with the PDX Stormwater Pollution Control Plan (SWPCP) required under the 1200-COLS permit. Examples include procedures to prevent non-stormwater discharges.

- The Port's Stormwater Management Program also contains source controls applicable at PDX which are regulated under the MS4 permit. Examples include detection and elimination of illicit discharges and public outreach and education.

3.3.2 PDX Deicing System

The PDX deicing system is used to manage the monitoring, collection, storage, treatment, and discharge of stormwater containing applied deicing chemicals, in accordance with the PDX deicing NPDES permit and the Port's Wastewater Discharge Permit from City of Portland Bureau of Environmental Services (BES) governing discharges to the sanitary sewer. During the deicing season, stormwater runoff is monitored for total organic carbon (TOC) concentrations (as a surrogate for biochemical oxygen demand [BOD]) in deicer-impacted stormwater runoff at key locations around the airport using online meters. As managed by deicing system operators and a supervisory control and data acquisition (SCADA) control system, stormwater is routed either to storage structures or to the Columbia Slough outfalls, based on how the measured TOC concentrations compare to TOC diversion concentration set points. Deicer-impacted stormwater that requires collection (to meet the wasteload allocation [WLA] for BOD in the deicing NPDES permit) is pumped across the airport to on-site storage facilities that hold dilute or concentrated runoff.

Dilute stormwater runoff requiring collection from (Drainage) Basins 2, 4, 6, and 7a is routed to the Dilute Detention Basin (DDB) prior to being pumped to one of two Dilute Storage Tanks (DSTs). In Basin 1, dilute stormwater runoff requiring collection is routed through two pump stations (PS-N and PS-S) directly to the DSTs. Dilute stormwater in the DSTs is typically routed either by gravity flow or pumped flow to the Columbia River in accordance with the daily BOD WLA to the River in the deicing NPDES permit. Dilute stormwater in the DSTs can also be routed to the adjacent deicing treatment system, although this is rare in practice.

Stormwater runoff from concourse areas with direct application of aircraft deicer with a TOC concentration that exceeds the concentrate system diversion concentration set points is pumped to the concentrated storage tanks (CSTs). Collected runoff from the CSTs can be directed either to the deicing treatment system or to the sanitary sewer at the discretion of the deicing system operators. Treated effluent from the deicing treatment system is typically discharged to the sanitary sewer, but it can be routed to the Columbia River. Based on the terms of the deicing NPDES permit, discharges to the Columbia River are only allowed from November through May.

Deicing system infrastructure, including pumps, conveyance piping, tanks, and the deicing treatment system, was specifically sized to accommodate stormwater flows and BOD mass loads for the projected flight schedule at the airport in 2022 based on the 2007 terminal area forecast. The design of the deicing system minimizes, but does not eliminate, the possibility that BOD discharges to the Columbia Slough will exceed the daily BOD WLA in the deicing NPDES permit.

Due to the interconnected nature of deicing infrastructure and drainage infrastructure in Basins 1, 2, 4, 6, and 7, stormwater management and deicer collection activities in these basins have the potential to affect each other. When the deicing system is in collection mode, stormwater is pumped out of the storm sewer trunk lines and diverted toward deicing storage facilities, which has the effect of reducing flow volumes draining through downstream drainage infrastructure. Conversely, improvements to address drainage infrastructure bottlenecks have the potential to increase flow rates and affect TOC mass loads draining to downstream deicing collection pump stations, which presents a potential risk to deicing NPDES permit compliance. It is the Port's goal that the risk of non-compliance for the deicing NPDES permit not be increased. To mitigate this risk, select stormwater management solutions were evaluated for potential impacts to the deicing system and deicing NPDES permit compliance, as described in Section 4.

3.4 Drainage Basin Descriptions

This section provides individual descriptions of each of the nine major PDX drainage basins, as introduced in Section 3.2.2, including their site features, drainage facilities, and major water quality control facilities. All nine basins and the drainage infrastructure within them are illustrated on Figure 3-1.

3.4.1 Basin 1

Basin 1 is the westernmost drainage basin at PDX, and is bounded to the west by the Peninsula Canal, the north by the Columbia River, to the south by the Columbia Slough and Broadmoor Golf Course, and to the east by the centerline of Runway 3-21. It generally includes all Port and non-Port property draining to MCDD Pump Station #2.

3.4.1.1 Site Features

Basin 1 includes the portion of the PDX airfield located north and west of the intersection of the South Runway (Runway 10R/28L) and Runway 3-21. It also includes the far west end of the North Runway (Runway 10L/28R), limited ramp area west of the terminal, and the southwest ramp. West of the airfield, the drainage basin includes Southwest Quad and Riverside Golf Course, as well as Port-owned and non-Port-owned properties along NE 33rd Drive and Sunderland Avenue, including ORANG's Kliever Armory, deicer treatment facility, Columbia River Correctional Institution, and associated other commercial and industrial facilities.

3.4.1.2 Drainage Infrastructure and Facilities

The Basin 1 stormwater drainage system is comprised of both piped and channelized systems. The airfield portion of Basin 1 is served by three separate piped drainage systems. The Basin 1 North system serves the west end of the North Runway, the Northwest Ramp and fuel farm, and the western portion of the South Runway. It drains to Outfall 1C east of Kliever Armory, and enters a channel network that drains south across Riverside Golf Course to MCDD Pump Station #2. The Basin 1 South system serves the northwestern portion of the terminal ramp, Runway 3-21, and the eastern portion of the South Runway airfield, and drains to Outfall 1S southeast of the Southwest Ramp. A third drainage system serves the Southwest Ramp and drains to Outfall 1E. Flows from Outfalls 1S and 1E enter a channel network that flows along the southern edge of Southwest Quad and west across Riverside Golf Course to MCDD Pump Station #2. Once at MCDD Pump Station #2, all flows from the converged channel networks in Basin 1 are pumped out to the Columbia Slough.

3.4.1.3 Regional BMPs

The following regional BMPs are located in Basin 1:

- Dilute Pump Station N (PS-N)
- Dilute Pump Station S (PS-S)
- Concentrate Pump Station D (PS-D)
- Deicing Treatment System and DSTs

Since Basin 1 includes a portion of the PDX airfield where deicing activities may occur, multiple pump stations are integrated into the drainage systems to allow for the diversion of concentrate (Pump Station D) and dilute (Pump Stations N and S) deicing stormwater. Pump Station D serves the terminal ramp in Basin 1 South, while Pump Stations N and S are situated near Outfalls 1C and 1S, respectively. Additionally, the deicing treatment system and DSTs are located in Basin 1 along NE 33rd Drive, but they manage deicing stormwater collected from deicing system pump stations in Basins 1-7.

There are no existing regional BMPs serving general (non-deicing) stormwater in Basin 1, but sporadic BMPs serve drainage from individual development sites, including Kliever Armory and the deicing treatment system site.

3.4.2 Basin 2

Basin 2 is located in the southwestern portion of PDX, and is bounded by the South Runway centerline to the north, the Columbia Slough to the south, and the western edge of Broadmoor

Golf Course and the Runway 3-21 centerline to the west. It generally includes all Port and non-Port property draining to Broadmoor Pump Station.

3.4.2.1 Site Features

Basin 2 includes part of the airfield along the southern portion of Runway 3-21, and extends east onto the South Central and Central Ramps as far as the western edge of Boeing and Aeroterm hangars. Basin 2 also includes the vegetated area located southwest of Runway 3-21, which includes a portion of the Runway Safety Area (RSA), and the surrounding perimeter road and AOA fence. West of the AOA fence, Basin 2 includes Broadmoor Golf Course, as well as nearby commercial and industrial non-Port properties along NE 33rd Drive.

3.4.2.2 Drainage Infrastructure and Facilities

The Basin 2 stormwater drainage system is comprised of both piped and channelized systems. The northern portion of Basin 2 (i.e., the airfield) is drained by two piped systems which discharge to the south into the open channels at Broadmoor Golf Course. The eastern piped system serves a majority of the airfield portion of Basin 2 (approximately 130 acres), which drains through the West Detention Basin before draining through 24-inch gravity pipes across the Perimeter Road to Outfall 2. Additionally, a small area west of the southwest end of Runway 3-21 (approximately 12 acres) drains through the western piped system through a 12-inch pipe under the Perimeter Road. West of the Perimeter Road, stormwater from both pipes converge in the open channels within Broadmoor Golf Course, before being pumped by MCDD’s Broadmoor Pump Station to the Slough.

3.4.2.3 Regional BMPs

The following regional BMPs are located in Basin 2:

- West Quiescent Basin (WQB)
- West Detention Basin (WDB)
- Pump Station F (PS-F)

As described in Section 3.3, the WQB is used for spill control, while both the WQB and WDB provide water quality treatment for TSS and other pollutant removal. The WDB also provides some detention to reduce peak flows. Since Basin 2 includes a portion of the PDX airfield where deicing activities may occur, Pump Station F is integrated into the drainage system to allow for the diversion of dilute deicing stormwater.

3.4.3 Basins 3, 4 and 5

Basins 3-5 are located in the southern portion of the airport, and are bounded to the west by Basin 2, to the east by Basin 6 and the ORANG facilities, and to the south by the Columbia Slough. They include all area draining to Outfalls 3-5, which is entirely owned by the Port.

3.4.3.1 Site Features

Basins 3-5 are generally grouped together in the SWMP due to their small sizes and similar site characteristics, including leased hangars and buildings surrounding the South Ramp. Basin 3 is the smallest of the nine major PDX drainage basins, and generally aligns with the Boeing lease area, including a hangar and ramp areas to the east. Basin 4 is directly east of Basin 4, and includes a majority of the South Ramp as well as the FedEx hangar. Basin 5 is east of Basin 4, and includes AirTrans Way along with adjacent leased hangars to the west.

3.4.3.2 Drainage Infrastructure and Facilities

Basins 3-5 are each served by an independent drainage system that is primarily piped. Each piped drainage system drains south by gravity through an outfall to the Columbia Slough (Outfalls 3-5).

3.4.3.3 Regional BMPs

The following regional BMPs are located in Basin 4:

- Pump Station G (PS-G)
- Central Quiescent Basin

As described in Section 3.3, the Central Quiescent Basin is used for spill control, as well as water quality treatment for TSS removal. Since Basin 4 includes a portion of the PDX airfield where deicing activities may occur, Pump Station G is integrated into the Basin 4 drainage system to allow for the diversion of dilute deicing stormwater.

3.4.4 Basin 6

Basin 6 is located in the southern central portion of PDX, and is bounded to the west by Taxiway J and Basin 5, to the east by Taxiway C6 and the Colwood Industrial Park, to the north by Concourse D in Basin 7, and to the south by the Columbia Slough. It generally includes all areas draining to Outfall 6, which are primarily owned by the Port.

3.4.4.1 Site Features

A large portion of Basin 6 consists of the Portland Air National Guard Base facilities, which is owned by the Port but leased to ORANG. The ORANG base is located south of Taxiway C and the South Runway, and east of Taxiway J. To the north of ORANG, Basin 6 includes the central portion of the South Runway and associated taxiways, between Taxiway E and Taxiway C6, as well as a central portion of the passenger terminal, parking garage, and Concourses B and C.

3.4.4.2 Drainage Infrastructure and Facilities

The Basin 6 stormwater drainage system includes a piped system that serves the northern portion of the basin and discharges into the East Quiescent Basin followed by the East Detention Basin. The ORANG facility is served by several separate piped systems that discharge to a central network of channels and basins before combining into a pipe that discharges into the East Detention Basin. Stormwater from the airfield and ORANG combines in the East Detention Basin, and is then pumped out by PS-6 into a gravity pipe that drains to the Columbia Slough.

3.4.4.3 Regional BMPs

The following regional BMPs are located in Basin 6:

- East Quiescent Basin (EQB)
- East Detention Basin (EDB)
- DDB
- CSTs

- Pump Station I (PS-I)
- Pump Station J (PS-J)

As described in Section 3.3, the EQB is used for spill control, while both the EQB and EDB provide water quality treatment for TSS and other pollutant removal. The EDB also provides some detention to reduce peak flows. Since Basin 6 is centrally located and includes a portion of the PDX airfield where deicing activities may occur, a variety of deicing system facilities are located in Basin 6. The DDB collects and stores deicing stormwater flows diverted by dilute deicing pump stations in a variety of drainage basins, until those flows are pumped by PS-I to the DSTs and ultimately the deicing outfall to the Columbia River in Basin 1. The CSTs collect and store deicing stormwater flows diverted by concentrate deicing pump stations in a variety of drainage basins, until those flows are pumped by PS-J to the deicing treatment system or sanitary sewer connection.

3.4.5 Basin 7

Basin 7 is located in the northern central portion of PDX, and is bounded to the west by Taxiway E, to the east by the east end of the North Runway (10L-28R), to the north by the Columbia River, and to the south by McBride Slough and NE Alderwood Road. It generally includes all areas draining to Outfall 7, which are primarily owned by the Port.

3.4.5.1 Site Features

The northern portion of Basin 7 includes the central and eastern portions of the North Runway and associated taxiways. It also includes the portion of NE Airport Way between the terminal garage and the Southeast Ramp, along with adjacent hotels, general aviation (GA) hangars, and other commercial and industrial businesses. To the south of NE Airport Way, Basin 7 includes the Southeast Ramp and PDX Cargo Center, as well as the eastern portion of the South Runway east of Taxiway C6. Additionally, it includes the portion of NE 82nd Ave between NE Alderwood Road and NE Air Cargo Road.

3.4.5.2 Drainage Infrastructure and Facilities

The Basin 7 stormwater drainage system is primarily piped, with a primary trunk line that begins near Taxiway A3 in the north airfield and conveys flows southeast toward Outfall 7a. The trunk line has numerous tie-ins along its length from discrete piped drainage networks near the north airfield, the GA Ramp, NE Airport Way, Southeast Ramp and NE 82nd Ave, and south airfield. At Outfall 7a, Basin 7 stormwater flows through a gravity outfall pipe into McBride Slough.

McBride Slough is a remnant of the channel networks that were put in place to allow development of the Columbia River floodplain. At this time, McBride Slough is an isolated series of channels that are physically disconnected from Columbia Slough, but hydraulically connected through a discharge pipe referred to as the “straw pipe”. The straw pipe, located under a business park east of NE Alderwood Ave and west of NE 82nd Ave, conveys stormwater from McBride Slough to the Columbia Slough, and was constructed in 1936. Based on concerns about straw pipe material of construction (corrugated metal), age, and condition, as determined through a video inspection, the Port is planning to functionally replace the straw pipe with a new discharge pipe crossing the Colwood Industrial Park. This proposed pipe, which is currently in the process of being planned and designed, is commonly referred to as the “Colwood” or “Trammell Crow” pipe.

Minor PDX drainage basins 7b-7d also drain through gravity outfalls to McBride Slough, although they contribute a much smaller percentage of flow than Basin 7. Basins 7b-7d have been simplistically represented in the Basin 7 stormwater hydraulic model to characterize drainage in the McBride Slough watershed and support sizing analyses for the Colwood pipe.

3.4.5.3 Regional BMPs

The following regional BMPs are located in Basin 7:

- Cartridge filter containing 44 cartridge for water quality treatment
- Pump Station E (PS-E)

The 44-cartridge filter is intended to provide treatment for past developments in the basin. Since Basin 7 includes a portion of the PDX airfield where deicing activities may occur, PS-E is integrated into the drainage system to allow for the diversion of dilute deicing stormwater.

3.4.6 Basin 8

Basin 8 is located east of Basin 7, and is bounded to the north by the Columbia River and to the south by NE Alderwood Road. It is generally east of NE 82nd Ave and extends just to the east of NE Mt Hood Ave. It generally includes all areas draining to Outfall 8, which are primarily owned by the Port.

3.4.6.1 Site Features

Basin 8 primarily consists of non-airfield areas, but it does include a sliver of the eastern end of the North Runway, as well as the vegetated area located to the southeast that includes a portion of the RSA. South and east of the Perimeter Road, Basin 8 includes hotels and rental car lease areas along NE Airport Way, as well as western portions of the Red and Blue Economy Parking Lots. South of NE Airport Way, Basin 8 includes a large portion of the PIC area, including business parks along NE Cascades Parkway, Cascade Station retail center, and undeveloped fields to the south. At the far south end, Basin 8 includes a portion of the PDX Employee Parking Lot.

3.4.6.2 Drainage Infrastructure and Facilities

The Basin 8 stormwater drainage system is comprised of both piped and channelized systems. The developed portion of Basin 8 is served by a series of separate piped drainage systems that drain to a major channel network. The eastern piped system serves the Red and Blue Economy Parking Lots, Cascade Station, and portions of NE Airport Way in between. The western piped system serves areas to the west, including rental car and hotel areas, as well as business parks south of NE Airport Way. A third piped system serves undeveloped areas southeast of Cascade Station, and a fourth piped system serves a portion of NE Alderwood Road just to the east of NE 82nd Ave. These piped systems drain into a channel network that drains across the undeveloped portion of the PIC toward the PDX Employee Parking Lot. At that point, the channels drain into a gravity pipe network that picks up additional flows from the lot and NE Alderwood Road before discharging by gravity through Outfall 8A to the Columbia Slough.

3.4.6.3 Regional BMPs

There are no existing regional BMPs in Basin 8, although there are distributed BMPs that serve individual development areas (e.g., sand filters in Cascade Station). The Port is also planning to implement a regional cartridge filter BMP commonly referred to as the East Landside Stormwater

Enhancement Vault. The BMP is proposed to be constructed in 2015-2016 to meet DSM water quality criteria for over 23 acres of planned development in Basins 8 and 9, including projects in the vicinity of the Economy Parking Lots, NE Airport Way and NE Mt Hood Ave.

Since Basin 8 does not include areas where airfield deicing activities occur, there are no deicing system facilities or diversion pump stations located within this drainage basin.

3.4.7 Basin 9

Basin 9 is the easternmost drainage basin at PDX, and is bounded to the north by the Columbia River and to the south by the Columbia Slough. It is located east of NE Mt Hood Ave and Basin 8, and the Port-owned property in Basin 9 is located west of Interstate 205. Basin 9 also includes off-site drainage from Oregon Department of Transportation (ODOT) along Interstate 205, as well as additional non-Port properties located just to the east of Interstate 205. It generally includes all Port and non-Port property draining to Outfall 9.

3.4.7.1 Site Features

Basin 9 consists entirely of non-airfield areas, including the eastern portion of the Red and Blue Economy Parking Lots, a portion of NE Airport Way, and the eastern portion of PIC and Cascade Station. As described above, it also includes portions of Interstate 205, and various business on non-Port property located east of Interstate 205.

3.4.7.2 Drainage Infrastructure and Facilities

The Basin 9 stormwater drainage system is comprised primarily of interconnected piped systems serving a variety of Port-owned and non-Port-owned areas. Separate piped networks serve a variety of areas in Basin 9, all of which combine into a gravity trunk line draining to the Columbia Slough at Outfall 9. Individual pipe networks contributing to Outfall 9, along with areas served and pipe ownership are summarized in Table 4 below.

Table 4 – Basin 9 Pipe Networks and Ownership

Pipe Network	Area Served by Pipe Network	Pipe Ownership
Pipe system northwest of NE Airport Way and Highway 205	Economy Parking Lots	Port
Pipe crossing to east side of Interstate 205	• Interstate 205 northbound on-ramp • Businesses east of Interstate 205, north and south of NE Airport Way	ODOT
Pipe serving northern portion of Interstate 205	Northern portion of Interstate 205 and NE Airport Way interchange	ODOT
Pipe system in PIC west of Interstate 205	• Cascade Station • Undeveloped portion of PIC	City and Port
Pipe system south of NE Alderwood Road	• PDX Employee Parking Lot • NE Alderwood Road	City and Port

The southern portion of the Interstate 205 / NE Airport Way interchange drains to a standalone ODOT outfall to the Columbia Slough, and does not contribute to Outfall 9.

3.4.7.3 Regional BMPs

There are no existing regional BMPs in Basin 9, but the Port is planning to implement the East Landside Stormwater Enhancement Vault, as described in Section 3.4.6.3, to serve select planned development projects in Basins 8 and 9. Since Basin 9 does not include areas where airfield deicing activities occur, there are no deicing system facilities or diversion pump stations located within this drainage basin.

4 STORMWATER MANAGEMENT ISSUES AND DRIVERS

4.1 Introduction

Section 4 provides an overview of key stormwater management issues facing PDX that have been characterized as part of the analyses performed in support of the SWMP. Although a variety of stormwater management issues were analyzed and considered in the stormwater master planning process, three types of issues in particular were used to define specific stormwater management needs (and drive stormwater management solutions) within the SWMP:

- Ponding
- Stormwater Asset Failure
- Required Stormwater Controls

Each of the three issue types above is described in a subsection below, including the drivers for addressing each issue (including risks and regulatory requirements), potential factors contributing to each issue, the occurrence of each issue as characterized at PDX, and potential stormwater management strategies to resolve each issue. Stormwater management needs corresponding to these three issues, and corresponding solutions, are provided at the end of the SWMP document.

This section also provides a brief overview of tangentially-related stormwater management issues that were considered during the course of the SWMP, including climate change, deicing system impacts, spill control, and existing conditions water quality assessments. Each of these issues was separately analyzed, and recommendations are separately documented outside the SWMP. However, the GS&P Team did also consider these issues for relevance to SWMP needs and solutions, and relevant conclusions have been integrated into the SWM fact sheets, where applicable.

4.2 Ponding

As indicated in Section 1.4, ponding refers to the presence of stormwater on the surface, typically above the top elevation of local drainage structures or above the lowest elevations in grassy areas without drainage infrastructure. Although ponding can be expected during large storm events where the capacity of the drainage system is exceeded, it can become a significant issue when the ponding is excessive and extends into critical areas or poses a risk to safety or operations. For the purposes of the SWMP, this issue refers to a condition where the ponding creates one or more risks that the Port wishes to mitigate.

4.2.1 Drivers for Addressing Ponding

The regular occurrence of ponding at PDX presents a variety of safety, asset, and operational risks to the Port. Depending on the ponding location, specific risks likely to be associated with excessive airside or landside ponding at PDX include the following:

- Aircraft safety (wildlife strike) risk posed by stormwater ponding and chronically wet areas that are likely to attract hazardous wildlife to approach or departure airspace
- Aircraft safety risk posed by potential impacts of frequently wet conditions on the structural stability of soils within Runway Safety Areas
- Interruption to airport or tenant operations due to limited access or movement areas
- Restrictions to onsite development due to risk of property damage or floodplain requirements

- Risk of property damage in existing Port-operated or tenant-operated facilities
- Ground vehicle safety risk posed by potential hydroplaning of vehicles on public or private roadways
- Risks to personal safety posed by flooded buildings or ponding that poses a threat to pedestrians

To manage the aviation-related risks identified above, the FAA has established objectives, guidance, and minimum criteria pertaining to airport drainage and stormwater management at airports. These criteria, as well as the risks they address, serve as drivers for addressing excessive ponding issues at PDX. Specific drivers from FAA advisory circulars (ACs) include the following:

- FAA AC 150/5200-33 for Hazardous Wildlife Attractants and PDX Wildlife Hazard Management Plan – Discourages hazardous wildlife attractants, including stormwater facilities with open water surfaces, within 10,000 feet of the AOA. The Port expands upon the criteria in this AC through its Wildlife Hazard Management Plan, in which it outlines stormwater-related wildlife hazard management criteria pertaining to zones at different distances from the AOA fence.

- FAA AC 150/5320-5 for Airport Drainage Design – Establishes objectives for efficiently draining airports, including the need to provide for the safe passage of vehicles and operation of the facility. The AC includes guidance on the acceptable spread of ponding during specified design storms. During the 5-year storm there must not be surface ponding and during the 10-year storm the center 50% of runways and taxiways must remain free from ponding.

- FAA ACs 150/5300-13 for Airport Design – Provides guidance on airport design with the objective to increase safety at airports. Guidance includes design objectives for the runway safety area (RSA). The RSA must be able to support various equipment associated with airport operations as well as support aircraft without resulting in damage to the aircraft. Additionally the drainage of the RSA must prevent water accumulation.

4.2.2 Potential Factors Contributing to Ponding

A variety of site-specific factors can lead to the development of temporary or long-term recurrent ponding areas. In general the potential root causes or factors that may lead to ponding at PDX include:

- Availability and sizing of infrastructure
  - Lack of drainage infrastructure in certain locations

- Insufficient flow capacity in gravity pipes
  - Pipes carrying flows exceeding design flow due to increased development over time
  - Pipes potentially undersized in original design
  - Please note that it was not possible to assess which of the above sub-bullets might be the cause of particular pipes being undersized, due to repeated changes in PDX development.

- Site grading and conveyance profiles:
  - Pipes with flat slopes, low slopes, or backward slopes, or connecting pipes with mismatched inverts (upstream pipe that is lower than connecting downstream pipe)
  - Site topography being significantly lower than surrounding parcels, making the area more subject to impacts from surcharged infrastructure and tailwater conditions
  - Inconsistent grading of overland flow pathways and channels, due to grading changes
- Downstream conditions:
  - Presence of treatment or flow control structures (e.g., weirs) that create a hydraulic head upstream of the structure
  - Insufficient flow capacity for MCDD pump stations
  - Pump station operational settings
  - High tailwater conditions, particularly in the Columbia Slough and connected upstream channels that submerge upstream infrastructure and reduce the available flow capacity
- Site hydrology impacts and limitations:
  - Restrictions to infiltration due to variation in soil characteristics or compaction
  - Influence of seasonally high groundwater elevations on ponding
  - Groundwater infiltration into pipes restricting available flow capacity
- Potential maintenance and condition issues limiting flow capacity:
  - Presence of sediment in pipes and structures that reduce the available flow capacity
  - Blockages of inlet pipes or channels with sediment or fill, grass clippings, or other materials
  - Pipe condition issues that may allow groundwater infiltration or have indentations that reduce flow capacity

The specific root causes potentially associated with any given ponding location vary. For ponding issues that are critical enough to have been identified as stormwater management needs, the potential factors contributing to the issue are described in the Fact Sheets. The elevation and extent of ponding also varies between storm events depending on the intensity and duration of the precipitation, soil moisture conditions, and downstream Slough elevations during the event that affect the flow hydraulics in the upstream drainage system.

4.2.3 Characterization of Ponding at PDX

The occurrence of ponding at PDX was characterized using the PDX stormwater hydraulic model, which was developed in Autodesk SSA (Storm and Sanitary Analysis) software to simulate hydrologic conditions and hydraulic performance of the PDX drainage system under existing and future conditions at PDX. The “existing” or “2015” conditions model was originally developed in 2012, and updated in select areas (based on select surveys, record drawings, and updated GIS information) only where it was necessary to add more detail during the process of developing the SWMP between 2013 and 2015. Key sources for the model included the Port’s GIS system for drainage infrastructure information and the 2005 LiDAR for surface topography. The “future” conditions model reflects planned PDX development through 2035, based on current Port and tenant development plans, as compiled by the Port in August 2014 and illustrated in Figure 4-1.

Although the stormwater hydraulic model is referred to generally in this SWMP as a single model, it is in fact a series of models associated with individual drainage basin areas.

The model was simulated for both 2015 and 2035 conditions to determine potential ponding areas around the airport during the 10-year and 100-year recurrence interval storm events. The ponding areas indicated by the model are associated with hydraulic restrictions in the drainage infrastructure as installed (associated with the following contributing factors: availability and sizing of infrastructure, insufficient flow capacity in gravity pipes, conveyance profiles, and downstream conditions). However, other potential causes of ponding, including detailed site grading, site hydrology impacts and limitations, and potential maintenance and conditions issues, were not able to be characterized in detail for purposes of the stormwater hydraulic modeling effort. Ponding caused solely by those contributing factors may not appear in the SWMP.

The stormwater hydraulic modeling analysis indicated the presence of ponding for larger storm events in many locations at PDX. The ponding areas were reviewed and discussed with Port staff. As part of this review, the ponding locations identified through the modeling effort were compared to observations of ponding around the airport, including those in the vicinity of the airfield that are managed for wildlife hazards in accordance with the PDX Wildlife Hazard Management Plan.

The ponding areas were assessed by the Port based on the significance of the risk that the ponding had on airport operations, safety, and assets. The Port's evaluation of risk included considerations for location, significance of operations, and ponding extent. Individual ponding areas that were determined to pose a critical risk requiring mitigation were defined as ponding-related "stormwater management needs." Locations of these ponding-related stormwater management needs at PDX (and estimations of their ponding extents based on 2035 conditions) are illustrated on Figure 4-2. Stormwater management needs are described in more detail in Section 5, and individual ponding-related stormwater management needs are described in the stormwater management need fact sheets (at the end of the SWMP prior to the appendices).

Stormwater hydraulic modeling was also performed to evaluate and select specific stormwater management solutions to address ponding for each of the identified stormwater management needs. Solutions are specific measures needed to mitigate the stormwater management need and address the risk. Strategies used to identify these solutions are described in the subsection below, and individual stormwater management solutions are described in the stormwater management solutions fact sheets. For an overview of the ponding-related stormwater management needs and solutions identified in each drainage basin, please refer to the drainage basin-specific stormwater management fact sheet sections (provided at the end of the SWMP, prior to the appendices).

4.2.4 Strategies for Addressing Ponding

As part of the stormwater modeling analysis, critical ponding areas were assessed to determine the primary root cause of ponding at each ponding location, to facilitate targeting a solution approach. In general, the strategies for reducing ponding included the following:

- Add flow capacity in the form of drainage infrastructure to drain areas more efficiently and reduce system backups.
- Provide underground storage to temporarily detain flows to prevent surface ponding.

- Perform surface re-grading to reduce isolated low spots.

Proposed stormwater management solutions for ponding areas were prioritized based on their ability to meet the following objectives, where possible:

- Provide regional benefits by reducing multiple ponding areas simultaneously, if possible.
- Address ponding in an efficient manner by targeting root cause of ponding (e.g., pinch point in system) to the extent possible.
- Stack objectives by addressing ponding with potential benefits toward other stormwater management issues and considerations (e.g., stormwater asset failure risk mitigation, spill control, deicer management, or other water quality control benefits).
- Align with nearby planned development, where there are potential synergies with planned construction activities and temporary closures or operational changes.
- Minimize impacts to existing airport facilities, infrastructure, and operations.

For each ponding-related stormwater management need, criteria were established to define the necessary reduction in ponding to mitigate the risk. These criteria for the basis for determining the method, size, and scope of improvements to address the issue. These criteria varied based on the location and nature of the ponding, as follows:

- Critical ponding on existing/future pavement (risk to operations) or in vegetated areas in the vicinity of airfield or approach/departure airspace (risk to aircraft safety): Reduce the 10-year storm peak ponding elevation to the lowest available catch basin grate, structure rim elevation in the Port GIS database, or low spot in the local grading.
- Critical ponding with risk to existing/future buildings: Reduce the 100-year storm peak ponding elevation to the lowest known building first floor elevation, based on LiDAR data or adjacent structure rim elevation from the Port GIS database.

4.3 Stormwater Asset Failure

Stormwater assets can fail or be compromised in performance due to structural deterioration over time. Failure of stormwater infrastructure can occur suddenly (e.g., a pipe collapse) and have potentially significant consequences (e.g., flooding of critical operational areas) that may not be easily or quickly fixed. In general, the risk that a stormwater asset might fail can be characterized as Likelihood of Failure (LOF). The risks associated with a failing asset can be broadly characterized as Consequence of Failure (COF). In the stormwater master planning process, detailed maps of pipe age and estimated percent of useful life expended were prepared as a simplified indicator for LOF. Other than a specific analysis of straw pipe failure impacts to Basin 7, COF was generally not quantified for PDX stormwater assets. Instead, high level consideration was given to which stormwater assets would cause the most extensive and impactful flooding if pipe failure occurred. Those considerations were used to target a small number of aging pipe segments whose failure would be particularly problematic. This primarily focused on large storm sewers that carry the bulk of a drainage area's flow to the outfall. Stormwater management need and solution fact sheets were developed for the targeted set of pipe segments for this SWMP, particularly focusing on areas where ponding issue solutions could also address risk of asset failure. In the future, the Port's Asset Management department will continue the process of identifying stormwater assets for inspection and prioritizing needs for repair, rehabilitation, or replacement.

In July 2014, the GS&P team submitted the Port Stormwater Asset Management Assessment Report to the Port of Portland. This document provides a detailed description of analyses performed pertaining to existing Port stormwater assets, as well as recommendations for further development of the Port's asset management program. This section incorporates key findings from that report. Please refer to that report for further details pertaining to this section, including data sources.

4.3.1 Drivers for Addressing Risks of Asset Failure

Stormwater assets play a central role in the functioning of PDX, by draining stormwater runoff away from key operational facilities. Should a significant stormwater asset fail, the effect on operations, safety, and other assets at PDX could be widespread and significant. As a result, an understanding of the risks of asset failure (including likelihood of failure and potential consequences of failure) is essential to drive and prioritize stormwater management actions (e.g., asset replacement and repairs) to mitigate the most significant risks.

The ponding-related COF for any particular stormwater asset largely depends upon the size of the asset's tributary area, as well as the criticality of that area to PDX operations. The risks of ponding in the case of asset failure are similar to those previously described for ponding, but the magnitude of the impacts have the potential to be much greater. This is due to the potential for a failed pipe to severely limit or completely block drainage, resulting in higher ponding elevations and broader extents of ponding. Additionally, the time required to identify the source of the problem, acquire resources and equipment, and perform the emergency repairs may result in a ponding duration that extends well beyond the storm event duration.

Other significant risks associated with stormwater asset failure include potential structural impacts to facilities installed above the buried pipe, particularly for large-diameter pipes. At PDX, stormwater assets pass below buildings and structures, roadways, aircraft aprons, runways, taxiways, and other facilities critical to airport operations and safety. In the case of structural failure of a large pipe, the impacts may cause failure of adjacent and overlying facilities, which will likely lead to much more significant safety risks, operational interruptions, and financial damages.

Asset failure may present the following risks, in addition to those previously identified for ponding areas:

- Safety and operational issues from flood waters extending into structures and into vehicle or aircraft movement areas
- Damage to infrastructure, buildings, airfield facilities, aircraft, vehicles, utilities, and operational equipment
- Exposure of cargo and materials to stormwater, including materials that may present an environmental hazard

- Compromised operations as temporary and permanent fixes to the pipe failure are implemented
- High costs associated with emergency fixes to failed piping and damaged infrastructure

Airports, much like large municipalities, will be facing a looming crisis over the next few decades as they deal with stormwater assets that were installed in many cases more than 50 years ago and are well past their intended lifespan. Making decisions on the repair, rehabilitation, and replacement of stormwater infrastructure is highly challenging, for several reasons:

- It is easy to succumb to an “out of sight, out of mind” perspective on assets that are generally not visible and that may not have presented a major problem to-date.
- It can be costly to perform detailed inspections of the infrastructure.
- Even with inspections, it is difficult to predict with any certainty when stormwater infrastructure will fail or the extent of the failure.
- Repair, rehabilitation, and replacement of aging assets can be expensive and disruptive to operations.

These concerns, however, need to be balanced with the potentially significant consequences of not proactively managing assets. The Port recently experienced an excellent example of this when an inspection of the McBride Slough culvert (commonly referred to as the “straw pipe”), which is currently the only conduit providing an outlet for drainage from Basin 7 to the Columbia Slough. This inspection revealed multiple pipe locations with significant defects, including pipe wall deflections, joint separations, and significant rusting through the pipe to the soil. Should the pipe collapse before it can be replaced, it would flood NE Airport Way, much of the terminal, and the eastern halves of the North and South Runways.

4.3.2 Potential Factors Contributing to Likelihood of Failure

Stormwater assets, such as gravity flow conveyance pipes, pump stations, structures, and storage tanks have long lifespans, typically ranging from 30 years to 100 years. While the lifespans are long, the condition of all stormwater assets is subject to degradation over time, which may vary due to construction factors and exposure to particular environmental factors. As the condition of an asset worsens, the risk of asset failure increases. Minor changes in condition over time might affect the asset performance, but are not likely to pose substantial risks. Major changes in condition, however, can result in substantial impacts on performance and potentially complete failure.

The actual lifespan of a specific pipe can be affected by a variety of environmental and construction factors. The contribution of these factors toward the risk of asset failure can only be determined by identifying the presence of such conditions or performing pipe condition assessments. Potential conditions affecting asset lifespan include, but are not limited to, the following:

- Pipe-to-pipe joint design
- Pipe-to-structure joint design

- Construction quality
- Surface land use, including loads applied to the surface by buildings and vehicles
- Soil characteristics
- Groundwater presence
- Root growth
- Geotechnical stability
- Soil corrosivity
- Chemical degradation, especially in the presence of standing water containing biodegradable contaminants such as deicer chemicals

4.3.3 Characterization of Likelihood of Failure at PDX

There are several methods by which the LOF for stormwater assets can be characterized:

- Changes in performance (e.g., decrease in the flow rate conveyed)
- Changes in observed impacts (e.g., increase in ponding at an inlet)
- Visual condition assessment
- % of useful life expended based on pipe age

For stormwater gravity pipe conveyance infrastructure, changes in performance based on flow rate are difficult to characterize because of the variability of stormwater flow. The most obvious indicator of the failure of an asset is the presence of ponding in an area that previously did not have an issue.

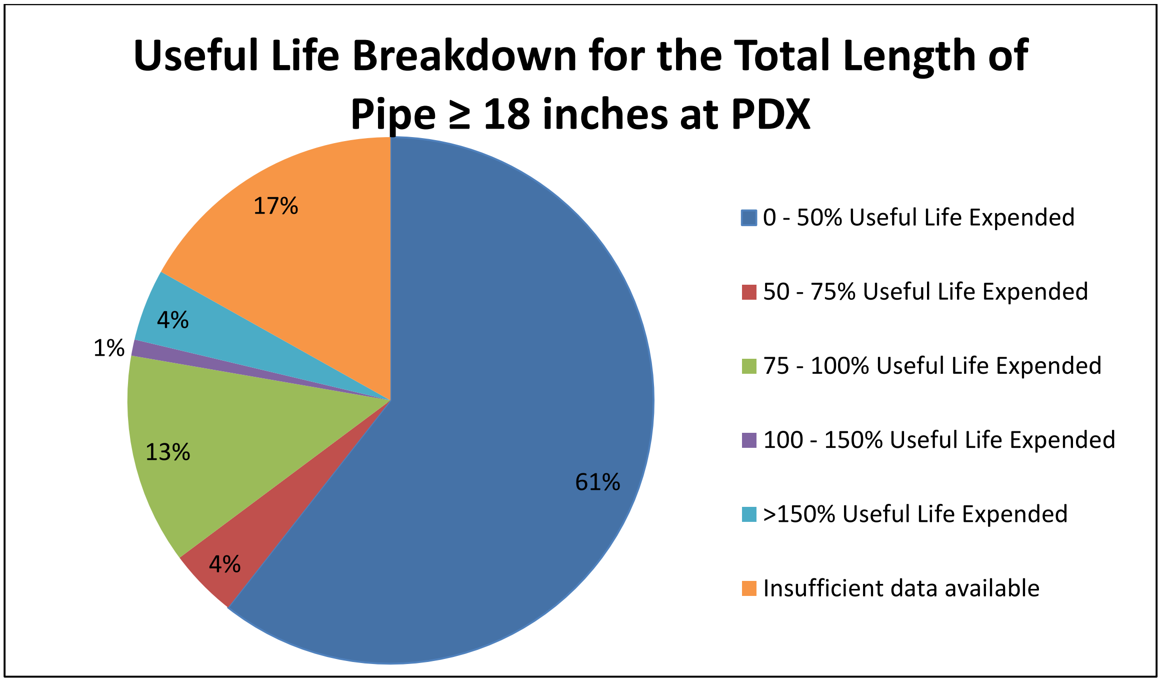
Visual condition assessments (using Closed Circuit Television [CCTV] or divers) and to a lesser degree, visual inspection of pipe-structure joints from the surface, provide the most direct evidence of asset condition. To date, the Port has conducted a relatively small number of stormwater pipe asset condition assessments, and these have tended to be associated with routine maintenance checks or imminent development projects (e.g., the South Runway Field Inspection Program and Taxiway E North Field Inspection Program). The Port has also conducted a limited number of inspections based on concerns about potential pipe condition, including an inspection of the straw pipe (McBride Culvert Inspection) in 2013, and an inspection of the Basin 7 trunk line in 2014.

Because the pipe condition assessments completed to-date have been limited to a small percentage of the pipes at PDX, an alternative means of characterizing the LOF was sought. As a preliminary indicator, calculations were performed in the master plan process to estimate the percent of useful life expended. The calculation is based strictly on pipe age, as gathered from Port records, as compared to the estimated lifespan for the pipe segment based on the pipe material. Due to significant data gaps in pipe age data for the smallest pipes, the useful life expended analysis was limited to pipes 18 inches in diameter and above. The expected lifespan data was gathered from pipe suppliers and other industry sources, as described in the aforementioned report. The useful life equation is provided below:

% Useful Life Expended = (Pipe Age / Estimated Lifespan for Pipe) x 100

Exhibit 4 shows a summary of findings for % useful life expended at PDX. Useful life results are also shown spatially in Figure 4-3.

Exhibit 4 – Summary of % Useful Life Expended in Gravity Pipes at PDX



Key overall findings from the analysis of gravity stormwater pipe assets (with diameter equal or greater than 18 inches) at PDX include:

- The oldest pipes at PDX date to 1941.
- The oldest corrugated metal and concrete pipes installed at PDX have exceeded or are near the end of their useful lifespans, based strictly on an assessment of age and expected lifetimes for the pipe materials.
- Some corrugated metal pipes (which ordinarily have an expected lifespan of 30 years) may have a tar coating on the inside of the pipes that could add 5 to 20 years to the lifespan (industry estimates vary). Port records are not specific regarding whether individual pipe segments are lined so observations of the pipes may be needed.
- PDX has approximately 900,000 lineal feet of buried storm sewers, with 185,000 lineal feet of that total equal to or greater than 18 inches in diameter. The larger pipes are generally associated with the highest consequences of failure because they typically drain larger areas.
- Approximately 5% or 9,250 lineal feet of PDX storm sewer pipe equal to or greater than 18 inches in diameter has exceeded its expected useful life based on pipe age and material.
- Approximately 18% or 33,000 lineal feet of PDX storm sewer pipe equal to or greater than 18 inches in diameter has exceeded 75% its expected useful life.
- There is insufficient data available on pipe age for approximately 17% of the PDX pipes that are 18 inches or greater in diameter (32,000 lineal feet). In addition, approximately 20%

(37,000 lineal feet) of the pipes on this size range have insufficient data available on pipe material. It is suspected that pipes without known age data may be relatively old. If this suspicion is true, the Port may have as much as 35% (65,000 lineal feet) of pipes greater than or equal to 18 inches that have expended more than 75% of their useful life. An Excel table identifying the pipes with insufficient data was provided to the Port as part of this project.

- The pipes that have expended the greatest percentage their expected useful life are concentrated in the northern portion of the airfield (shown in purple and red in Figure 4-3). This includes:
    - The 60-inch diameter portion of the Basin 7 trunk line that passes under Taxiway A, under NE Airport Way and down to the Southeast Ramp.
    - Lateral south of Taxiway A running from approximately the west edge of Concourse D east past the North Ramp and connecting into the main drainage trunk line for Basin 7.
    - The western-most portion of the main drainage line for NE Airport Way.

- An overlay of the useful life expended figure on the planned development areas shows locations where pipes that are near or past their expected useful life align with planned development projects. It appears that 60% to 70% of lineal feet of pipe with expected useful life currently exceeded at PDX could be associated with planned development work, although the type of development work might not, in all cases, lend itself to replacement of the pipes.

- The following list identifies planned development projects that intersect pipes with more than 75% useful life expended. In some instances, pipes located within future development areas do not have enough available data to calculate the percentage of useful life expended, as indicated in the far right column of the table.

List of Planned Development Projects Overlapping Pipes with Potentially High LOF

Project Name	Anticipated Construction Year	Reasons for Potentially High LOF of Pipes: Pipes with 75-100% Useful Life Expended	Pipes with >100% Useful Life Expended	Pipes ≥ 18 inches with No Useful Life Characterization
Terminal Roadway Rehabilitation	2014			X
Long Term Parking Road Rehabilitation	2014		X	X
Mt Hood Avenue Ramps Rehabilitation	2014			X
Public Safety & Security Garage Exp.	2015	X		
DD-GA West Redevelop Phase 1	2015		X	
Employee Parking Lot Bus Route	2015			X
RAC QTA Expansion	2016		X	X
Parking lot and bus route rehabs (Blue, East, Economy Red, Blue Economy)	2015-2022			X
Rehab Airtrans Way	2016			X
DD-GA West Redevelop Phase 2 (Atlantic Aviation)	2016		X	
GA Taxi Lane Rehab	2020		X	
Perimeter Road Rehabilitation	2017	X		X
Airport Way Rehabilitation	2017			X
Taxiway B Center & Exits Rehab	2018	X		X
Southeast Apron Rehabilitation	2023		X	X
Taxiway J Rehabilitation	2024	X		
North Frontage Road	2020			X
MP Intersect NE 82nd AW	2020			X
Central Apron E Reconstruction	2020		X	
ARFF Bay Asphalt Apron	2021	X		
Taxiway A & Exits Rehabilitation	2023		X	
MP Airtrans Ramp Construction	2022		X	X
Consolidated RAC	2027-2035			X
Dredge Fill Southwest Quad	2035+			X
Runway 3-21 & Taxiway M Rehab	2021	X		X
Taxiway E North Rehabilitation	2015	X		
Taxiway T Southwest Rehabilitation	2014	X		
T/W T SE, T/W B East & CCA Apron 2	2021	X		X
TW T & K Centerline Lights	2014		X	X
ORANG Parcel C Modifications	2015	X		X
ORANG Parcel D1 2030	2030	X		
ORANG Parcel D2 2030	2030	X		

4.3.4 Strategies for Addressing Risks of Asset Failure

The Port has set a goal of proactively managing Port stormwater infrastructure, as opposed to a "run-to-failure" approach. A proactive approach has the potential to reduce the risk to ongoing Port operations and infrastructure from inadequately functioning stormwater systems. A proactive, planned approach will also reduce collective stormwater infrastructure life-cycle costs as a result of coordinating infrastructure repair/replacement with ongoing development project implementation.

As part of a proactive approach, the Port's strategies for managing airport-wide risks of asset failure on an ongoing basis are as follows:

- Track available data on existing stormwater assets using GIS, asset management spreadsheets, and other tools, to identify data gaps and better characterize LOF and COF.
- Prioritize condition assessments (e.g., field inspections) for stormwater assets based on characterized LOF or COF, and provide targeted direction to maintenance.
- Identify and prioritize opportunities to integrate asset condition assessments, repair, rehabilitation, or replacement into ongoing development project implementation efforts.
- Identify and prioritize "standalone" projects to repair, rehabilitate, or replace stormwater assets that are high LOF or COF, but unable to be integrated into development projects.

In the stormwater master planning work, critical stormwater assets with a high risk of failure were aligned with ponding-related stormwater management solutions where possible. These combined solutions involve replacing existing storm sewers with larger pipes to increase drainage capacity, and in the process removing or abandoning/filling pipe that has a high percentage of useful life expended. Please refer to the stormwater management fact sheet sections (provided at the end of the SWMP, prior to the appendices) for solutions corresponding to asset management-related stormwater management needs in each drainage basin.

Results of the useful life expended analysis for PDX assets are illustrated on Figure 4-3. Critical asset risks that were able to be addressed by proposed stormwater ponding solutions were defined as stormwater management needs, and the locations of these identified needs are depicted on Figure 4-4. Additional assets with potentially high LOF may need to be characterized as needs by Asset Management as part of the ongoing program.

4.4 Required Stormwater Controls

The Port has to meet runoff standards for controlling the quality and quantity of post-construction stormwater runoff from applicable new development and redevelopment projects at PDX. These requirements are largely driven by MS4 permit requirements for post-construction site runoff, which are aimed at minimizing the potential for runoff from impervious surfaces to impact receiving waters. These standards may drive the need for stormwater controls, also referred to as BMPs, to be incorporated into the stormwater management system. Depending on the location at PDX, the BMP design criteria and selection guidance will be in the Port's DSM or the City of Portland's Stormwater Management Manual. Consult Chapter 1.5 in the DSM for determining which manual is applicable.

Site-specific stormwater controls may also be required to address runoff from industrial activities regulated under the 1200-COLS permit or other regulatory programs. These requirements should be evaluated on a case-by-case basis without means for meeting these requirements incorporated into the applicable BMPs as needed.

4.4.1 Drivers for Addressing Stormwater Control Requirements

The MS4 permit requires the Port to develop and follow standards for post-construction stormwater management. Any new development or redevelopment project that creates or replaces 500 square feet or more of impervious surface is required to provide post-construction controls per the DSM or City's Stormwater Management Manual. This requirement also applies if there is a larger common plan of development for the project site that meets these thresholds. To maintain permit compliance, stormwater BMPs need to be implemented to address this requirement where new development or redevelopment occurs at PDX.

Several aspects of post-construction BMP implementation drove incorporation of BMP planning into the stormwater master planning effort:

- BMPs require some footprint of land at PDX, which may impact future development plans.
- BMPs must be tied into the stormwater infrastructure to treat the affected stormwater. This may affect other stormwater management needs and solutions such as addressing ponding, deicer management, and spill control.
- BMPs may serve multiple projects and therefore may be constructed as standalone projects, not affiliated with individual development projects

Without proper planning, potential difficulties and inefficiencies may occur while attempting to implement BMPs for future development and redevelopment projects. For example, adequate area may not be available for the planned development as well as the required stormwater BMP. Or, additional costs may be incurred to overcome issues caused by lack of planning (e.g., a higher cost BMP or additional stormwater infrastructure is required).

In addition to the BMPs required to meet regulatory requirements new developments, two other water quality drivers were considered in the stormwater master planning process: deicer management and spill control. The deicer management considerations focus on whether changes to the existing deicing system are needed. The spill control issue is associated with looking for opportunities to add spill controls to Basin 7, which currently does not have spill controls.

4.4.2 Potential Factors Contributing to Stormwater Control Requirements

The Port is continually planning new development or redevelopment projects across the entire airport property. These projects may be internal infrastructure repair and maintenance (e.g., runway pavement rehabilitation), redevelopment of existing infrastructure (e.g., demolishing a building and constructing new in its place) or completely new development (e.g., Port or tenant constructing in an undeveloped site). These types of projects create new impervious surfaces or redevelop existing impervious surfaces, which may trigger the need for post-construction stormwater controls. In the past, BMPs have not been implemented for all new development and redevelopment projects at PDX. With the issuance of the DSM in January 2014, a means for providing the required BMP treatment for all qualifying development and redevelopment projects must be identified.

4.4.3 Characterization of Stormwater Control Requirements at PDX

As previously described, the Port identified planned development and redevelopment projects through 2035 to support the stormwater master planning effort (see Appendix A for a list of projects). Each project was mapped (see Figure 4-1) and the anticipated impervious area was calculated. It was understood in the preparation of the 2035 development map that not all potential development projects will be implemented, that some projects not currently being considered may be added, and that the function, location, and footprint of the identified projects may change. The purpose of the 2035 development map was to prepare a relatively conservative estimate of the potential development such that relatively conservative estimates of BMP requirements could be assessed. This helps the Port's planning process by reasonably identifying extents and locations of land at PDX that need to be set aside for BMPs.

An approach to BMP siting was developed that attempted to regionalize BMP construction rather than relying on each development project's BMP being located adjacent to the development. The objective was to provide the Port more flexibility in siting BMPs, utilize land for BMPs that was not otherwise allocated to development, and reduce BMP costs through economies of scale associated with larger BMPs instead a series of smaller BMPs. The siting strategy was initiated using the map of planned development projects. Development projects were grouped by location within their drainage basins and then within smaller regions of each drainage basin. The regions are called BMP Strategy Areas (BMP SAs). Each BMP SA was evaluated for the location and extent of the applicable projects in context of the existing stormwater infrastructure. Refer to Figure 4-5 for the locations of identified stormwater management needs pertaining to required stormwater controls, including the planned projects as well as the BMP SA boundaries.

To determine the extent of potential BMPs needed, the DSM standards were applied to development projects identified on the 2035 development map to calculate the required water quality design basis for the projects. This design basis was then used in the evaluation process described in the next subsection about BMP strategies.

To assess the interaction of deicer management and stormwater management needs, three types of evaluations were made:

- Evaluate effect of planned airport development on deicing system capacity needs and instances of non-compliance with the deicing NPDES permit
- Evaluate effect of proposed stormwater management solutions on deicing system capacity needs and instances of non-compliance with the deicing NPDES permit
- Evaluate opportunities to use deicing system infrastructure to help manage the stormwater ponding issues without compromising the system's compliance objectives.

To assess the spill control issue, an initial analysis was made of the potential to integrate spill controls in Drainage Basin 7 with stormwater management solutions for ponding and water quality BMPs. Potential sizes for spill control mechanisms and the potential locations for the spill controls were assessed in the context of proposed stormwater management solutions.

Findings from both the deicer management and spill control analysis are found in Section 5 and in the individual stormwater management solution fact sheets (at the end of the SWMP before the appendices).

4.4.4 Strategies for Providing Required Stormwater Controls

The Port's strategy for addressing the post-construction stormwater BMP controls is based on implementing regional BMP controls, where practicable, and using distributed BMPs more specific to development project locations when needed. Regional BMPs provided required treatment for more than one development project. They tend to be more efficient than localized BMPs in capital costs, operations and maintenance costs, and land requirements. Project-based, distributed controls are associated with single development projects or small clusters of projects.

The following criteria were used to identify the applicable BMP strategy for each BMP SA:

- Regional BMPs were targeted where projects within a BMP SA are drained through common stormwater infrastructure to a location with space to construct a relatively large BMP.

- Project-based BMPs were targeted when a common drainage solution routed to a regional BMP was not practicable or in situations where development projects were planned for undeveloped site without existing stormwater infrastructure where localized BMPs could be easily implemented.

Potential BMP options (regional and project-based) were evaluated for all new developments and redevelopment projects identified on the 2035 development map. Once decisions were made to utilize regional or project-specific BMPs for each development project, concepts for specific BMP facilities were prepared for stormwater management solution fact sheets. In some cases, the fact sheets are limited to planning recommendations because insufficient information on the future development was available.

For each regional BMP site, a conceptual BMP type was identified with the BMP capacity and footprint calculated based on meeting DSM or City of Portland stormwater standards. Where project-based BMPs were applicable, the concept, size, and location of the BMP is highly dependent on the development site details. In these cases, a list of potential BMPs along with specific BMP planning recommendations were provided to guide the Port during the selection and design of the appropriate BMPs. For an overview of the stormwater control-related stormwater management needs and solutions identified in each drainage basin, please refer to the stormwater management need and solution fact sheets (at the end of the SWMP before the appendices).

4.5 <u>Other Stormwater Management Considerations at PDX</u>

This section provides an overview of related stormwater management topics at PDX that were considered or evaluated during the SWMP development process. Although these topics did not drive the development of SWM fact sheets, in select cases they either helped to shape the solutions or led to additional recommendations that were incorporated into the SWM fact sheets. Each topic is described below, along with an overview of the extent to which it was evaluated on the SWMP project.

4.5.1 Climate Change

As part of the stormwater master planning process, the potential impacts of climate change on ponding were also considered. Evaluation of data from the most recent climate change model findings from the International Panel on Climate Change indicated the following simulated changes in the climate at PDX for the year 2060:

- Significant increase in number of hot days and nights
- Decrease in number of cold days
- 10% increase in rainfall totals for long duration events and in number of heavy rain days per year
- Decrease in snow and frost days
- Increase in periods of extended dry days

No evidence was identified to suggest noteworthy increases in the intensity of precipitation events between now and 2060, although it is difficult to project how the unique features of the PDX area microclimate will react to long-term increases in temperature.

The evidence acquired in this analysis was not sufficient to warrant a change in the design storm basis for proposed stormwater infrastructure changes at this time. However, both the understanding of climate change and the tools used to assess climate change will continue to evolve. As each individual stormwater management solution is considered for implementation, the Port is advised to consider newly available information on local climate change.

4.5.2 Deicing System Impacts

Several potential SWM solutions were identified as needing further investigation to determine potential effects on the PDX deicing system. Interactions between the deicing system and stormwater drainage system were evaluated to determine if changes were needed to deicing system infrastructure or operations to support stormwater management solutions, or whether any solutions should be discarded or modified to mitigate potential deicing system impacts. The following analyses were conducted to evaluate interactions between the drainage system and the deicing system:

- Assess full-time use of deicing pump station PS-N to help relieve ponding in South Runway (10R-28L) infield areas and reduce hazardous wildlife attractant risk.

- Evaluate effect of increases in storm sewer trunk line capacities upstream of deicing pump stations PS-N, PS-S, PS-E, PS-I, DSTs, and PS-P on the deicing system.

- Quantify effects of changes in some aircraft deicer application locations.

- Consider feasibility of pumping a portion of Basin 7 runoff directly to PS-E to relieve capacity issues in the Basin 7 storm sewer trunk line.

- Determine if planned development projects between 2015 and 2035 would require a change in the deicing system infrastructure to maintain regulatory compliance.

The evaluation was based on quantifying whether proposed stormwater management measures affected the frequency of non-compliance with the Port's deicing NPDES permit for deicing related stormwater discharges to the Columbia Slough and the Columbia River.

The findings of the evaluation did not identify significant changes to the risk of non-compliance with the deicing NPDES permit. It is expected that DST-1 will fill more frequently and DST-2 will be used more frequently if the proposed stormwater management solutions are implemented and if the airport impervious area increases to the planned 2035 levels assumed in the SWMP. However, the analysis did not reveal a compliance risk associated with this change.

The primary conclusions from this analysis of the deicing system impacts include:

- No changes in deicing system infrastructure are needed to accommodate the proposed stormwater management (SWM) solutions.

- No changes in the deicing system infrastructure are needed to support currently planned PDX development through 2035, provided that deicing activity does not exceed the levels for the year 2022 that were assumed in the original deicing system basis-of-design.

- It is not necessary to upsize PS-I and the associated force main.

- Operating PS-N in both summer and winter with no diversion concentration set points (SWM Solution 1-F) will have minimal impact on the deicing system and will help relieve a significant wildlife attractant problem. It will, however, require additional routine maintenance due to increased use. Operating during the summer months will also require a permit update to discharge stormwater through the existing Columbia River outfall year-round.

- One alternative that was considered as a means to relieve Basin 7 capacity issues involved pumping the central portion of Basin 7 directly to PS-E and bypassing the trunk line. This alternative was determined to be infeasible due to insufficient capacity at PS-E, and was eliminated in favor of Solution 7-A.

- Constructing, operating, and maintaining a new pump station in Basin 7 to route a portion the basin's stormwater to the Columbia River (Solution 7-A) is the best way to address the basin's under-capacity issues. This solution decreases the risk of non-compliance with the deicing NPDES permit and eliminates any need to modify PS-E or PS-I. This new Basin 7 pump station will likely require an additional TOC monitoring station and a modification to the deicing NPDES permit for the new Columbia River outfall.

The above conclusions have been reflected within the applicable SWM solution fact sheets, where appropriate, and detailed recommendations will be provided in a memorandum outside of the SWMP ("Summary of Deicing System Analysis for PDX Stormwater Master Plan").

One additional finding is that the runoff from the Southwest Ramp in Basin 1 (South) discharges directly to the so-called "Elrod Ditch" and does not pass through PS-S. PS-S provides deicing collection for Basin 1 South based on online monitoring, in accordance with the deicing NPDES permit. If deicing activities are planned to occur on this ramp in the future, deicing stormwater from the Southwest Ramp should be routed to PS-S to allow for monitoring and collection as needed.

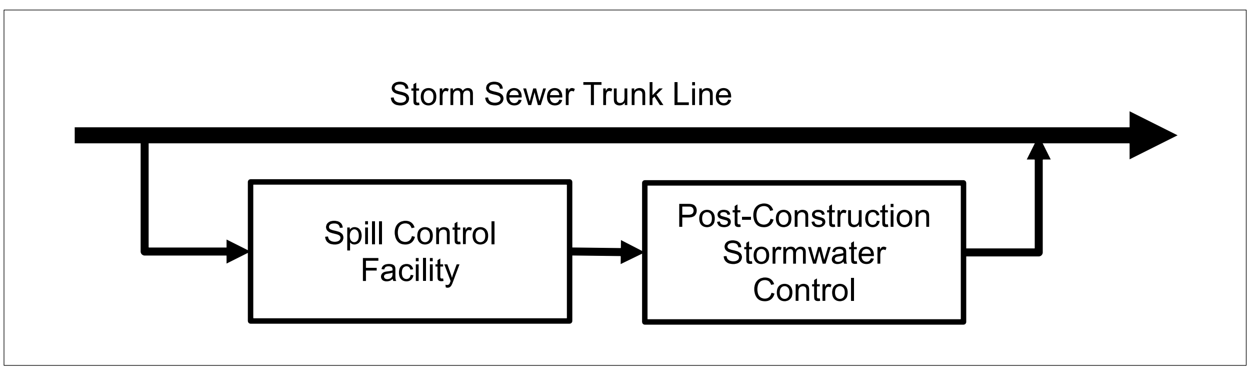
4.5.3 Spill Control

As described in Section 3, a variety of structural and non-structural controls are employed at PDX to minimize the potential for spills, facilitate efficient spill response, and minimize the risk of releasing a spill off-site. These measures are implemented in accordance with the PDX SWPCP and SPCC Plan. In addition to existing controls, the Port is considering the addition of further spill control facilities in Basin 7, to improve responsiveness to potential spills.

As part of the SWMP analyses, the GS&P Team developed preliminary spill control facility concepts to serve Basin 7. The proposed strategy involved implementing a flow-through spill control facility (oil-water separator) upstream of each of the four proposed post-construction stormwater control solutions in Basin 7 (Solutions 7-D, 7-E, 7-F, and 7-G). This strategy takes advantage of potential synergies with the construction of the stormwater controls, and has the side benefit of minimizing the potential for the stormwater controls to be impacted by accidental spills.

Exhibit 5 provides a schematic of a potential flow routing approach to and from each spill control facility, as well as the placement of the facility relative to the storm sewer trunk line and post-construction stormwater control. Based on this approach, both the spill control facility and stormwater control would be located off-line, meaning that both facilities would be designed to receive a limited flow rate that is diverted from the trunk line (typically using a lift station), while larger storm flows would have the opportunity to bypass the diversion and continue draining through the trunk line. The flow exiting the post-construction stormwater control would be tied back into the trunk line downstream. Consistent with this approach, each of the spill control facilities in Basin 7 was sized consistently with the design flow rates for the proposed post-construction stormwater controls.

Exhibit 5 – Spill Control Facility Flow Schematic



The spill control facilities are generally described in the SWM fact sheets for Solutions 7-D, 7-E, 7-F, and 7-G. The GS&P Team will provide a technical memorandum with detailed recommendations in a separate deliverable outside of the SWMP. As the implementation and sizing of these spill control facilities is not explicitly driven by a regulatory requirement, this approach represents one potential strategy for further mitigating spill risks.

4.5.4 Water Quality Analyses

During the development of the SWMP, the GS&P Team assisted the Port with evaluating water quality for stormwater runoff at PDX and other Port facilities within the City of Portland Urban Services Boundary. The team provided a summary of existing water quality regulations as well as potential future changes to regulations which may impact the Port. A significant portion of the water quality task involved the development of an EPA SWMM stormwater model to conduct analyses related to compliance with the Port's MS4 permit, including:

- 303(d) pollutant evaluation
- Total Maximum Daily Load (TMDL) pollutant load reduction and benchmarks evaluation
- Wasteload allocation evaluation and attainability assessment
- Stormwater BMP retrofit plan
- Hydromodification assessment

These analyses had little effect on the SWMP solutions, except for one aspect. In some regional BMP stormwater solutions, the GS&P Team recommended preserving space for additional BMPs to be added if future stormwater regulations require more stringent water quality treatment. For example, where a cartridge filter would provide adequate treatment for current regulations, the area for installation of a future subsurface flow wetland BMP should be reserved if future regulations decrease the effluent limits for certain pollutants, such as bacteria or organics. Deliverables associated with these water quality analyses are listed in Appendix C.

5 OVERVIEW OF STORMWATER MANAGEMENT NEEDS AND SOLUTIONS

5.1 Introduction

Stormwater management (SWM) needs and solutions have been defined to characterize the specific stormwater management issues identified through the stormwater master planning process, as well as approaches for addressing those issues. Critical information on each location-specific SWM need and solution is presented in the form of an individual fact sheet. The SWM need and solution fact sheets allow easy access to critical information on individual needs and solutions in each drainage basin, to facilitate planning and implementation.

This section provides an overview of SWM needs and solutions at PDX, including the different types of needs and solutions, the process for identifying needs and solutions, summary figures showing the locations of needs and solutions across PDX, and guidance for interpretation of the fact sheets. Refer to the end of the SWMP for individual sections of fact sheets pertaining to each drainage basin. Refer to Section 6 for guidance on next steps to further characterize the needs and refine or implement the solutions, as part of SWMP implementation.

5.2 Definition of Stormwater Management Needs

As described in Section 4, the stormwater master planning process focused on three specific stormwater management issues at PDX: ponding, asset failure, and stormwater controls. The Port reviewed the occurrences of these issues across PDX and assessed potential risks (to operations, safety, infrastructure, development planning, and regulatory compliance) at each location. Issue occurrences that were determined to pose an unacceptable risk and require a solution were classified as SWM needs. Table 5 provides a summary of the basis used to classify each type of issue as a SWM need.

Table 5 – Stormwater Management Issues and Needs

SWM Issue / Need Type	Issue Occurrences Classified as Needs
Ponding	Ponding areas with an extent, frequency or location that presents critical risks to PDX operations, safety, or development plans based on current stormwater hydraulic modeling assumptions
Stormwater Asset Failure	Assets with high risk of failure that align with ponding-related needs
Required Stormwater Controls	Planned development or redevelopment that meets DSM applicability criteria requiring water quality BMPs

Figures 4-2, 4-4, and 4-5 illustrate the airport-wide locations of identified ponding needs, stormwater asset failure needs, and stormwater control needs, respectively.

5.3 Identification of Stormwater Management Solutions

The stormwater master planning team followed a strategic approach to develop coordinated and optimized solutions for addressing a variety of SWM needs. The general process that was followed to select appropriate solutions for each SWM need is described in the following subsections.

5.3.1 Step 1 – Develop Site-Specific Solution Alternatives

The process for identifying site-specific solutions started with a review of SWM need locations across the airport, as well as potential strategies to address each need, as described in Section 4. A primary objective of this review was to consider potential opportunities to implement combined regional solutions that might be able to address a multitude of needs more efficiently than numerous smaller, piecemeal solutions. For the ponding needs, this involved considering the root cause(s) of ponding within each drainage system, and whether the ponding in particular need areas was driven by a basin-wide issue such as a trunk line with insufficient capacity, or whether the ponding was largely driven by local anomalies or drainage restrictions.

For water quality control needs, analysis of using regional versus local solutions involved considering the grouping of planned development areas into BMP Strategy Areas, with the ability to route drainage from multiple development projects toward a combined treatment facility, as opposed to having multiple smaller facilities that serve the individual developments. The ability to use regional solution strategies depended on the locations of the needs, as well as their stormwater collection infrastructure and drainage destinations. For some of the water quality control needs, a regional approach was not feasible due to the isolated locations of development areas or the uncertain plan for draining the development areas.

5.3.2 Step 2 – Evaluate Scale and Extent of Solutions Required to Address Needs

The next step in developing SWM solutions was evaluating the solution size and extent required to address the needs (in cases where the solution was required to be based on new or modified infrastructure). Potential ponding solution alternatives were evaluated for effectiveness using the stormwater hydraulic model, and the sizes, locations, and extents of infrastructure modifications were adjusted using an iterative process until required ponding reductions were achieved (based on the ponding criteria defined in Section 4). As part of this iterative process for the ponding solutions, the infrastructure being considered for replacement was compared to the results of the stormwater asset useful life expended analysis.

Where appropriate for addressing the need, ponding solution alternatives were extended or adjusted to include replacement of aging pipes with a high risk of failure and minimize impacts to more recently constructed infrastructure.

For the water quality control solutions, BMP Strategy Areas served by each BMP were adjusted for consistency with updates to flow diversions and drainage patterns proposed as part of the ponding and asset management solutions. BMP capacities were determined in accordance with DSM water quality treatment criteria, as required for compliance with the MS4 permit. These capacities were calculated based on the extent of new development and redevelopment occurring within the BMP SA served by each BMP, as defined through the 2035 planning horizon and illustrated on Figure 4-5. The detailed solutions in the fact sheets are based on this development scenario. BMP solutions were also secondarily sized based on an exploration of long-term development beyond 2035, assuming that all impervious area within the BMP SA would ultimately be redeveloped. Estimated footprints for this scenario are provided based on the estimated capacities for the selected BMP types and DSM guidance for sizing BMPs.

BMPs were selected for each BMP SA from the list of potential BMPs in the DSM to meet the treatment needs. The characteristics of the specific BMP SA land uses and stormwater infrastructure were evaluated to further refine the options. The recommended BMP was then sited in an appropriate location for the estimated BMP footprint considering existing and planned development and airport operations. The solution for each regional BMP includes a conceptual layout as well as additional considerations for implementing the solution.

BMPs were assumed to treat projects within their existing drainage basins to avoid the costs (both capital and operations and maintenance) of pumping stormwater over long distances to other drainage basins. Additionally, tracking water quality treatment credits across drainage basin boundaries would add significant complications that are not addressed in this document, such as quantification of the potential pollutants available for treatment in the proxy drainage area.

5.3.3 Step 3 – Refine Solutions to Maximize Benefits and Minimize Impacts

In the third step of SWM solution development, solution alternatives identified through the steps above were compared for performance, evaluated and optimized based on constructability, potential risks of implementation, and cost-effectiveness. Solution footprints, extents, and locations were compared to existing airfield facilities and infrastructure to assess potential construction impacts. Where possible to reduce impacts without affecting solution effectiveness, solution alternatives were further refined, realigned, or relocated. Where multiple alternatives existed to solve a potential need, alternatives (or portions of alternatives) that were expected to be less cost-effective or result in significant unavoidable construction impacts were ruled out in favor of preferable alternatives.

In some cases, regional and local alternatives were combined in order to maximize performance while minimizing costs. As an example, in Basin 8, it was determined that a regional drainage solution near the outfall (SWM Solution 8-A) provided a large benefit basin-wide and the most cost-effective impact, although it did not entirely address the identified upstream ponding needs. To avoid large-scale replacement of the upstream Basin 8 trunk lines, including portions crossing NE Airport Way and recently constructed Cascade Station, the outfall solution was supplemented with added storage in select upstream pipes near the ponding needs to allow ponding criteria in those areas to be addressed. Based on similar approaches, some SWM needs were found to require the implementation of more than one SWM solution (both local and regional), and some of the regionally-focused SWM solutions were found to fully or partially address more than one SWM need.

Finally, potential opportunities for integration of SWM solutions with deicer management and spill control needs were considered.

5.4 Stormwater Management Solution Types

Three types of solutions were identified as a means to address identified SWM needs. The three solution types are listed below and described further in the following subsections:

- New or modified drainage infrastructure
- Operational changes
- Future planning considerations pertaining to planned future development

5.4.1 New or Modified Infrastructure

The majority of solutions proposed in the SWMP involve the construction of new or modified drainage or treatment infrastructure to address ponding, asset failure, or stormwater control needs.

For ponding needs, implementation of new or modified infrastructure generally involves replacing existing undersized infrastructure (where the root cause of ponding is insufficient drainage capacity) with larger gravity pipe systems or pumping systems to drain ponding areas more efficiently. Where possible, the pipes being replaced were aligned with stormwater assets with high useful life expended, to address both ponding and asset management-related SWM needs. For stormwater control needs, solutions propose the construction of regional BMPs to meet regulatory requirements. Proposed infrastructure solutions may be constructed either as standalone projects or in conjunction with a closely related or adjacent planned development project.

Fact sheets for solutions of this type include information which aligns with a Port project charter, including planning-level opinions of probable cost for the proposed new or modified infrastructure. These solutions may be implemented in advance of new development within the region, or to address issues that are present under existing conditions.

The airport-wide locations and extents of proposed new or modified infrastructure solutions are illustrated on Figures 5-1 and 5-2. Figure 5-1 shows the locations of new or modified drainage infrastructure to address ponding and asset-related needs. Figure 5-2 shows the proposed locations of stormwater control solutions.

5.4.2 Operational Change

This solution type involves a change in the operation of existing infrastructure to improve drainage efficiency. This category includes only one SWM solution (SWM Solution 1-F), where it was determined that an existing deicing system pump station (PS-N) could be operated on a continuous basis year-round to reduce flooding along the South Runway (SWM Need 1-1), when implemented in conjunction with a separate infrastructure upgrade to the Basin 1 North trunk line (SWM Solution 1-A). Operational changes alone are not sufficient to address risk of stormwater asset failure or to comply with requirements for water quality controls, so this solution type was considered only for ponding-related needs.

As this solution type does not entail capital costs, the fact sheet provides only an estimate of impacts to operating costs. This solution (1-F) may be implemented at any time to improve drainage issues observed under existing conditions, though the need will not be fully addressed until the associated infrastructure solution (1-A) is also implemented.

5.4.3 Future Planning Considerations

A portion of the SWM solutions described in the fact sheets are limited to high-level planning recommendations pertaining to site drainage and water quality treatment for proposed new development areas (either individual projects or a few adjacent development projects). This category applies to areas that are largely undeveloped or vegetated under existing conditions, but where significant new development is proposed. In comparison, the “new or modified infrastructure” solution type generally addresses modifications to existing infrastructure in areas of existing development or planned redevelopment. In the new development areas, there is generally a lack of existing pipe infrastructure to serve the proposed development, and the layout and drainage characteristics for the development are not yet well-defined.

Due to the conceptual nature of the development and the unknowns described above, the solutions in this category focus on providing high-level planning recommendations that can be incorporated into the project planning and design. Example considerations include the identification of tie-in points and minimum grade elevations to minimize the potential for ponding, as well as general BMP selection and sizing guidance. The specific drainage and treatment infrastructure needed for these solutions will ultimately need to be evaluated by the project designer, depending on the selected development characteristics.

The fact sheets for solutions falling into this category do not include capital costs for the drainage recommendations, as those are highly dependent upon the specific development and it is assumed that those will be incorporated into project costs. Planning-level cost information is provided for potential BMPs for these areas based on typical development characteristics. It is not recommended that these solutions be implemented in advance of the corresponding development projects, due to the rapidly evolving nature of development planning at PDX.

5.5 Summary of Proposed SWM Solutions at PDX

A total of 38 SWM solutions are proposed at PDX to address a variety of SWM needs. Table 6 provides a high-level summary of the proposed SWM solutions at a glance, based on solution types and the types of issues addressed. Table 7 provides a more in-depth summary of all 38 solutions, including the type of solution, corresponding needs addressed by the solutions, approximate construction and planning/design schedules, opinions of probable costs, and related solutions.

Implementation timeframes were identified for each SWM solution based on alignment with related or adjacent planned PDX development and approximate planning and design lead times. See Appendix A for a summary list of planned PDX development through 2035, including development project schedules and related SWM solutions, and refer to Figure 4-1 for a map of these planned development projects. Due to the uncertainty of project schedules, and the need to coordinate with a variety of projects, the schedule identified for each solution was identified as a five to ten-year timeframe (2016-2020, 2021-2025, or 2026-2035).

Additionally, an opinion of probable cost was developed for each solution, as summarized within each fact sheet and detailed in Appendix B. A summary of the cost and schedule breakdown of proposed solutions, based on solution type is provided in the table below. Please note that costs were not evaluated for drainage-related solutions within the “future planning considerations” solution type, due to the lack of detail available for the corresponding development areas. Costs were evaluated for BMPs within the “future planning considerations” solution type by estimating an approximate BMP size based on the development area, and applying other planning-level assumptions.

Table 6 – Proposed SWM Solutions by Type and Issues Addressed

SWM Solution Type	Number of Solutions Addressing Each Type of Issue			
	Solutions Addressing Ponding Needs	Solutions Addressing Asset Needs	Solutions Providing Stormwater Controls	*Total Number of Solutions in Category*
New or Modified Infrastructure	11[1]	5[1]	10	***22***[1]
Operational Change	1	0	0	***1***
Future Planning Considerations	3	0	12	***15***
Total Number of Solutions in Category	***15***[1]	***5***[1]	***22***	***38***

Notes:

1. Of the 22 “new or modified infrastructure” solutions, 4 address both ponding and asset issues, 7 address ponding alone, 1 addresses asset failure alone, and 10 are standalone stormwater controls.

Table 7 – Summary of Proposed SWM Solutions

SWM Solution ID	Solution Name	Solution Type: New or Modified Infrastructure	Solution Type: Operational Change	Solution Type: Future Planning Considerations	Corresponding SWM Need ID	Need Type: Ponding	Need Type: Stormwater Asset Failure	Need Type: Stormwater Controls	Proposed BMP Type (if applicable)	Capital Cost Summary	Anticipated Implementation Timeframe	Planning and Design Lead Time (Months)	Related Solutions Required to Address Need(s)	Other Solutions to Coordinate With
1-A	Replace Portion of Basin 1 North Trunk Line	X			1-1	X			N/A	$2,200,000	2016-2020	<6	1-F	
1-B	Replace Portion of Basin 1 South Trunk Line	X			1-2, 1-3	X	X		N/A	$3,200,000	2021-2025	6-12		1-C, 1-L
1-C	Replace Pipe Serving South Runway (10R-28L) in Basin 1 South	X			1-4, 1-5	X	X		N/A	$720,000	2021-2025	<6	1-B	1-B, 1-L
1-D	Drainage Planning Recommendations for NE 33rd Drive Development			X	1-6, 1-7	X			N/A	N/A	2016-2020	6-12		
1-E	Drainage Planning Recommendations for Southwest Quad and Fazio Fields Development			X	1-8	X			N/A	N/A	2026-2035	12-24	1-F	
1-F	Operate PS-N Continuously		X		1-1	X			N/A	N/A	2016-2020	<6	1-A	7-A
1-G	Water Quality Planning Recommendations for BMP Strategy Area (BMP SA)-1.1			X	0-1			X	Project Based	$4,100,000	2016-2020	6-12		1-D
1-H	Water Quality Planning Recommendations for BMP Strategy Area (BMP SA)-1.2			X	0-1			X	Project Based	$690,000	2016-2020	6-12		
1-I	Provide Regional Water Quality Treatment for BMP Strategy Area (BMP SA)-1.3	X			0-1			X	Cartridge Filter / SSF Wetland	$1,400,000	2016-2020	12-24		1-A
1-J	Water Quality Planning Recommendations for BMP Strategy Area (BMP SA)-1.4			X	0-1			X	Project Based	$330,000	2016-2020	6-12		1-A
1-K	Water Quality Planning Recommendations for BMP Strategy Area (BMP SA)-1.5			X	0-1			X	Project Based	$15,000	2016-2020	6-12		
1-L	Provide Regional Water Quality Treatment for BMP Strategy Area (BMP SA)-1.6	X			0-1			X	Cartridge Filter / SSF Wetland	$2,900,000	2021-2025	12-24		1-B, 1-C
2-A	Replace Basin 2 Outfall Pipe and Portion of Basin 2 Trunk Line	X			2-1	X			N/A	$1,400,000	2016-2020	6-12		2-B
2-B	Provide Regional Water Quality Treatment for BMP Strategy Area (BMP SA)-2.1	X			0-1			X	SSF Wetland w/ Surface Storage	$1,400,000	2016-2020	12-24		2-A
3-A	Water Quality Planning Recommendations for BMP Strategy Area (BMP SA)-3.1			X	0-1			X	Project Based	$77,000	2016-2020	6-12		
4-A	Provide Regional Water Quality Treatment for BMP Strategy Area (BMP SA)-4.1	X			0-1			X	Cartridge Filter only	$1,100,000	2026-2035	6-12		
5-A	Provide Regional Water Quality Treatment for BMP Strategy Area (BMP SA)-5.1	X			0-1			X	Bioretention	$1,100,000	2021-2025	6-12		

		Solution Type				Need Type								
SWM Solution ID	Solution Name	New or Modified Infrastructure	Operational Change	Future Planning Considerations	Corresponding SWM Need ID	Ponding	Stormwater Asset Failure	Stormwater Controls	Proposed BMP Type (if applicable)	Capital Cost Summary	Anticipated Implementation Timeframe	Planning and Design Lead Time (Months)	Related Solutions Required to Address Need(s)	Other Solutions to Coordinate With
6-A	Water Quality Planning Recommendations for BMP Strategy Area (BMP SA)-6.1			X	0-1			X	Project Based	$290,000	2026-2035	6-12		
6-B	Water Quality Planning Recommendations for BMP Strategy Area (BMP SA)-6.2			X	0-1			X	Project Based	$180,000	2026-2035	6-12		
6-C	Water Quality Planning Recommendations for BMP Strategy Area (BMP SA)-6.3			X	0-1			X	Project Based	$1,200,000	2016-2020	6-12		6-D
6-D	Provide Regional Water Quality Treatment for BMP Strategy Area (BMP SA)-6.4	X			0-1			X	Detention Basin / Terrace Filter	$1,300,000	2016-2020	6-12		6-C
7-A	Provide Pump Station to Address Basin 7 Capacity Limitations	X			7-1, 7-2, 7-4	X			N/A	$15,500,000	2016-2020	12-24	7-B	1-F, 7-C, 7-F, 7-H
7-B	Replace and Extend Pipe Across Southeast Ramp to Post Office	X			7-4, 7-5	X	X		N/A	$1,500,000	2016-2020	<6	7-A	7-H
7-C	Replace Lateral North of North Ramp	X			7-6, 7-7	X	X		N/A	$4,100,000	2016-2020	6-12		7-A, 7-H
7-D	Provide Regional Water Quality Treatment for BMP Strategy Area (BMP SA)-7.1	X			0-1			X	Cartridge Filter / SSF Wetland	$1,000,000	2021-2025	12-24		
7-E	Provide Regional Water Quality Treatment for BMP Strategy Area (BMP SA)-7.2	X			0-1			X	Cartridge Filter / Underground Storage	$3,300,000	2016-2020	6-12		
7-F	Provide Regional Water Quality Treatment for BMP Strategy Area (BMP SA)-7.3	X			0-1			X	Cartridge Filter only	$390,000	2016-2020	6-12		7-A
7-G	Water Quality Planning Recommendations for BMP Strategy Area (BMP SA)-7.4			X	0-1			X	Project Based	$490,000	2016-2020	6-12		
7-H	Improve Basin 7 Trunk Line to Address Risk of Asset Failure	X			7-3		X		N/A	$4,200,000	2016-2020	6-12		7-A, 7-B, 7-C
8-A	Replace Basin 8 Outfall Pipe	X			8-1, 8-2, 8-3	X			N/A	$1,000,000	2021-2025	6-12	8-B, 8-C, 8-D	
8-B	Replace Portion of Eastern Basin 8 Trunk Line Along NE Airport Way	X			8-1	X			N/A	$810,000	2016-2020	<6	8-A	
8-C	Replace Pipe Along NE Airport Way Frontage Road in Northwest Basin 8	X			8-2	X			N/A	$110,000	2016-2020	<6	8-A	
8-D	Add Fill and Pipe Storage Southeast of North Runway (10L-28R)	X			8-3	X			N/A	$330,000	2021-2025	<6	8-A	
8-E	Provide Regional Water Quality Treatment for BMP Strategy Area (BMP SA)-8.1	X			0-1			X	Cartridge Filter / Underground Storage	$4,400,000	2016-2020	6-12		8-F

SWM Solution ID	Solution Name	Solution Type: New or Modified Infrastructure	Solution Type: Operational Change	Solution Type: Future Planning Considerations	Corresponding SWM Need ID	Need Type: Ponding	Need Type: Stormwater Asset Failure	Need Type: Stormwater Controls	Proposed BMP Type (if applicable)	Capital Cost Summary	Anticipated Implementation Timeframe	Planning and Design Lead Time (Months)	Related Solutions Required to Address Need(s)	Other Solutions to Coordinate With
8-F	Water Quality Planning Recommendations for BMP Strategy Area (BMP SA)-8.2			X	0-1			X	Project Based	$160,000	2021-2025	6-12		8-E
8-G	Provide Project-based Water Quality Treatment for BMP Strategy Area (BMP SA)-8.3			X	0-1			X	Project Based	$3,400,000	2026-2035	6-12		
9-A	Drainage Planning Recommendations for Development Along NE Mt St Helens Avenue			X	9-1	X			N/A	N/A	Development Driven	6-12		
9-B	Water Quality Planning Recommendations for BMP Strategy Area (BMP SA)-9.1			X	0-1			X	Project Based	$1,100,000	2026-2035	6-12		

5.6 Stormwater Management Fact Sheets

As previously described, each SWM need and solution is described in the form of a fact sheet for ease of reference. The needs and solutions are documented separately because some solutions address multiple needs, and some needs require multiple solutions in order to be addressed. Presenting SWM needs separately from solutions also allows for the possibility that alternate solutions to those provided can be implemented if circumstances warrant.

To facilitate coordination between needs and solutions fact sheets, they are grouped together in individual fact sheets sections that are specific to each drainage basin. At the beginning of each section of fact sheets, an introduction provides an overview of the fact sheets pertaining to that drainage basin, as well as a table correlating needs to solutions, and a table correlating solutions to needs. Users are encouraged to review the tables to identify fact sheets of interest, as well as corresponding needs or solutions fact sheets. Corresponding needs and solutions fact sheets are intended to be used together to gain an understanding of how the issues relate to the solutions and vice versa.

Each SWM need fact sheet provides information that characterizes the site-specific stormwater management issue. Specific topics discussed in each fact sheet include issue location, characteristics, recommendations for further characterization, regulatory drivers, factors contributing to the issue, consequences for not mitigating the need (i.e., risks), and criteria for defining how the need is met (i.e., what defines the issue as being fixed).

Each SWM solution fact sheet provides recommendations for implementation of a solution that involves new or modified infrastructure, operational change, or planning considerations. Specific information provided in each fact sheet includes a description of the solution, implementation considerations, risks if the solution is implemented, schedule analysis, and cost analysis. The categories in the SWM solution fact sheets were selected such that information can be transferred to Port Charter and Business Case documentation for capital projects. The SWM solutions presented are the result of an analysis of multiple alternatives. Where warranted, alternatives that were considered, but not selected as solutions, are discussed in the fact sheets.

Immediately following this subsection are the following two exhibits, which provide guidance on the content within the need and solution fact sheets, respectively:

- Exhibit 6: Stormwater Management Need Fact Sheet Guidance Document
- Exhibit 7: Stormwater Management Solution Fact Sheet Guidance Document

These guidance documents include text boxes providing guidance to the user on interpreting the content of various tables and headings within the fact sheets. Users may benefit by referencing these guidance documents alongside one of the corresponding filled out fact sheets, as needed for clarification of fact sheet content.

The drainage basin-specific fact sheet sections are located at the end of the SWMP document, after the figures and prior to the appendices. Additionally, Figures 5-3 and 5-4 map out regulatory boundaries at PDX that will affect the implementation of select solutions. Figure 5-3 displays FEMA regulatory floodplains, and Figure 5-4 displays environmental zones regulated by the City of Portland.

Exhibit 6 - Stormwater Management Need Fact Sheet Guidance Document

SWM NEED FACT SHEET #-#

Stormwater Management Need Tracking Information

SWM Need ID	Need Name	Issue Type	Author	Revision Date
#-#	Need name	Ponding	GS&P	June 2015

Guidance: *The first number corresponds to drainage basin number, and the second number represents a sequential index number for needs in that basin.*

Guidance: *Issue and solution types are explained in Section 5.*

Stormwater Management Solutions Identified to Address Need

SWM Solution ID	Solution Name	Solution Type		
		New or Modified Infrastructure	Operational Change	Future Planning Consideration
#-X	***Guidance:*** *The solutions in this table are all required to fully address the identified need. Review the solution fact sheets alongside this need fact sheet.*	X		
#-X			X	

Issue Characterization

Issue Type	Issue Description
Ponding	***Guidance:*** *This table explains the specific issue creating the need, and observation or characterization of the issue that has taken place. Please refer to Section 4 for further background on characterization of stormwater management issues at PDX.*

Guidance: *"NFS" in the footer indicates that this is a stormwater management need fact sheet. In the sequence of the document, the needs fact sheets are organized into groups by basin, followed by the solutions fact sheets for each basin, which are identified in the footer with "SFS".*

Factors Potentially Contributing to Issue

Factor	Characterization Basis
Guidance: *This column identifies factors that may be causing the issue. The presence of these factors will drive the nature of the solution.*	***Guidance:*** *This column indicates to what extent the presence of this factor and its contribution to the issue have been characterized. If not well-characterized, further characterization may be required before implementing a solution (see below).*
Factor 1	Extent to which presence of factor has been characterized as potentially driving this need at PDX.
Factor 2	

Recommendations to Further Characterize Issue and Define Need

The following actions are recommended to further characterize the issue before designing and implementing the identified solution(s).

Action	Description
Guidance: *This table identifies additional actions that may be prudent to further characterize the significance of and contributors to the issue before moving forward with a solution. Confirmation of issue extent and contributing factors may help to optimize the solution to address root causes in a cost-efficient manner, as well as justify moving forward with the solution. Examples of further characterization actions are provided below, but will vary between fact sheets.*	
Groundwater Analysis	Description of actions to be performed to characterize issue
Additional Technical Analysis	
Surveying / Field Data Collection	
Inspections / Condition Assessment	

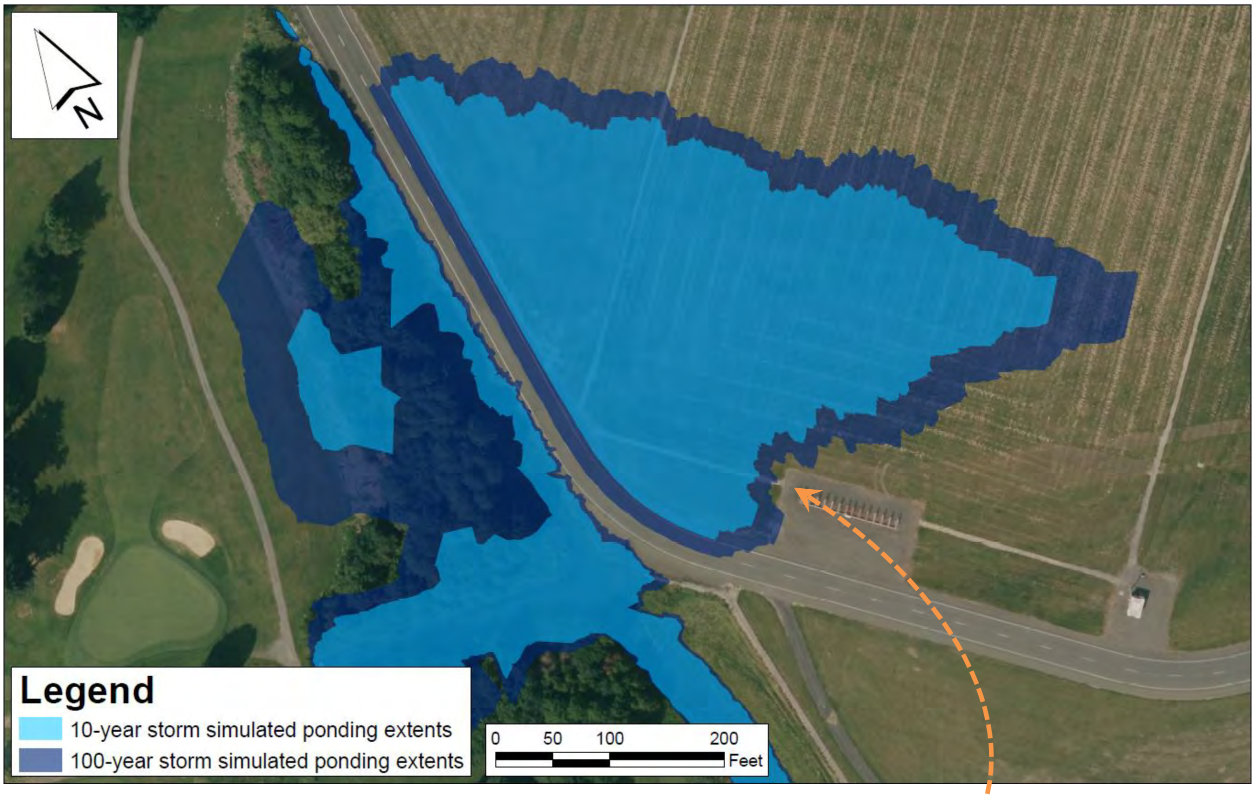


Figure 1: Plan View of Need

Guidance: *Figure illustrates the location, extent, and nature of the issue / need, as currently understood. Note that the figure may exclude nearby issues / needs that are not associated with the focus of the fact sheet (i.e., unrelated ponding or asset needs nearby are not displayed in this figure).*

Regulatory Drivers for Stormwater Management Need

Driver	Description
Guidance: *This table identifies regulatory drivers for addressing the identified need (drivers for implementing a solution). The regulatory drivers include regulatory criteria, where applicable, as well as regulatory objectives or positions that may conflict with the presence of the issue. Other drivers for addressing the need include the potential consequences of not mitigating the need (see table below).*	
Regulatory Document	Description of regulatory criteria or objectives that conflict with identified issue and drive it to be defined as a need requiring a solution.

Consequence of Not Mitigating Stormwater Management Need

Item	Description
Guidance: *This table identifies consequences associated with opting to not address the stormwater management need or maintaining the status quo. The items in this table represent risks that have been determined to be associated with the issue. These risks are anticipated to remain until an appropriate solution has been implemented, or factors driving the need have been otherwise addressed.*	
Operations	Description of risk posed by the issue
Wildlife Hazard Management	
Planning and Development	

Criteria to be Addressed by Stormwater Management Solutions

Item	Description
Guidance: *This table identifies criteria that were selected, based on the nature of the issue, to define the stormwater management need and the extent of the solution. These criteria are consistent with those identified for the issue types described in Section 4 of the SWMP.*	
Flooding of Existing/Future Pavement	Description of specific criteria to be addressed
Flooding of Existing/Future Buildings	
Ponding in Unpaved Areas Identified as Critical for Ponding Reduction	
Asset Management Criteria	
Water Quality Treatment Criteria	

Exhibit 7 - Stormwater Management Solution Fact Sheet Guidance Document

SWM SOLUTION FACT SHEET #-X

Stormwater Management Solution Tracking Information

SWM Solution ID	Solution Name	Capital Cost Summary	Anticipated Implementation Timeframe	Author	Revision Date
#-X	Solution name	$#	####-####	GS&P	June 2015

Guidance: *The number corresponds to the drainage basin number, and the letter represents an alphabetical index for solutions in that basin.*

Guidance: *See cost and timeframe at end of fact sheet.*

Guidance: *Need types are explained in Section 5.*

Stormwater Management Needs Addressed by Solution

SWM Need ID	Need Name	Need Type		
		Address Ponding and Facilitate Drainage	Address Risk of Stormwater Asset Failure	Provide Required Stormwater Controls
#-#	Need Name	X		
#-#	Need Name		X	

Guidance: *The needs in this table are met or partially met by this solution. Review the need fact sheets alongside this solution fact sheet.*

Solution Description

Solution Type	Summary Description
New or Modified Infrastructure	***Guidance:*** *This table provides an overview of the proposed solution. A text section below the table provides a more in-depth description of the solution, including the location and extents, components and features, and anticipated benefits.*

Guidance: *"SFS" in the footer indicates that this is a stormwater management solution fact sheet. In the sequence of the document, the solutions fact sheets are organized into groups by basin, and each group of solutions fact sheets follows the corresponding group of needs fact sheets for that basin, which are identified in the footer with "NFS."*

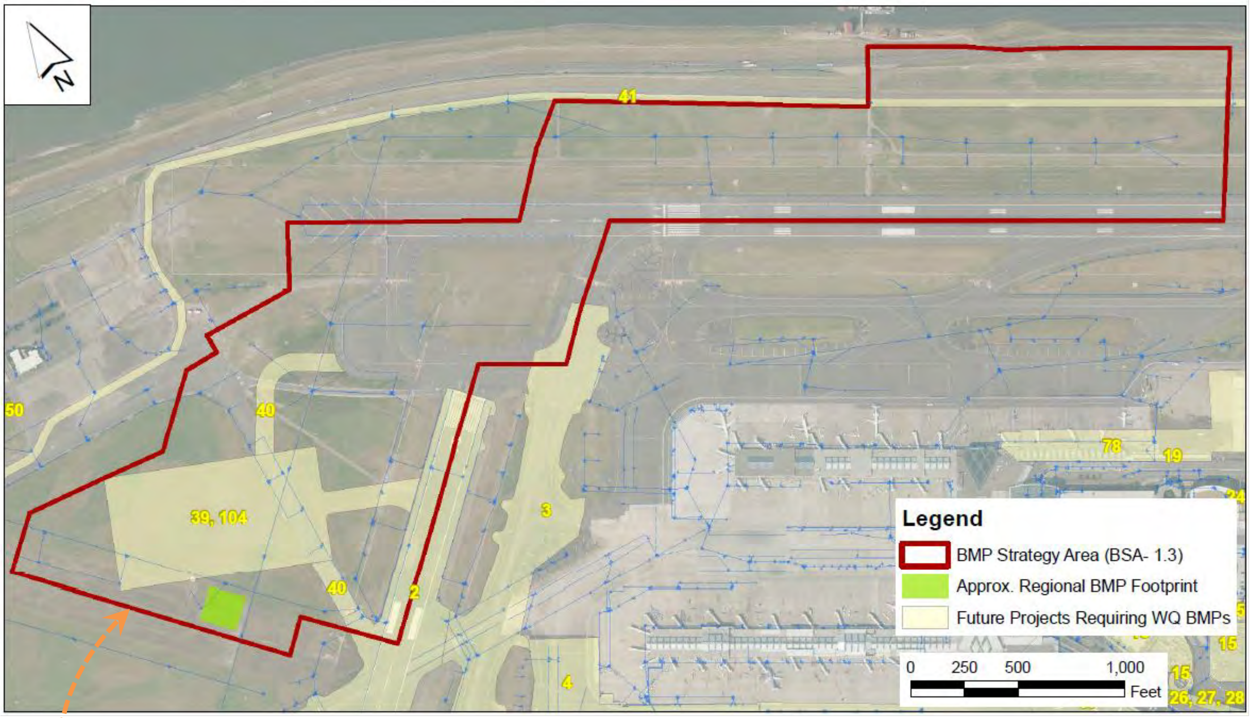


Figure 1: Plan View of Solution

Guidance: *Figure illustrates the location and extent of the proposed solution. Note that the figure may exclude nearby solutions that are covered by a different fact sheet (i.e., nearby proposed BMPs or infrastructure that are not included in this fact sheet are not displayed in this figure).*

Implementation Considerations

The following tables provide recommended considerations as the project moves from planning concept to implemented solution. The tables below address three phases of implementation, including planning and design, construction, and post-construction.

Guidance: *The table below summarizes considerations for implementation of the proposed solution that may be applicable during planning and design phases. The Port may want to consider if the proposed solution, and the corresponding considerations below, can be integrated into the planning and design of a closely-related or nearby development project.*

Planning and Design Considerations

Item	Description
Field Data Collection	
Additional Technical Analysis	
Permitting	
Siting	
Coordination with Elements of Other Projects	
Enabling Projects	
Related Solutions	
Coordination with Port Departments	
Coordination with Tenants	
Coordination with Outside Agencies	
Design Disciplines Involved	

Guidance: *The table below summarizes considerations for implementation of the proposed solution that may be applicable during the construction phase. The table describes elements of the construction, as well as constructability challenges and potential impacts to operations during construction.*

Construction Considerations

Item	Description
Construction Components	
Airport Operational Impacts	
Construction Challenges	

Guidance: *The table below summarizes considerations for implementation of the proposed solution that may be applicable during the post-construction phase, with an emphasis on operations and maintenance.*

Post-Construction Considerations

Item	Description
Post-Construction Coordination with Airport Operations	
Considerations for Operation and Maintenance (O&M) of the Solution	

Guidance: *The table below summarizes potential risks that may be associated with implementing the proposed solution. Strategies recommended to mitigate the identified risks are also described in this table.*

Potential Risks if Solution is Implemented / Risk Mitigation Strategies

Item	Description	Mitigation Strategy
Regulatory Compliance		
Airport or Tenant Operations		
Aircraft Safety		
Future Development Limitations		

Guidance: *The table below provides scheduling considerations for the proposed solution, including schedule drivers and alignment with other construction projects, as well as potential construction timeframe and planning and design lead time.*

Schedule Analysis

Item	Description
Critical Schedule Drivers	Coordinate the construction with the following development project timeframes, to the extent that the construction of the solution can be aligned with construction of these projects:[1] • Project #: Project Name (20##) • Project #: Project Name (20##)
Target Construction Timeframe (2016-2020, 2021-2025, 2026-2035)	20##-20## ***Guidance:*** *The indicated timeframe was selected based on alignment with critical schedule drivers. If the identified drivers are determined to not be applicable, the timeframe may be adjusted accordingly.*
Planning and Design Lead Time (<6 months, 6-12 months, 12-24 months)	#-# months ***Guidance:*** *The selected lead time is indicative of the extent, location, and complexity of the proposed solution, as well as regulatory approvals/permitting.*

Notes:
1. Project numbers and timeframes were pulled from the Port's list of future development projects (Appendix A).

Guidance: *The table below provides planning-level cost considerations for the proposed solution, including an opinion of probable cost, as well as associated key cost assumptions that are unique to the solution. Cost assumptions common to a variety of solutions are summarized in Appendix B.*

Cost Analysis

Item	Description
Opinion of Probable Capital Cost (2015 Dollars)[1]	$#
Cost Estimate Class / Contingency (1-Bid received, 2-Construction, 3-Design, 4-Concept Design, 5- Screening/Planning)	
Fixed Asset Modifications Excluded from Cost Estimate	
Cost Assumptions	
O&M Cost Considerations	

Notes:

1. Supporting detailed cost tables are provided in Appendix B.

6 GENERAL RECOMMENDATIONS AND NEXT STEPS

6.1 Introduction

With the completion of the SWMP document, it is important that the Port begin integrating SWMP findings and recommendations into existing planning, properties management, engineering, environmental, and asset management processes to maximize the value of the SWMP. This section provides an overview of general recommendations and next steps for stormwater management at PDX that build on the content of the SWMP, including further characterization of issues and needs, implementation of proposed solutions, and enhancements to the PDX stormwater management program. Please refer to the individual stormwater management fact sheets for site-specific recommendations and next steps pertaining to individual needs and solutions.

6.2 Further Characterization of Stormwater Management Needs

The characterization of specific SWM needs at PDX was based on analysis performed up to the time of the SWMP document development in 2015. As circumstances evolve over time, additional information, changing conditions, or changing perspectives may result in the need to modify the SWM needs presented in this 2015 SWMP. Considerations that may drive updates or expansion of the SWM needs are discussed below.

6.2.1 Further Characterization of Ponding

The SWM ponding needs identified in the SWMP are fairly comprehensive because of the extensive analysis performed during the master plan. However, the characterization of SWM needs and issues is based on the information available at the time. A number of assumptions were required for the stormwater hydraulic modeling in particular because of limitations in available data. In addition, characterization of needs for future conditions is based on the 2015 view of how a more fully developed PDX would look in 2035. Model results and conclusions on needs could change as conditions evolve and more site-specific data becomes available. As new data becomes available, the Port will need to assess whether the data has the potential to affect results and furthermore has the potential to affect the SWM needs and solutions identified in the 2015 SWMP. Potential types of new information that could warrant reassessing model inputs and results related to ponding include:

- Site-specific groundwater depths and potential impacts on stormwater infiltration
- Detailed topography from new LiDAR or surveys
- New details on site development plans
- Filling of infrastructure data gaps
- Field observations of ponding

The Port will need to decide if model updates, and subsequent re-evaluation of results, will be made on a case-by-case basis (as new data are acquired) or on a regular schedule. Specific recommendations for further characterization of each SWM need are provided in the individual SWM need fact sheets.

6.2.2 Further Characterization of Stormwater Asset Failure Risks

The asset management-related issues that are currently classified as SWM needs in the 2015 SWMP involve assets that were identified as having a potentially high likelihood of failure, based on age-related useful life expended, and located in areas that were qualitatively assessed by the Port to have a significant consequence of failure. The Port's Stormwater AMP Team will assess the results of the useful life expended analyses to determine one of the following courses of action:

- No action
- Field condition inspections and documentation of defects:
    - No action
    - Schedule routine future inspections to track changes in condition
    - Subsequent repair, rehabilitation, or replacement of the asset, either in conjunction with a planned project, or as a standalone project
- Direct repair, rehabilitation, or replacement of the asset without condition characterization, either in conjunction with a planned project, or as a standalone project

As the Port's information base on stormwater asset condition grows, the Port may wish to update SWM needs and associated SWM solutions in the SWMP.

6.2.3 Further Characterization of Stormwater Control Needs

As described in Section 4, a variety of regulatory requirements may drive the need for stormwater water quality and quantity controls, but the focus of the SWMP at this time is the need for long-term BMPs to meet Port DSM criteria. The SWMP also identifies recommendations for additional spill control facilities in Basin 7. Additional long-term drivers for stormwater controls may be identified by the Port outside of the SWMP, including:

- Regulatory changes resulting in modifications to general or individual permits (e.g., new or lower pollutant benchmarks)
- Evolving interpretations of regulatory requirements (e.g., NMFS requirements)
- Consolidation of the Port's permits
- Exceedances of permit benchmarks
- Changes in industrial activities, resulting in changes in the type or magnitude of pollutants

It is recommended that the Port consider additional long-term strategies for compliance with these regulations and opportunities to coordinate with SWM solutions proposed in the SWMP.

6.3 General Recommendations for Implementation of Proposed Solutions

The SWM solution fact sheets provide specific guidance and considerations for implementing each proposed solution, including actions during the planning, design, construction and post-construction phases. Beyond those solution-specific considerations, the SWMP team has identified some key general recommendations for solution implementation, as well as considerations specific to each solution type. Recommendations for solution implementation are detailed in the following subsections.

6.3.1 Alignment of SWM Solutions with Planned Development Projects

The fact sheets recommend the alignment of SWM solutions, where possible, with future development projects. A key strategic function of the PDX stormwater management program will be to determine to what extent the proposed SWM solutions can be integrated into the development projects. Strategically, decisions to integrate SWM solutions into development projects should be made early in the planning process, to allow solutions to be accounted for in project design documents, budgets, and schedules. Some solutions will not align directly with development projects and may need to be implemented as standalone stormwater management projects, while others may be able to be phased and partially integrated into development projects.

6.3.2 Stormwater Management Solution Implementation Timeframes

In general, where SWM solutions have some relationship to planned development projects, the recommended implementation timeframe is aligned with the timing of planned development project(s). The general assumption is that the stormwater project would be implemented no later than the end of the proposed timeframe. As SWM solutions are considered for implementation, potential construction synergies between the solution and planned development projects, as well as other solutions, should be confirmed to allow project sequencing and timeframes to be refined. As development plans evolve, changes in construction timeframes should be communicated to the Stormwater AMP Team so that potential impacts to related SWM solutions can be assessed.

The stormwater capital projects identified in this SWMP are generally long-lead projects. Implementation of the projects likely requires a series of tasks prior to development of construction documents, including concept design, detailed analysis of environmental impacts, permitting, funding assessment, and coordination with operations and properties. Depending upon the project, the lead time needed for this work prior to design could take months to years. It will be important for the Port to coordinate the lead time needed for each individual project with the schedule for development projects that might encompass or impact the stormwater management project.

In cases where more than one solution is required to address a need, the timeframes of both projects will affect the timing of the issue being addressed. The Port may opt to phase the implementation of each related solution based on the timing of associated development projects; however, it is important to note that the ponding area served by the local solution may not be fully addressed until both solutions have been fully implemented.

6.3.3 Consideration of Evolving Development Projects

In the midst of the stormwater master planning process, it took an extensive period of time to crystallize the vision of the development projects that may be implemented by the SWMP 2035 future planning horizon. It was clear through this process that the list, extent, and timing of potential development projects are constantly in flux. Those changes can have significant impacts on the need for individual SWM solutions, as well as the extent and cost of the stormwater projects. It is critical that the proposed solutions be reviewed in light of the current development plan and stormwater needs at the time of implementation.

It is recommended that the development map and project list developed for the SWMP (Figure 4-1 and Appendix A, respectively) be maintained and updated to reflect changes to the overall PDX development plan, to facilitate planning for stormwater management actions as well as other Port planning functions. Additionally, as development projects are implemented, it is recommended that related solutions be reviewed to confirm that the solution aligns with project characteristics as they exist at that time.

6.3.4 Recommendations for Ponding-Related Solutions

For the purposes of the SWMP, fifteen SWM solution fact sheets have been developed that relate to addressing ponding and facilitating drainage. Of these solutions, eleven propose new or modified infrastructure (illustrated on Figure 5-1), three involve planning considerations for future development projects, and one involves an operational change to existing infrastructure. General considerations for solutions intended to address ponding include the following:

- As solutions evolve, it is critical that they remain focused on addressing the clearly understood root cause (e.g., small pipes, misaligned inverts, etc.).
- The variation in local groundwater elevations is currently not clearly understood. High groundwater tables could affect the ability of SWM solutions to eradicate ponding for the design event. As groundwater data becomes available, the details of solutions to address ponding should be re-assessed.
- Managing sediment and construction debris upstream of deicing system pump stations is critical.
- Allow sufficient time for permitting in advance of design. Typically at least 6 months should be allocated.
- Many of the pipe removal and abandonment projects will have a temporary impact on operations because of their proximity to runways and taxiways, making coordination with operations critical, even as early as the planning stages.
- It appears feasible that existing deicer management infrastructure can be used to help with ponding issues in Basin 1.

6.3.5 Recommendations for Asset Management-Related Solutions

For the purposes of this SWMP, five SWM solution fact sheets relate to addressing the risk of stormwater asset failure. This section provides considerations for these five identified SWM solutions, as well as considerations for additional asset management-related solutions that may be identified and prioritized by the Port outside of the SWMP.

All five SWM solutions fall under the category of new or modified infrastructure, and require the replacement or rehabilitation of pipes with high useful life expended as of the year 2015. Although high useful life expended is an indicator of a potentially high risk of stormwater asset failure, SWM solutions were not developed in the SWMP for all pipes that have high useful life expended. The five SWM solutions were selected for the SWMP because the pipes involved have very high useful life expended and drain significant or critical areas of the airport (several of the solutions involve drainage basin trunk lines). The solutions also have some alignment with development projects and are closely related to proposed ponding solutions. Four of the SWM solutions (1-B, 1-C, 7-B, and 7-C) solve a ponding issue, and only SWM Solution 7-H (Improve Basin 7 Trunk Line to Address Risk of Asset Failure) is strictly intended to address an aging asset.

In general, asset management projects should be coordinated with development projects planned by the Port. It may be prudent to implement portions of solutions with adjacent development projects if timing, budgets, and design can be coordinated. However, for the five identified asset management-related SWM solutions, it is anticipated that a majority of the construction will need to be performed as standalone projects.

It is anticipated that the Port will be implementing an ongoing program for assessing the need to further characterize storm sewer pipe condition and develop solutions for the repair, rehabilitation, or replacement of the pipes. Identification of specific pipes for further assessment and/or solutions will be the role of the Stormwater AMP Team. The asset management group would coordinate the actual inspections. Specific recommendations for the Port in this process include:

- The Port has identified that when pipes greater than or equal to 18 inches in diameter reach 75% of useful life expended based on age and pipe material, the potential needs for repair, rehabilitation and replacement will begin to be considered.

- Condition assessment using CCTV and/or divers is recommended for pipes within or adjacent to the boundaries of planned development projects if those pipes have more than 75% useful life expended based on age and estimated material useful life. An overlay of pipes reaching that useful life threshold on the PDX development map was prepared for the Port Stormwater Asset Management Assessment Report, previously submitted to the Port in July 2014.

- For pipes that are not likely to be associated with development projects, condition assessments should be considered on a regular basis starting at the threshold of 75% useful life expended. It is recommended for the Port to plan inspections of all pipes greater than or equal to 18 inches in diameter that have reached the 100% useful life expended threshold. The pipes to be inspected should be prioritized for assessment based on the consequences of a potential pipe failure. If the consequences create a significant and widespread risk to operations, safety, infrastructure, or regulatory compliance, the pipes associated with those risks should be given highest priority for inspection. Conditions that can lead to highly consequential risks include: outfalls, major trunk lines, pipes whose failure would impact emergency response routes, pipes whose failure would impact the North and South Runways, and pipes whose failure would limit airport access.

- Solutions should be prioritized for pipes with moderate to severe structural defects, as these are associated with a higher risk of pipe failure, which could lead to significant surface ponding or structural impacts to overlying facilities. The Port should implement a standardized system for coding of pipe defects, such as the National Association of Sewer Service Companies (NASSCO) Pipeline Assessment & Certification Program (PACP), to provide consistency in interpretation of condition over time. Any abandoned pipes need to be filled with a material intended to prevent collapse and passage of water. A variety of grout and concrete products can be used. Decisions on repairing or rehabilitating pipes as opposed to replacing the pipes should consider structural integrity as a critical factor. Not all pipe repair/rehabilitation methods intended to reduce water movement in and out of the pipes can provide the improvements in structural stability that may be needed to avoid complete failure.

6.3.6 Recommendations for Stormwater Control-Related Solutions

For the purposes of the SWMP, 24 SWM solution fact sheets have been developed that relate to required stormwater controls. Of these, eleven fact sheets provide recommendations for new regional BMPs, and thirteen provide general planning recommendations for projects falling within particular BMP Strategy Areas. General considerations for the implementation of stormwater control solutions include the following:

- For regional BMPs, it is recommended that the Port develop a system for implementing the regional BMPs in relation to the development projects, such as recommended timelines for regional BMP installation following the development projects' construction. The BMP tracking tool recommended later in this section could be integrated into this system.

- Water quality planning recommendations are expected to be used to help select and design project-based BMPs in concert with the timeline of the specific development project or cluster of projects.

- Some regional BMPs are expected to be required in areas within the deicing system. It is unknown if any negative side effects, such as biofouling, would occur if dilute deicer stormwater is routed through the post-construction stormwater BMPs. It is recommended that one of the proposed BMPs be pilot tested to observe if any treatment performance or maintenance issues arise from the deicer stormwater.

- Many BMPs are not intended to pass the full flow rate from conveyance pipes, so hydraulic bypasses are necessary to route flow not needing to be treated around the BMP.

- Providing a means of accessing the BMPs by Port vehicles is important for maintenance.

- The deicing system appears to be sufficiently sized to manage flows associated with the 2035 development without creating an appreciable risk of non-compliance with the deicing NPDES permit.

- The deicing system appears to be sufficiently sized to manage changes in flows associated with the various proposed SWM solutions.

- There are opportunities to integrate spill control upstream of proposed regional stormwater BMP controls in Basin 7, although the degree of protection offered by the spill control units may be limited in some cases by available space at the proposed site.

6.4 General Recommendations for the PDX Stormwater Management Program

Through the course of the SWMP development, GS&P had an opportunity to work with the Port to assess existing stormwater management issues and discuss Port decision-making processes pertaining to stormwater management. Based on these experiences, GS&P has developed several recommendations for enhancing the PDX stormwater management program.

6.4.1 Communication Protocols

During the stormwater master planning process, the GS&P team and the project benefited significantly from the insights provided by the numerous Port staff and departments involved in the project. Project meetings provided an excellent illustration of just how pervasive stormwater management considerations are at PDX. The discussions also illustrated that it is easy for important information pertaining to stormwater management decision-making to slip through the cracks. The many detailed considerations pertaining to stormwater analysis and management are challenging to communicate to the right audience on a timely basis, in the context of constantly evolving development conditions. It is therefore critical to the long-term successful implementation of the SWMP that the lines of communication for stormwater management information are as clear as possible. Although the Port's SWMP RACI Chart (Appendix E) describes the roles of Port staff, the Port may benefit from expanding the protocols to specify the types of information to be exchanged and the triggers for exchanging information with outside entities like tenants and design consultants.

Action Items:

- Develop expanded protocols for communication between departments at particular phases of project implementation, building on the general protocols described in the SWMP RACI Chart (Appendix E).

- Document key decisions pertaining to stormwater management and enhance the system for communicating these decisions to relevant parties.

6.4.2 Data Management

The stormwater master planning process utilized a great amount of existing information related to stormwater management and generated a large volume of new information. That information resides on multiple platforms. A significant challenge for the Port moving forward is providing effective documentation and efficient access to this data. The Port should consider a data management strategy that evaluates the most appropriate locations for the data and a means for access.

Further data organization could be performed to improve access and usefulness of the existing data to support stormwater management functions. Consider options for the overall management of stormwater asset data, given that the data is currently managed in a variety of ways.

Action Items:

- Develop organizational structure for access to stormwater management program resources, including tools and reference documents.

- Develop BMP implementation tracking tool that links planned development projects with post-construction water quality needs as well as capacities and functions of regional BMPs.

- Expand data sets used by Asset Management to improve understanding of asset characteristics, risks, and action items (e.g., linking potential ponding extents with assets, linking tributary subbasins to assets).

- Establish a coding system for tracking stormwater asset (pipes and structures) condition assessment results and defects and incorporating those locations into the Port GIS system, potentially using mobile applications with the ability to synchronize with GIS applications.

- Develop a prioritized list of locations to address stormwater asset data gaps and conflicts.

6.4.3 Guidance for Use of Stormwater Hydraulic Model

The PDX stormwater hydraulic model was developed to support the stormwater master planning process. The Port has access to the stormwater hydraulic model and is expected to use it to support ongoing planning and design of stormwater infrastructure. Due to the wide variety of Port staff and departments involved in stormwater management activities, it is recommended that protocols and guidance be developed for the model or similar tools that are intended for wide release. Without proper user guidance, it is possible that detailed assumptions and nuances that went into these tools may be lost or misinterpreted, especially as time passes after completion of the SWMP. For more information on models and tools developed as part of the SWMP, please refer to Section 2.3.2.

Action Items

- Develop user guidance for stormwater hydraulic model

- Clarify protocols for release of model to consultants and for maintaining and updating master model after development or drainage changes occur.

6.5 Future Updates to the SWMP

The PDX SWMP is a living document, and as circumstances evolve over time, the accuracy and relevance of the information in the SWMP will require verification. Updates to the SWMP could be triggered by the following:

- Changes in facility infrastructure, especially changes that differ significantly from the assumed current and future development conditions at the airport
- Changes in the extent, location, and function of development projects compared to the map of the PDX facility projected for the year 2035 that was prepared for the master plan process
- Differences in the timing of planned development projects that may affect priorities for stormwater conveyance, pumping, and treatment infrastructure
- Changes in regulatory requirements, especially those governing water quality and flow control requirements
- Results of field investigations, including evaluation of groundwater elevations
- Incidents of non-compliance with environmental regulatory permits
- Changes in ownership of properties
- Identifiable changes in weather patterns
- Significant changes in airport operations
- Information associated with future Airport Master Plans

FIGURES

PORT OF PORTLAND

PORTLAND INTERNATIONAL AIRPORT
STORMWATER MASTER PLAN

FIGURE 1-1
PORT PROPERTY
OWNERSHIP AT PDX

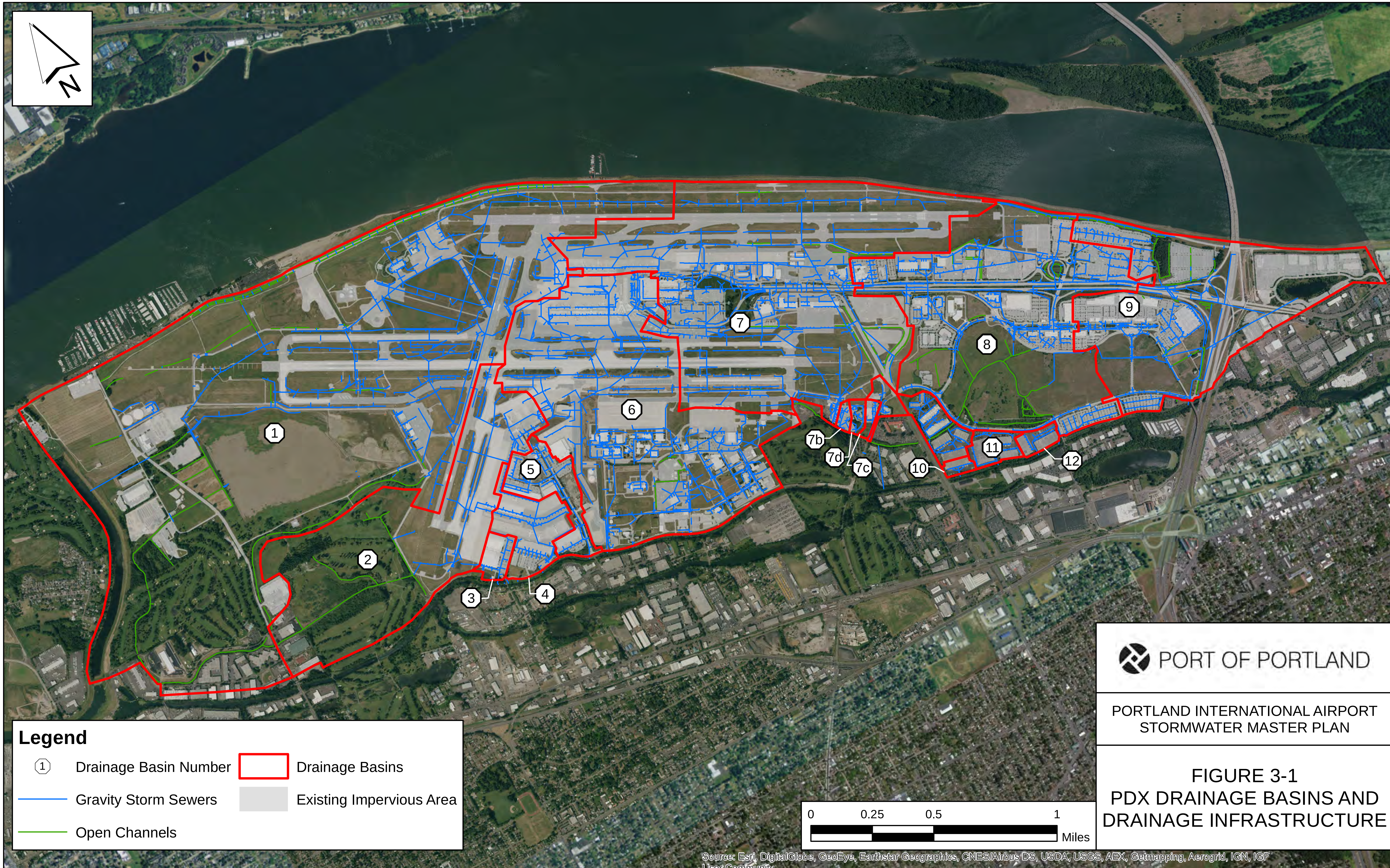


FIGURE 3-1
PDX DRAINAGE BASINS AND DRAINAGE INFRASTRUCTURE

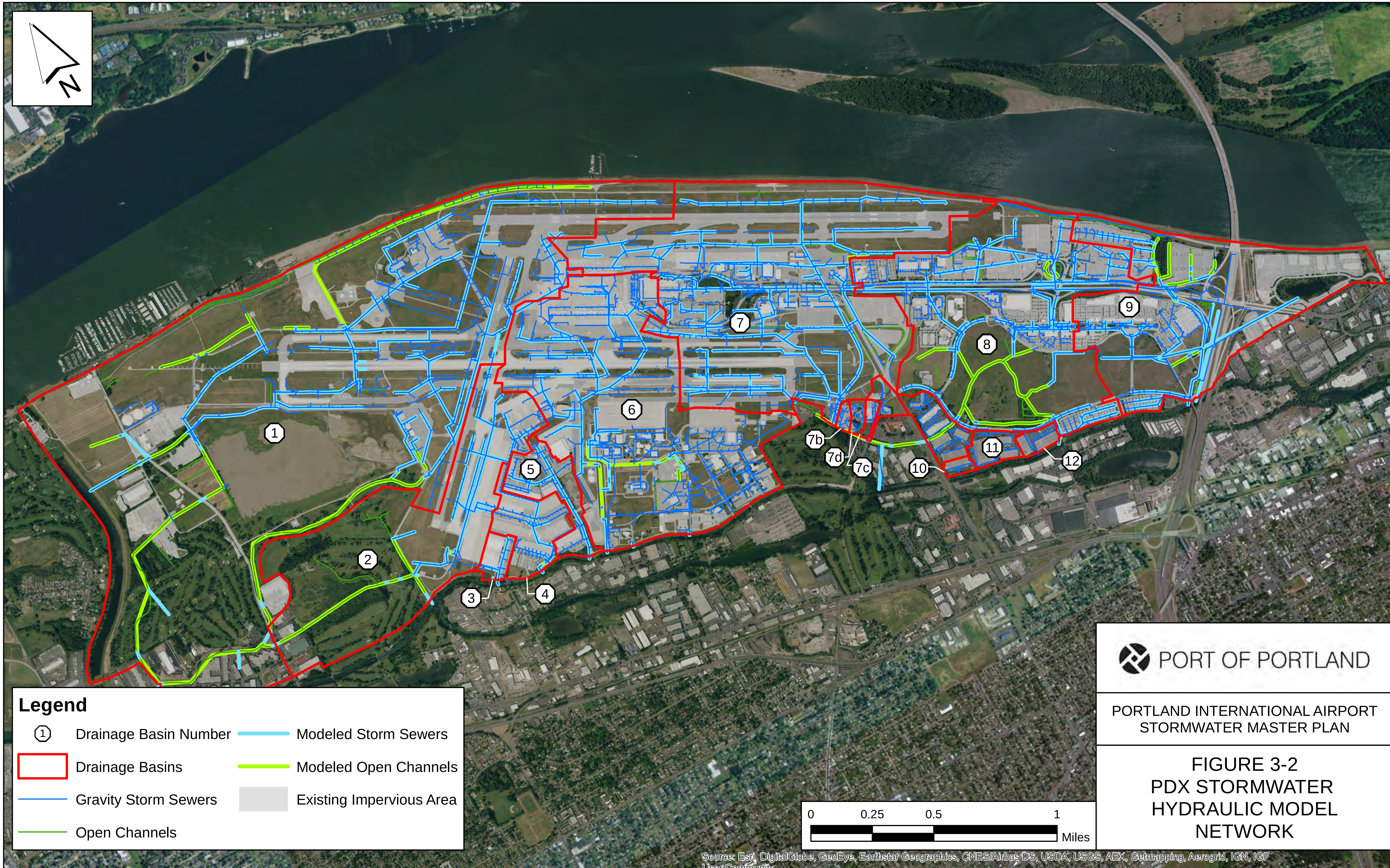
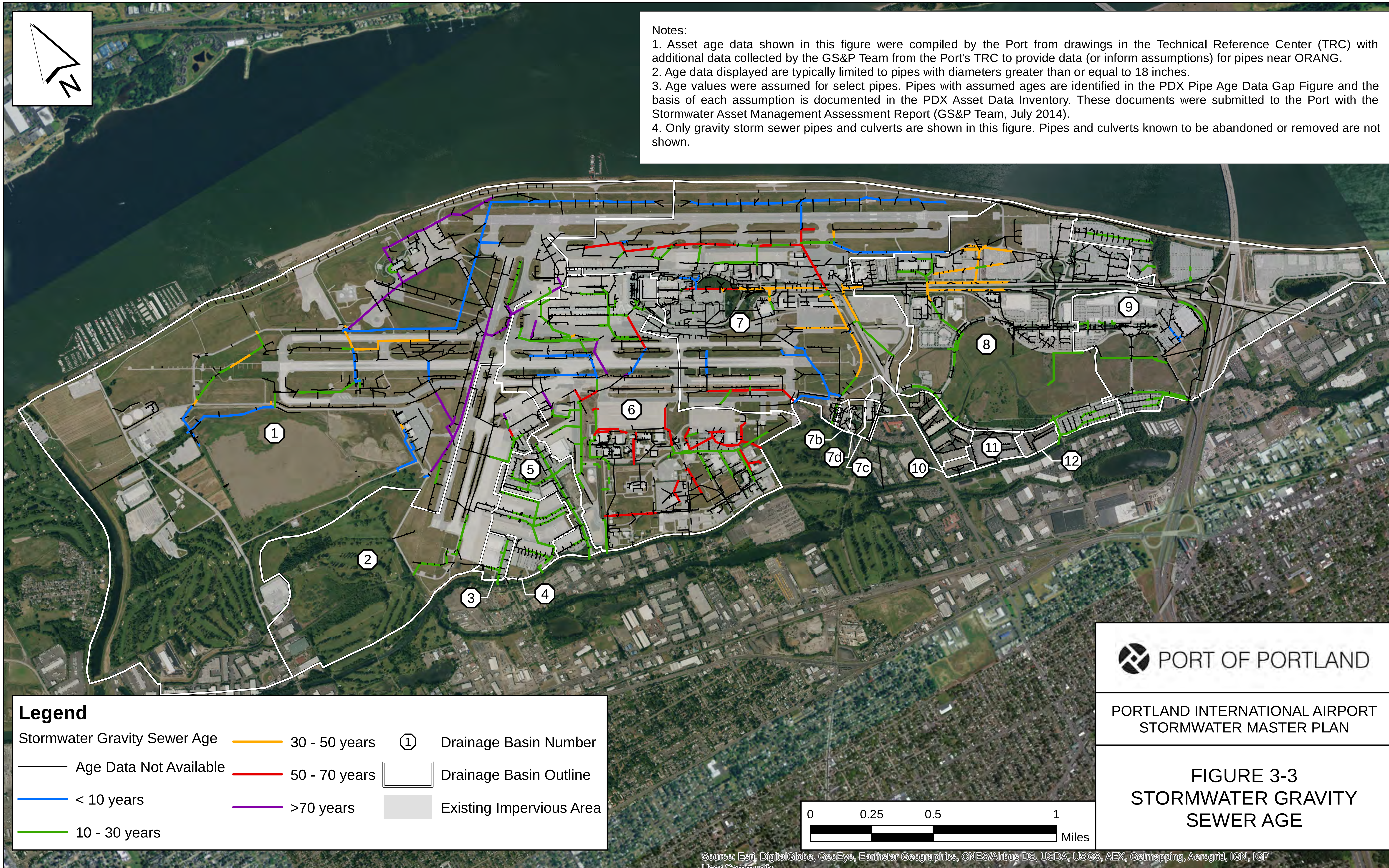
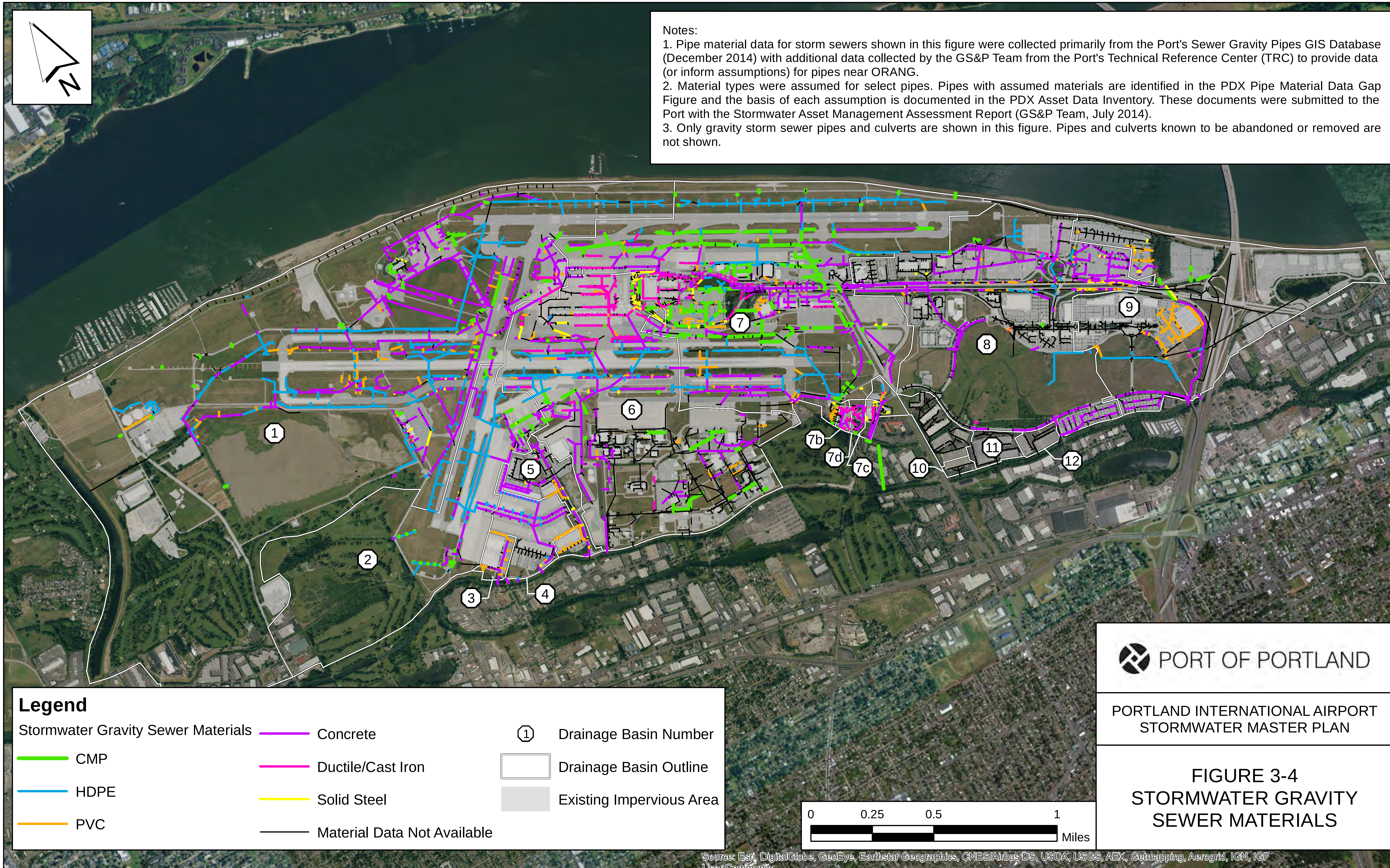


FIGURE 3-2
PDX STORMWATER
HYDRAULIC MODEL
NETWORK



Notes:
1. Asset age data shown in this figure were compiled by the Port from drawings in the Technical Reference Center (TRC) with additional data collected by the GS&P Team from the Port's TRC to provide data (or inform assumptions) for pipes near ORANG.
2. Age data displayed are typically limited to pipes with diameters greater than or equal to 18 inches.
3. Age values were assumed for select pipes. Pipes with assumed ages are identified in the PDX Pipe Age Data Gap Figure and the basis of each assumption is documented in the PDX Asset Data Inventory. These documents were submitted to the Port with the Stormwater Asset Management Assessment Report (GS&P Team, July 2014).
4. Only gravity storm sewer pipes and culverts are shown in this figure. Pipes and culverts known to be abandoned or removed are not shown.

Notes:
1. Pipe material data for storm sewers shown in this figure were collected primarily from the Port's Sewer Gravity Pipes GIS Database (December 2014) with additional data collected by the GS&P Team from the Port's Technical Reference Center (TRC) to provide data (or inform assumptions) for pipes near ORANG.
2. Material types were assumed for select pipes. Pipes with assumed materials are identified in the PDX Pipe Material Data Gap Figure and the basis of each assumption is documented in the PDX Asset Data Inventory. These documents were submitted to the Port with the Stormwater Asset Management Assessment Report (GS&P Team, July 2014).
3. Only gravity storm sewer pipes and culverts are shown in this figure. Pipes and culverts known to be abandoned or removed are not shown.



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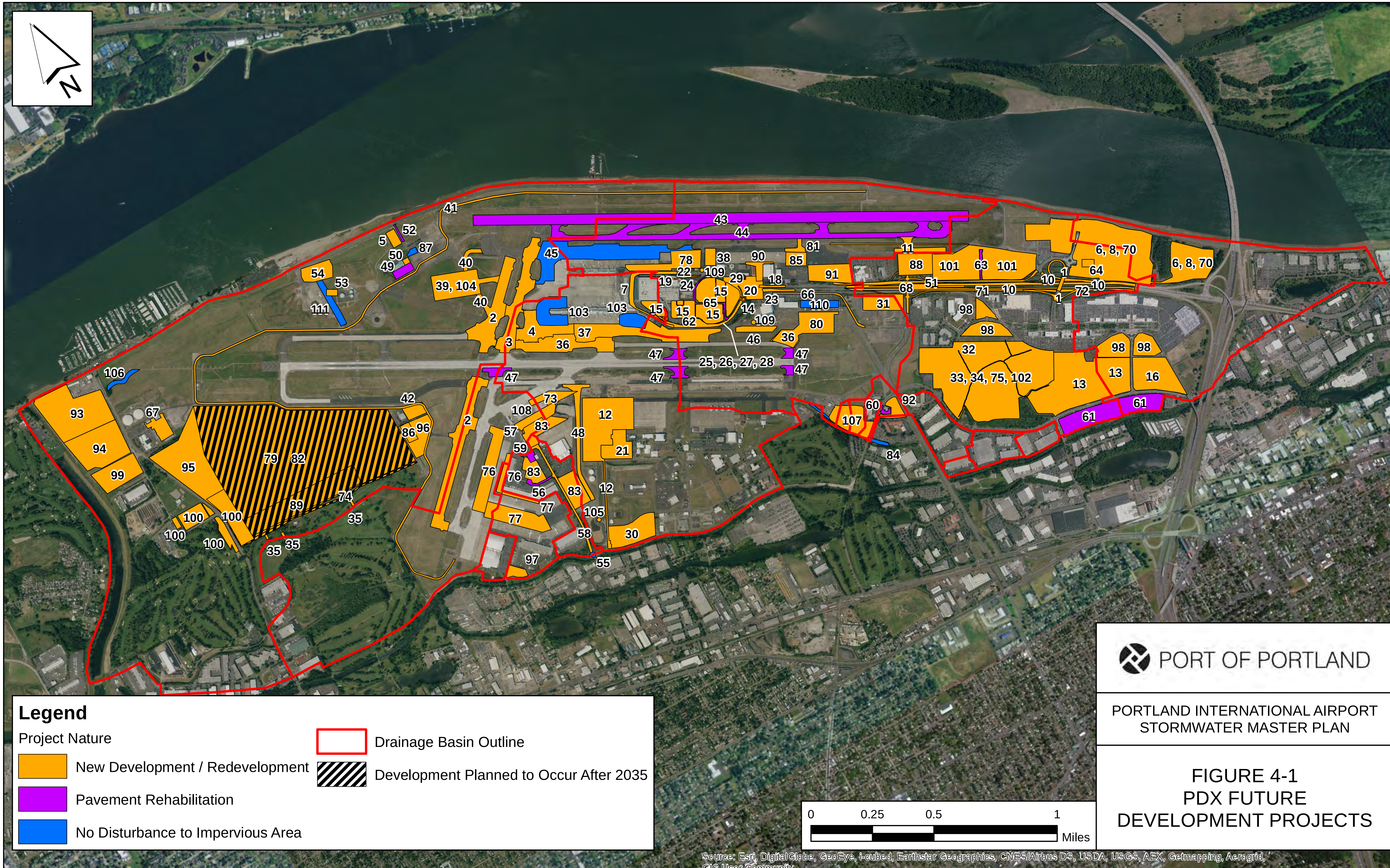
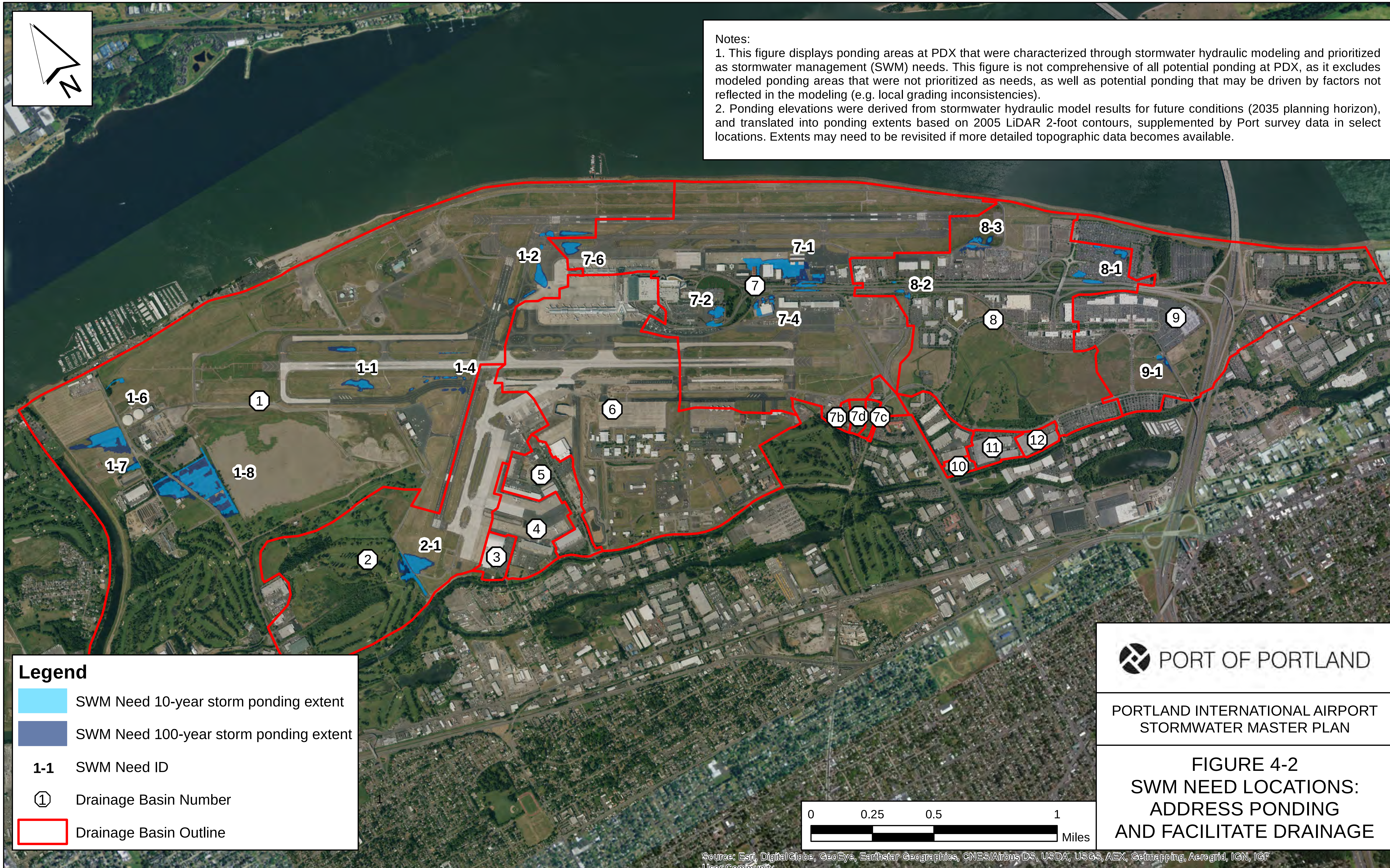
STORMWATER MASTER PLAN

FIGURE 3-4
STORMWATER GRAVITY
SEWER MATERIALS

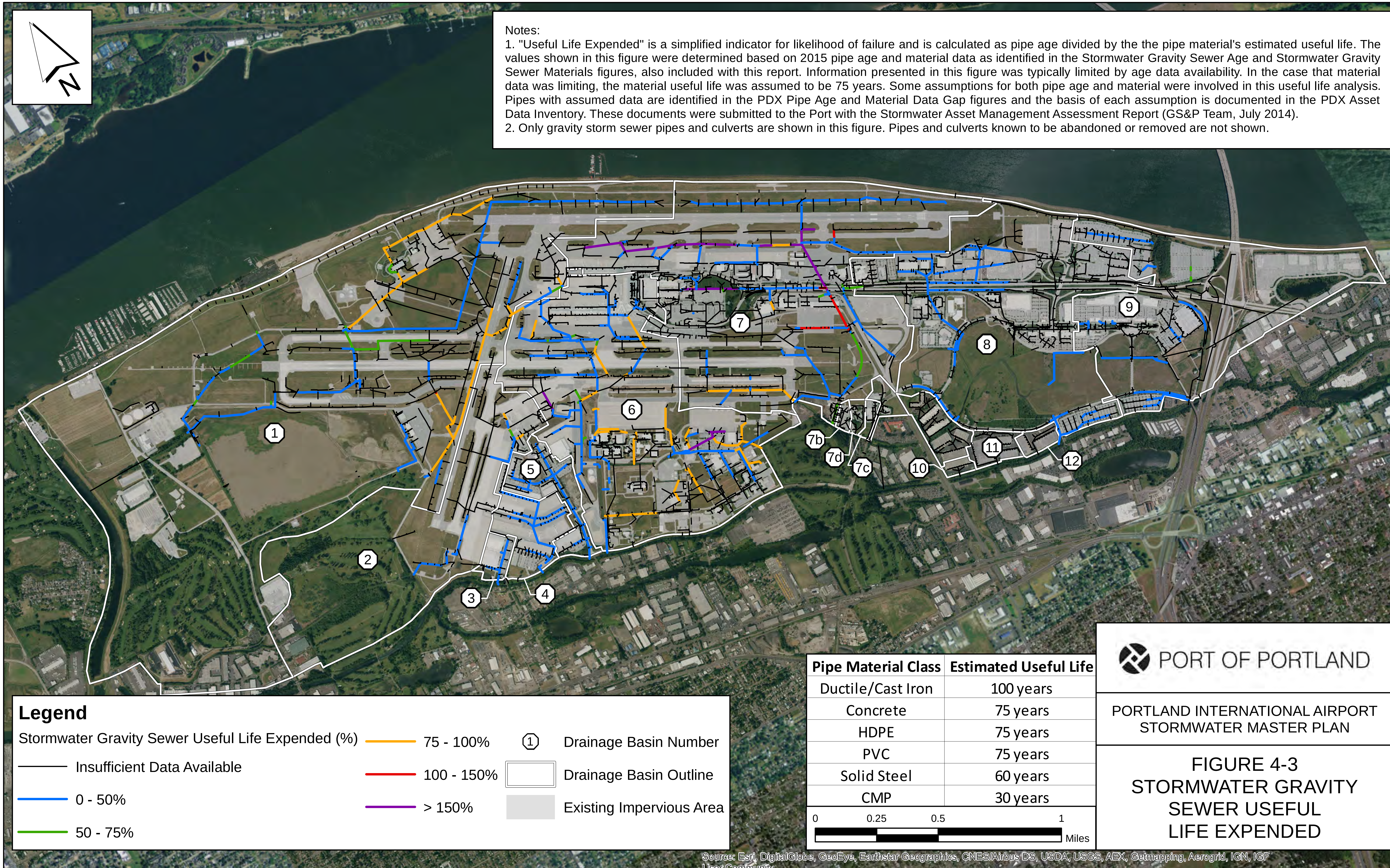

Legend
Project Nature
New Development / Redevelopment
Pavement Rehabilitation
No Disturbance to Impervious Area
Drainage Basin Outline
Development Planned to Occur After 2035
0
0.25
0.5
1
Miles
PORT OF PORTLAND
PORTLAND INTERNATIONAL AIRPORT
STORMWATER MASTER PLAN
FIGURE 4-1
PDX FUTURE
DEVELOPMENT PROJECTS
Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, GIS User Community



Notes:

1. This figure displays ponding areas at PDX that were characterized through stormwater hydraulic modeling and prioritized as stormwater management (SWM) needs. This figure is not comprehensive of all potential ponding at PDX, as it excludes modeled ponding areas that were not prioritized as needs, as well as potential ponding that may be driven by factors not reflected in the modeling (e.g. local grading inconsistencies).
2. Ponding elevations were derived from stormwater hydraulic model results for future conditions (2035 planning horizon), and translated into ponding extents based on 2005 LiDAR 2-foot contours, supplemented by Port survey data in select locations. Extents may need to be revisited if more detailed topographic data becomes available.

FIGURE 4-2
SWM NEED LOCATIONS: ADDRESS PONDING AND FACILITATE DRAINAGE



Notes:

1. "Useful Life Expended" is a simplified indicator for likelihood of failure and is calculated as pipe age divided by the the pipe material's estimated useful life. The values shown in this figure were determined based on 2015 pipe age and material data as identified in the Stormwater Gravity Sewer Age and Stormwater Gravity Sewer Materials figures, also included with this report. Information presented in this figure was typically limited by age data availability. In the case that material data was limiting, the material useful life was assumed to be 75 years. Some assumptions for both pipe age and material were involved in this useful life analysis. Pipes with assumed data are identified in the PDX Pipe Age and Material Data Gap figures and the basis of each assumption is documented in the PDX Asset Data Inventory. These documents were submitted to the Port with the Stormwater Asset Management Assessment Report (GS&P Team, July 2014).
2. Only gravity storm sewer pipes and culverts are shown in this figure. Pipes and culverts known to be abandoned or removed are not shown.

Legend

Stormwater Gravity Sewer Useful Life Expended (%)

- Insufficient Data Available
- 0 - 50%
- 50 - 75%
- 75 - 100%
- 100 - 150%
- > 150%
- ① Drainage Basin Number
- Drainage Basin Outline
- Existing Impervious Area

Pipe Material Class	Estimated Useful Life
Ductile/Cast Iron	100 years
Concrete	75 years
HDPE	75 years
PVC	75 years
Solid Steel	60 years
CMP	30 years

0 0.25 0.5 1 Miles

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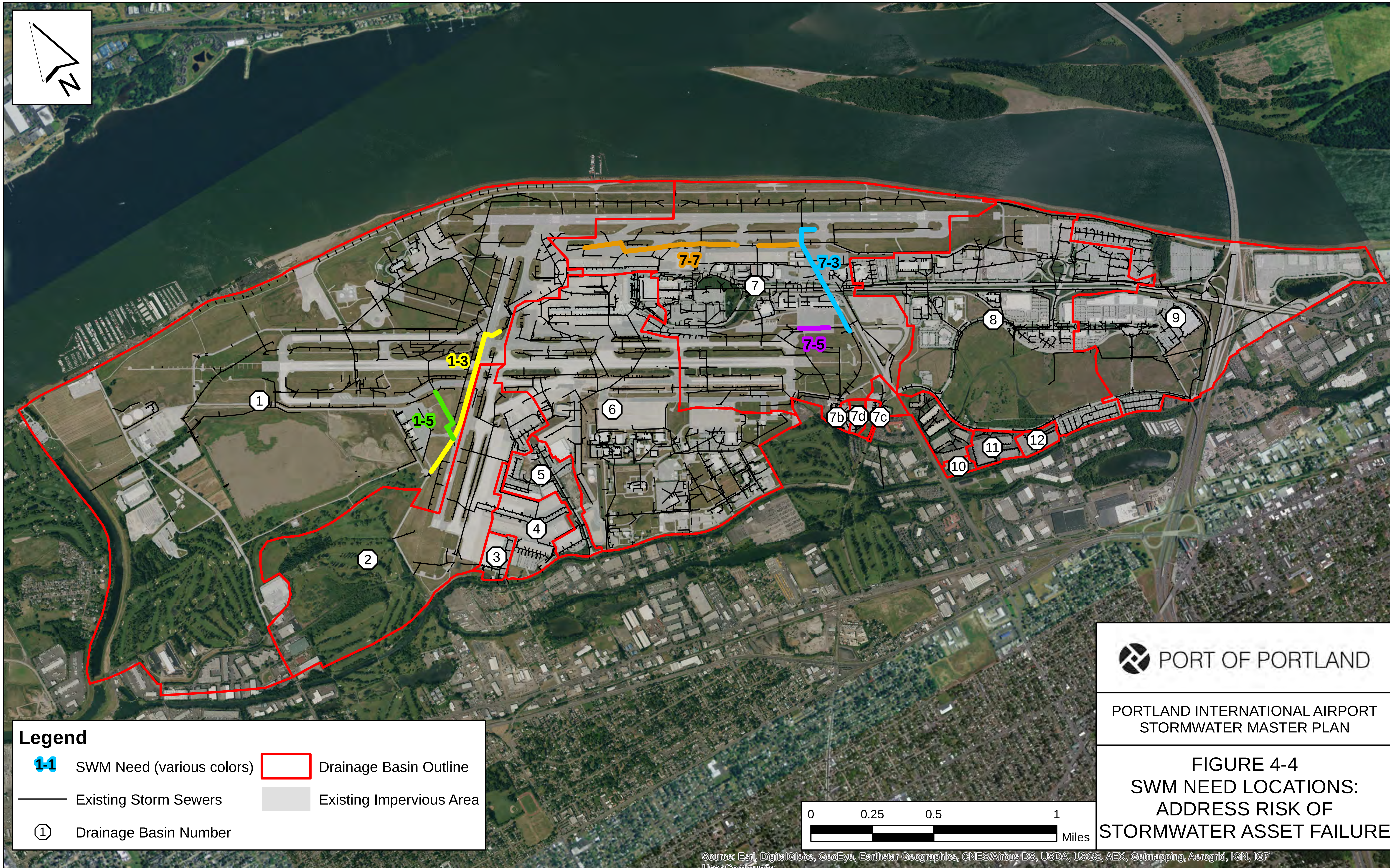
PORTLAND INTERNATIONAL AIRPORT
STORMWATER MASTER PLAN

FIGURE 4-3
STORMWATER GRAVITY
SEWER USEFUL
LIFE EXPENDED

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community



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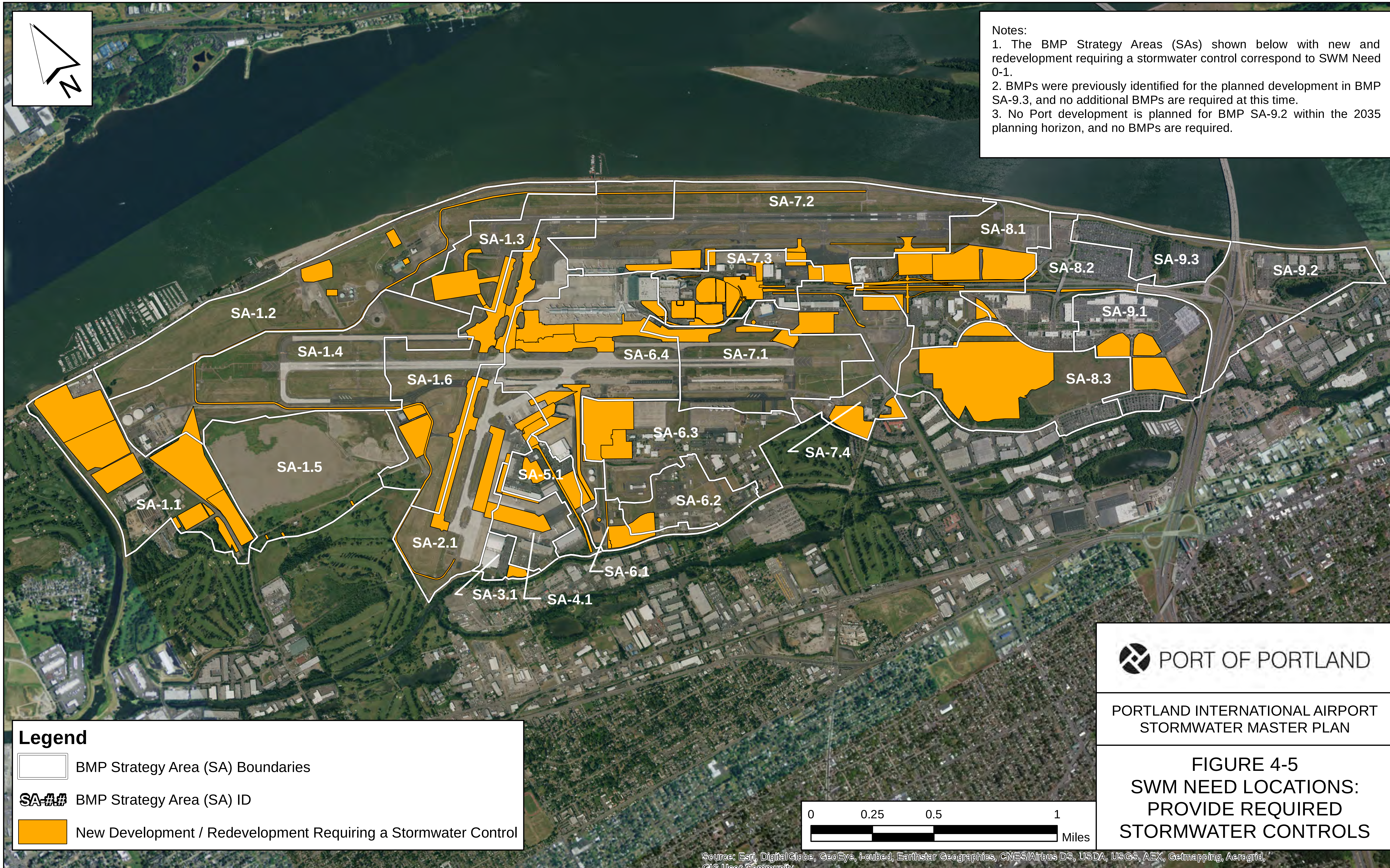
STORMWATER MASTER PLAN

FIGURE 4-4
SWM NEED LOCATIONS:
ADDRESS RISK OF
STORMWATER ASSET FAILURE



Notes:
1. The BMP Strategy Areas (SAs) shown below with new and redevelopment requiring a stormwater control correspond to SWM Need 0-1.
2. BMPs were previously identified for the planned development in BMP SA-9.3, and no additional BMPs are required at this time.
3. No Port development is planned for BMP SA-9.2 within the 2035 planning horizon, and no BMPs are required.

Legend

BMP Strategy Area (SA) Boundaries

SA-#.# BMP Strategy Area (SA) ID

New Development / Redevelopment Requiring a Stormwater Control

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STORMWATER MASTER PLAN

FIGURE 4-5
SWM NEED LOCATIONS:
PROVIDE REQUIRED
STORMWATER CONTROLS

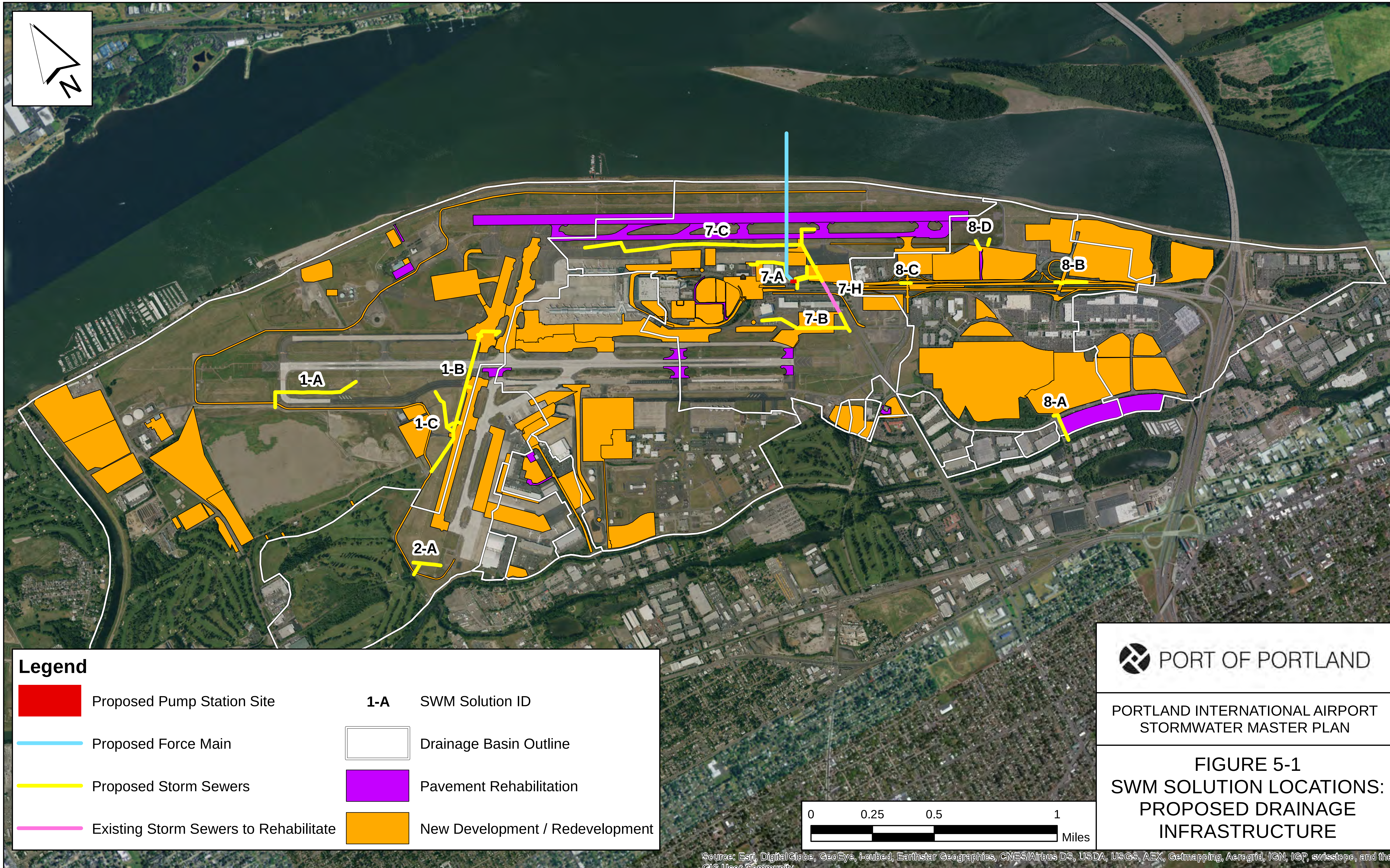
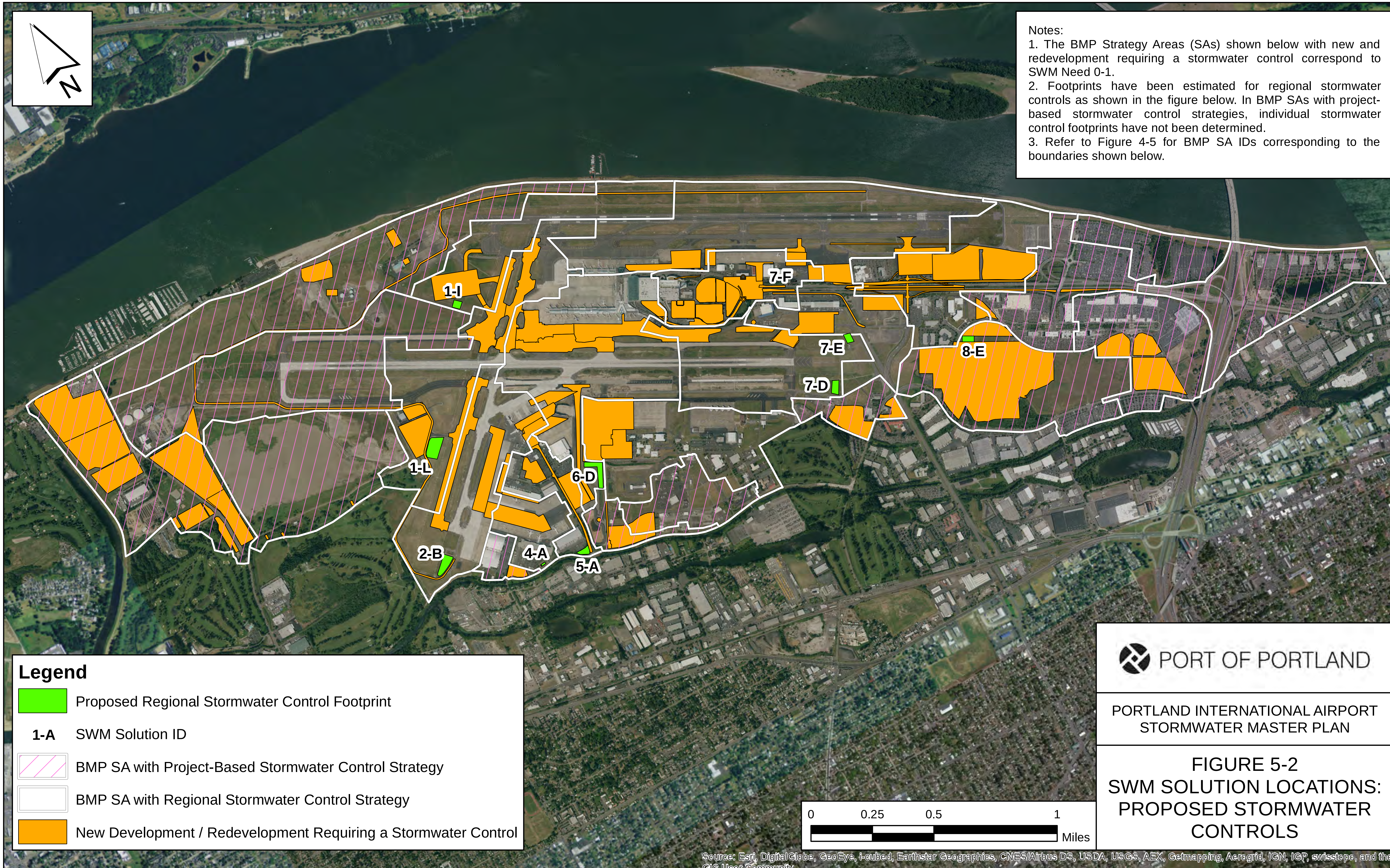


FIGURE 5-1
SWM SOLUTION LOCATIONS:
PROPOSED DRAINAGE
INFRASTRUCTURE



Notes:
1. The BMP Strategy Areas (SAs) shown below with new and redevelopment requiring a stormwater control correspond to SWM Need 0-1.
2. Footprints have been estimated for regional stormwater controls as shown in the figure below. In BMP SAs with project-based stormwater control strategies, individual stormwater control footprints have not been determined.
3. Refer to Figure 4-5 for BMP SA IDs corresponding to the boundaries shown below.

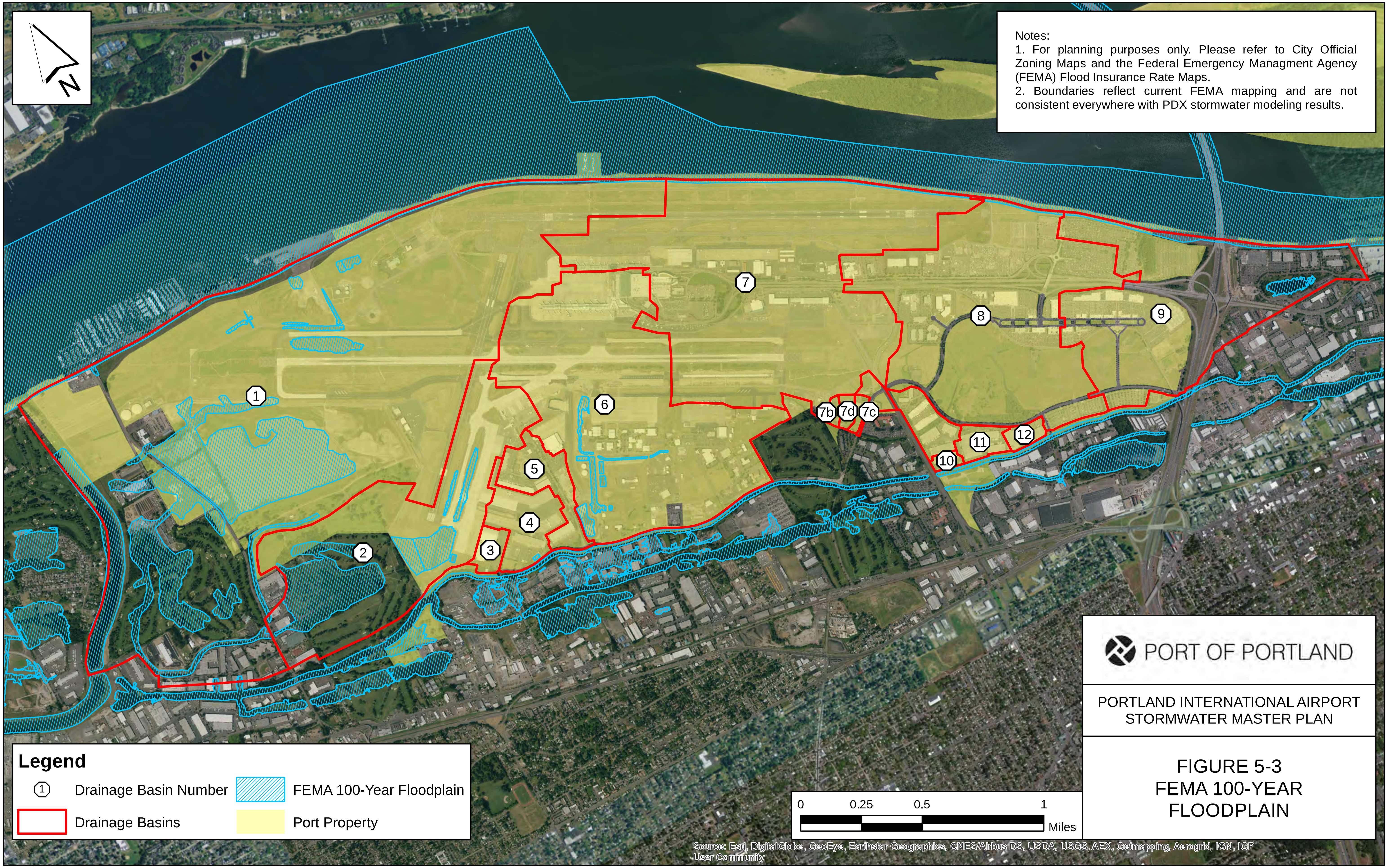
Legend

- Proposed Regional Stormwater Control Footprint
- **1-A** SWM Solution ID
- BMP SA with Project-Based Stormwater Control Strategy
- BMP SA with Regional Stormwater Control Strategy
- New Development / Redevelopment Requiring a Stormwater Control

PORT OF PORTLAND

PORTLAND INTERNATIONAL AIRPORT
STORMWATER MASTER PLAN

FIGURE 5-2
SWM SOLUTION LOCATIONS: PROPOSED STORMWATER CONTROLS



Notes:
1. For planning purposes only. Please refer to City Official Zoning Maps and the Federal Emergency Managment Agency (FEMA) Flood Insurance Rate Maps.
2. Boundaries reflect current FEMA mapping and are not consistent everywhere with PDX stormwater modeling results.
N
1
2
3
4
5
6
7
7b
7d
7c
8
9
10
11
12
Legend
Drainage Basin Number
Drainage Basins
FEMA 100-Year Floodplain
Port Property
0
0.25
0.5
1
Miles
PORT OF PORTLAND
PORTLAND INTERNATIONAL AIRPORT
STORMWATER MASTER PLAN
FIGURE 5-3
FEMA 100-YEAR
FLOODPLAIN
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP
User Community

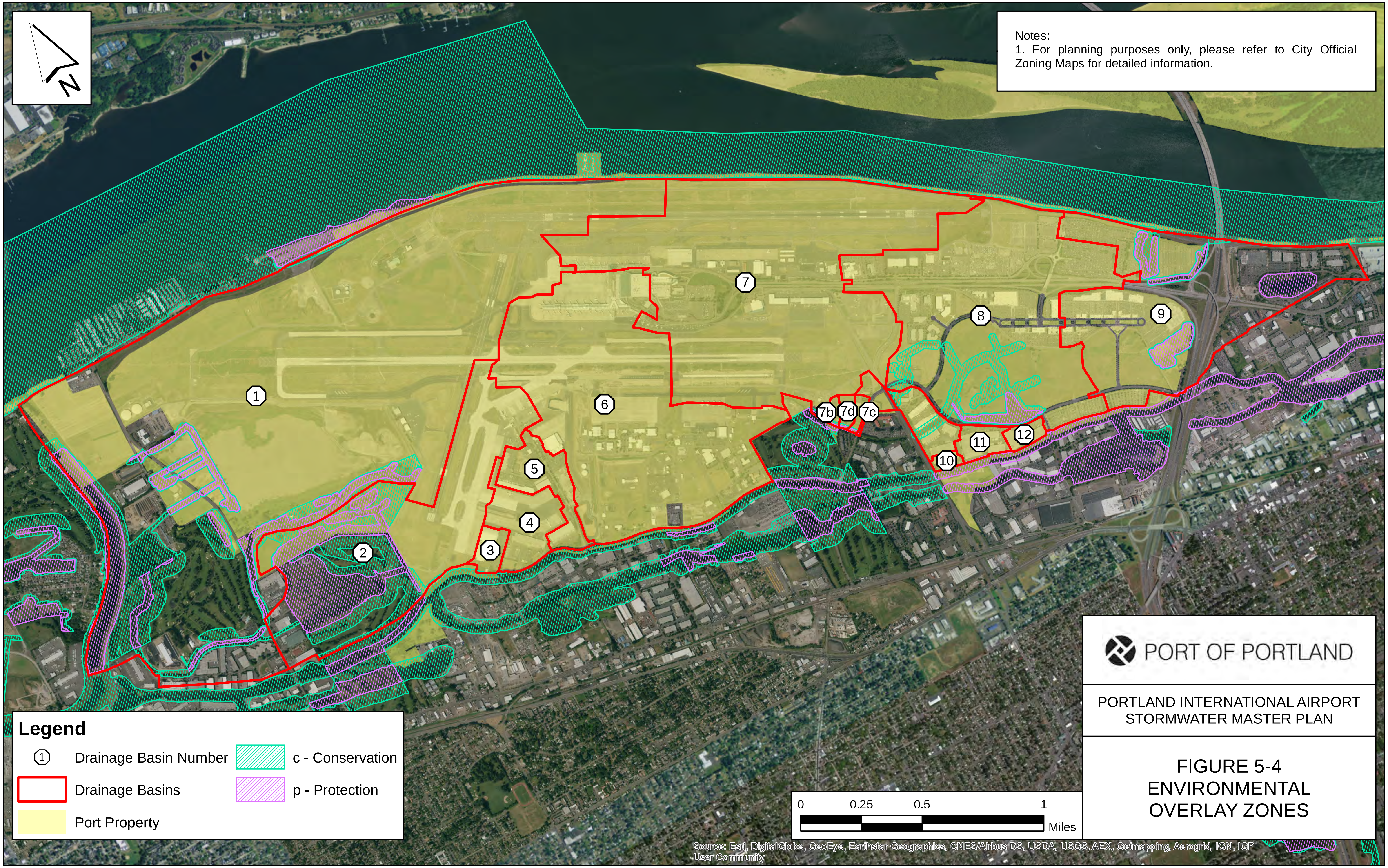


FIGURE 5-4
ENVIRONMENTAL
OVERLAY ZONES

STORMWATER MANAGEMENT FACT SHEETS

AIRPORT-WIDE STORMWATER MANAGEMENT FACT SHEETS

AIRPORT-WIDE STORMWATER MANAGEMENT FACT SHEETS

As described in Section 4, stormwater control requirements for new development and redevelopment are widespread at PDX, based on the Port's identification of future development projects through the 2035 planning horizon. Figure 4-5 illustrates that there are development projects requiring stormwater controls in each of the nine major drainage basins at PDX. For simplicity, a single fact sheet (SWM Need Fact Sheet 0-1) has been developed to describe the need to address airport-wide requirements for post-construction stormwater controls, as described in Table 8. This fact sheet describes regulatory drivers for stormwater controls, the consequences of not mitigating the need, the water quality treatment criteria, and recommendations to further characterize the need for stormwater controls.

Individual solution fact sheets have been developed to describe stormwater control recommendations for each of the applicable BMP Strategy Areas in Basins 1-9. Those fact sheets are provided in upcoming sections pertaining to drainage basin-specific SWM needs and solutions. It is recommended that SWM Need Fact Sheet 0-1 (immediately following the tables) be referenced in conjunction with each of the individual stormwater control solution fact sheets.

Table 8 – Airport-Wide SWM Needs

SWM Need ID	Issue Type	Need Description	Corresponding SWM Solution ID
0-1	Stormwater Controls	Address Requirement for Post-Construction Stormwater Pollutant and Runoff Control	• **Basin 1**: 1-G, 1-H, 1-**I**, 1-J, 1-K, 1-L, • **Basin 2:** 2-B, • **Basins 3-5:** 3-A, 4-A, 5-A, • **Basin 6:** 6-A, 6-B, 6-C, 6-D, • **Basin 7:** 7-D, 7-E, 7-F, 7-G, • **Basin 8:** 8-E, 8-F, 8-G, • **Basin 9:** 9-B

SWM NEED FACT SHEET 0-1

Stormwater Management Need Tracking Information

SWM Need ID	Need Name	Issue Type	Author	Revision Date
0-1	Address Requirement for Post-Construction Stormwater Pollutant and Runoff Control	Required Stormwater Controls	GS&P and Geosyntec	June 2015

Stormwater Management Solutions Identified to Address Need

SWM Solution ID	Solution Name	Solution Type		
		New or Modified Infrastructure	Operational Change	Future Planning Considerations
1-G	Water Quality Planning Recommendations for BMP Strategy Area (BMP SA)-1.1			X
1-H	Water Quality Planning Recommendations for BMP Strategy Area (BMP SA)-1.2			X
1-I	Provide Regional Water Quality Treatment for BMP Strategy Area (BMP SA)-1.3	X		
1-J	Water Quality Planning Recommendations for BMP Strategy Area (BMP SA)-1.4			X
1-K	Water Quality Planning Recommendations for BMP Strategy Area (BMP SA)-1.5			X
1-L	Provide Regional Water Quality Treatment for BMP Strategy Area (BMP SA)-1.6	X		
2-B	Provide Regional Water Quality Treatment for BMP Strategy Area (BMP SA)-2.1	X		
3-A	Water Quality Planning Recommendations for BMP Strategy Area (BMP SA)-3.1			X

SWM Solution ID	Solution Name	Solution Type		
		New or Modified Infrastructure	Operational Change	Future Planning Considerations
4-A	Provide Regional Water Quality Treatment for BMP Strategy Area (BMP SA)-4.1	X		
5-A	Provide Regional Water Quality Treatment for BMP Strategy Area (BMP SA)-5.1	X		
6-A	Water Quality Planning Recommendations for BMP Strategy Area (BMP SA)-6.1			X
6-B	Water Quality Planning Recommendations for BMP Strategy Area (BMP SA)-6.2			X
6-C	Water Quality Planning Recommendations for BMP Strategy Area (BMP SA)-6.3			X
6-D	Provide Regional Water Quality Treatment for BMP Strategy Area (BMP SA)-6.4	X		
7-D	Provide Regional Water Quality Treatment for BMP Strategy Area (BMP SA)-7.1	X		
7-E	Provide Regional Water Quality Treatment for BMP Strategy Area (BMP SA)-7.2	X		
7-F	Provide Regional Water Quality Treatment for BMP Strategy Area (BMP SA)-7.3	X		
7-G	Water Quality Planning Recommendations for BMP Strategy Area (BMP SA)-7.4			X
8-E	Provide Regional Water Quality Treatment for BMP Strategy Area (BMP SA)-8.1	X		
8-F	Water Quality Planning Recommendations for BMP Strategy Area (BMP SA)-8.2			X

SWM Solution ID	Solution Name	Solution Type		
		New or Modified Infrastructure	Operational Change	Future Planning Considerations
8-G	Water Quality Planning Recommendations for BMP Strategy Area (BMP SA)-8.3			X
9-B	Water Quality Planning Recommendations for BMP Strategy Area (BMP SA)-9.1			X

Issue Characterization

Issue Type	Issue Description
Required Stormwater Controls	The Port has established runoff control standards for controlling the quality and quantity of post-construction stormwater runoff from applicable development and redevelopment projects at PDX. These standards drive the SWM need for BMPs to be incorporated into the stormwater management design.

Factors Potentially Contributing to Issue

Factor	Characterization Basis
Port development or redevelopment projects involving new pavement construction or reconstruction	Using the Port's list of future development projects[1], the amount of new and reconstructed impervious area was calculated as the design basis for stormwater controls needed within each of the PDX drainage subbasins named BMP Strategy Areas (BMP SAs).

Notes:
1. Refer to Appendix A of the Stormwater Master Plan for the Port's list of future development projects.

Recommendations to Further Characterize Issue and Define Need

The following are actions recommended for further characterizing the issue before designing and implementing the identified solution(s).

Action	Description
Coordination with Outside Agencies	Confirm if NMFS criteria are to be addressed by BMPs, where applicable.
Additional Technical Analysis	Determine the extent of impervious area created or disturbed by the development project(s) to confirm or recalculate the design basis of the stormwater controls.[1]

Notes:
1. Refer to Figure 4-5 of the Stormwater Master Plan for an illustration of the planned development and redevelopment projects which create the SWM need for stormwater controls at PDX.

Regulatory Drivers for Stormwater Management Need

Driver	Description
MS4 Permit	The Port's MS4 Permit has a requirement that the Port develop and implement the Port of Portland Stormwater Design Standards Manual (DSM) which establishes the post-construction water quality control criteria.

Consequence of Not Mitigating Stormwater Management Need

Item	Description
Planning and Development	BMPs are a regulatory requirement of the MS4 Permit. The Port may be considered in non-compliance if a plan and schedule for BMP implementation for new and redevelopment is not acted upon. Without proper planning, potential difficulties and inefficiencies may occur while attempting to implement BMPs for future development and redevelopment projects. For example, adequate area may not be available for the planned development as well as the required stormwater BMP. Additional costs may also be incurred to overcome issues caused by lack of planning (e.g., a higher cost BMP or additional stormwater infrastructure is required).

Criteria to be Addressed by Stormwater Management Solutions

Item	Description
Flooding of Existing / Future Pavement	Not applicable.
Flooding of Existing / Future Buildings	Not applicable.
Ponding in Unpaved Areas Identified as Critical for Ponding Reduction	Not applicable.
Asset Management Criteria	Not applicable.
Water Quality Treatment Criteria	The DSM requires development or redevelopment projects that create or disturb 500 square feet or more of impervious surface to capture and treat 80% of the annual runoff volume. The DSM prescribes design requirements for stormwater controls to meet the treatment standard (e.g., sizing criteria and acceptable BMP design criteria) which are used in each stormwater management solution addressing this SWM need.

BASIN 1 STORMWATER MANAGEMENT FACT SHEETS

BASIN 1 STORMWATER MANAGEMENT FACT SHEETS

Basin 1 has a variety of SWM needs associated with ponding, asset management, and water quality treatment requirement issues. SWM needs in Basin 1 are summarized in Table 9 below, and SWM solutions proposed to address these needs are described in Table 10. Both tables indicate how the SWM solutions align with each SWM need, and vice versa. Basin 1 SWM need and solution fact sheets immediately follow the tables.

Ponding needs are derived from potential impacts to operations, future development, and hazardous wildlife attractants. The ponding needs are generally associated with undersized drainage infrastructure and standing water in the channels upstream of and including MCDD Pump Station #2. Three of the Basin 1 SWM solutions address multiple needs. The effectiveness, concepts, and costs of Solutions 1-A and 1-B are dependent upon the implementation of Solution 1-C which alleviates capacity constraints (and addressing asset useful life issues) in the storm sewer trunk line from Basin 1 running parallel with Runway 3-21. The Basin 1 water quality BMPs include a regional BMP treatment unit and distributed BMP units tied to specific developments.

Several of the Basin 1 SWM solutions have potential for impacts to the deicing system that required further evaluation. Findings from evaluations show that neither the capital solutions nor the operational solution would require changes to the deicing system infrastructure or increase the likelihood of non-compliance with the deicing NPDES permit. Several of the solutions will have relatively minor impacts on O&M requirements for the deicing system. Operating PS-N full time does increase the amount of time that DST-2 is used compared to present conditions.

Table 9 – Basin 1 SWM Needs

SWM Need ID	Issue Type	Need Description	Corresponding SWM Solution ID
0-1	Stormwater Controls	Address Requirement for Post-Construction Stormwater Pollutant and Runoff Control	1-G, 1-H, 1-I, 1-J, 1-K, 1-L
1-1	Ponding	Address Ponding in Basin 1 North Infield Areas of South Runway (10R-28L)	1-A, 1-F
1-2	Ponding	Address Ponding West of Terminal Along Taxiway T	1-B
1-3	Asset Management	Address Risk of Asset Failure for Basin 1 South Trunk Line	1-B
1-4	Ponding	Address Ponding in Basin 1 South Infield Areas of South Runway (10R-28L)	1-C
1-5	Asset Management	Address Risk of Asset Failure for Pipe Serving South Runway (10R-28L) in Basin 1 South	1-C
1-6	Ponding	Address Ponding in Wetland North of Deicing Treatment Facility	1-D
1-7	Ponding	Address Ponding in Planned Development Area West of NE 33rd Drive	1-D
1-8	Ponding	Address Ponding Along MCDD Channels in Southwest Quad and Fazio Fields	1-E

Table 10 – Basin 1 SWM Solutions

SWM Solution ID	Solution Type	Solution Description	Corresponding SWM Need ID
1-A	New or Modified Infrastructure	Replace Portion of Basin 1 North Trunk Line	1-1
1-B	New or Modified Infrastructure	Replace Portion of Basin 1 South Trunk Line	1-2, 1-3
1-C	New or Modified Infrastructure	Replace Pipe Serving South Runway (10R-28L) in Basin 1 South	1-4, 1-5
1-D	Future Planning Considerations	Drainage Planning Recommendations for NE 33rd Drive Development	1-6, 1-7
1-E	Future Planning Considerations	Drainage Planning Recommendations for Southwest Quad and Fazio Fields	1-8
1-F	Operational Change	Operate PS-N Continuously	1-1
1-G	Future Planning Considerations	Water Quality Planning Recommendations for BMP Strategy Area (BMP SA)-1.1	0-1
1-H	Future Planning Considerations	Water Quality Planning Recommendations for BMP Strategy Area (BMP SA)-1.2	0-1
1-I	New or Modified Infrastructure	Provide Regional Water Quality Treatment for BMP Strategy Area (BMP SA)-1.3	0-1
1-J	Future Planning Considerations	Water Quality Planning Recommendations for BMP Strategy Area (BMP SA)-1.4	0-1
1-K	Future Planning Considerations	Water Quality Planning Recommendations for BMP Strategy Area (BMP SA)-1.5	0-1
1-L	New or Modified Infrastructure	Provide Regional Water Quality Treatment for BMP Strategy Area (BMP SA)-1.6	0-1

SWM NEED FACT SHEET 1-1

Stormwater Management Need Tracking Information

SWM Need ID	Need Name	Issue Type	Author	Revision Date
1-1	Address Ponding in Basin 1 North Infield Areas of South Runway (10R-28L)	Ponding	GS&P	June 2015

Stormwater Management Solutions Identified to Address Need

SWM Solution ID	Solution Name	Solution Type		
		New or Modified Infrastructure	Operational Change	Future Planning Considerations
1-A[1]	Replace Portion of Basin 1 North Trunk Line	X		
1-F[1]	Operate PS-N Continuously		X	

Notes:

1. Both SWM Solution 1-A and SWM Solution 1-F are needed to address SWM Need 1-1.

Issue Characterization

Issue Type	Issue Description
Ponding	Ponding has been observed by Port Natural Resources staff in the grassy infield area south of South Runway (10R-28L). The observations were verified by stormwater hydraulic modeling of the Basin 1 North drainage system for the 10-year, 24-hour storm event, and the model additionally indicated ponding in the infield north of the runway during the 10-year event. See Figure 1 for the simulated ponding extents during both the 10-year and 100-year, 24-hour storm events under future (2035) development conditions. The ponding creates risks for operations and hazardous wildlife attraction that the Port wants to mitigate.

Factors Potentially Contributing to Issue

Factor	Characterization Basis
Insufficient Drainage System Capacity	Assessments using the PDX stormwater hydraulic model indicate that ponding during the 10-year and 100-year storm events is created by insufficient flow and storage capacity in the Basin 1 North storm sewer trunk line.
Potential Seasonal Variation in the Groundwater Table	Field observations of ponding suggest that a seasonally high groundwater table could contribute to ponding in this area.

Recommendations to Further Characterize Issue and Define Need

The following are actions recommended for further characterizing the issue before designing and implementing the identified solution(s).

Action	Description
Groundwater Analysis	A field study is recommended to characterize depth to groundwater and potential influence of groundwater on ponding. Seasonal and spatial variations in depth to groundwater should be characterized as part of this study.
Additional Technical Analysis	Based on the results of the groundwater analysis, changes to the Port's stormwater hydraulic model are recommended to update infiltration and hydrologic assumptions, update the extent of ponding, and confirm sizing of the corresponding solution.
Surveying / Field Data Collection	Metro is in the process of producing higher resolution LiDAR. A review of the Metro LiDAR is recommended after this data becomes available to better define the extents of ponding and confirm if ponding extends onto access roads.

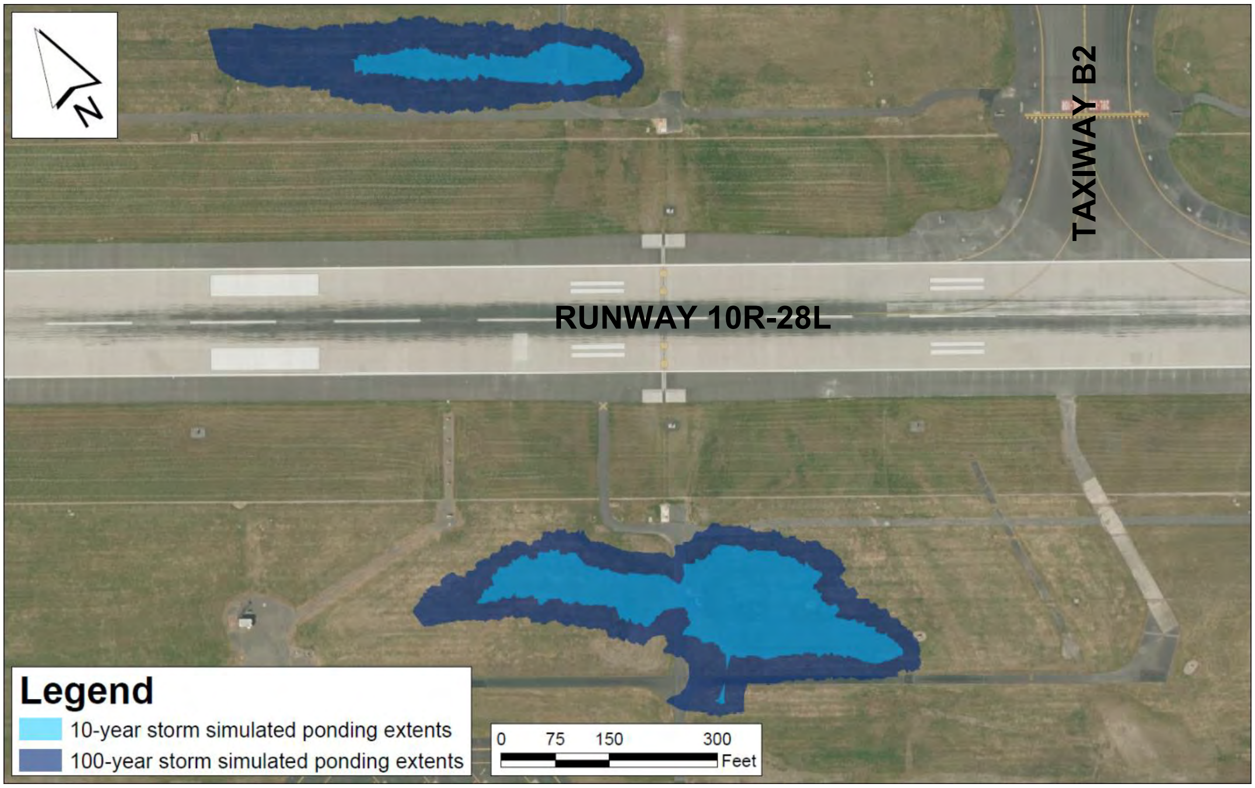


Figure 1: Plan View of Need

Regulatory Drivers for Stormwater Management Need

Driver	Description
FAA Hazardous Wildlife Attractant Criteria (FAA AC 150/5200-33)	Due to its proximity to the runway, ponding at this location may attract wildlife into the runway's approach or departure airspace or into the Air Operations Area (AOA). According to FAA AC 150/5200-33, this poses a potential wildlife strike risk to aircraft.
FAA Airport Drainage Design Criteria (FAA AC 150/5320-5)	Ponding is likely to occur on access roads between Taxiways B and C west during 10-year and 100-year storm events. According to FAA AC 150/5320-5, "the objective of storm drainage design is to provide for safe passage of vehicles or operation of the facility during the design storm event." Therefore, the need to address ponding on the access roads is driven by a regulatory need to provide for safe vehicle passage.

Consequence of Not Mitigating Stormwater Management Need

Item	Description
Operations	Ponding may limit use of wildlife access roads and the glide slope access road between Taxiways B and C west during the 10-year storm event. Ponding onto the access roads may compromise the safety of airport operational vehicles traveling along the access roads during storm events. The ponding may result in damage to passing vehicles or may interfere with airport operations because vehicles are required to travel via alternate routes.
Wildlife Hazard Management	Standing water near Runway 10R-28L poses an increased risk of hazardous wildlife attraction and for wildlife strikes.

Criteria to be Addressed by Stormwater Management Solutions

Item	Description
Flooding of Existing/Future Pavement	Eliminate ponding onto the access road during the 10-year storm.
Flooding of Existing/Future Buildings	Not applicable.
Ponding in Unpaved Areas Identified as Critical for Ponding Reduction	Reduce the 10-year storm peak ponding elevation to the lowest known ground elevation.
Asset Management Criteria	Not applicable.
Water Quality Treatment Criteria	Not applicable.

SWM NEED FACT SHEET 1-2

Stormwater Management Need Tracking Information

SWM Need ID	Need Name	Issue Type	Author	Revision Date
1-2	Address Ponding West of Terminal Along Taxiway T	Ponding	GS&P	June 2015

Stormwater Management Solutions Identified to Address Need

SWM Solution ID	Solution Name	Solution Type		
		New or Modified Infrastructure	Operational Change	Future Planning Considerations
1-B	Replace Portion of Basin 1 South Trunk Line	X		

Issue Characterization

Issue Type	Issue Description
Ponding	Ponding has been observed by Port staff west of the terminal concourses. Under future (2035) development conditions, stormwater hydraulic modeling simulations indicate that the ponding extends to Taxiway E2 and beyond the Taxiway T centerline during both the 10-year and 100-year, 24-hour storm events, as shown on Figure 1. The ponding creates risks for operations and hazardous wildlife attraction that the Port wants to mitigate.

Factors Potentially Contributing to Issue

Factor	Characterization Basis
Insufficient Drainage System Capacity	Assessments using the PDX stormwater hydraulic model indicate that ponding during the 10-year and 100-year storm events is created by insufficient flow and storage capacity in the Basin 1 South trunk line.

Recommendations to Further Characterize Issue and Define Need

The following are actions recommended for further characterizing the issue before designing and implementing the identified solution(s).

Action	Description
Groundwater Analysis	A field study is recommended to characterize depth to groundwater and potential influence of groundwater on ponding. Seasonal and spatial variations in depth to groundwater should be characterized as part of this study.
Additional Technical Analysis	Based on the results of the groundwater analysis, changes to the Port's stormwater hydraulic model are recommended to update infiltration and hydrologic assumptions, update the extent of ponding, and confirm sizing of the corresponding solution.

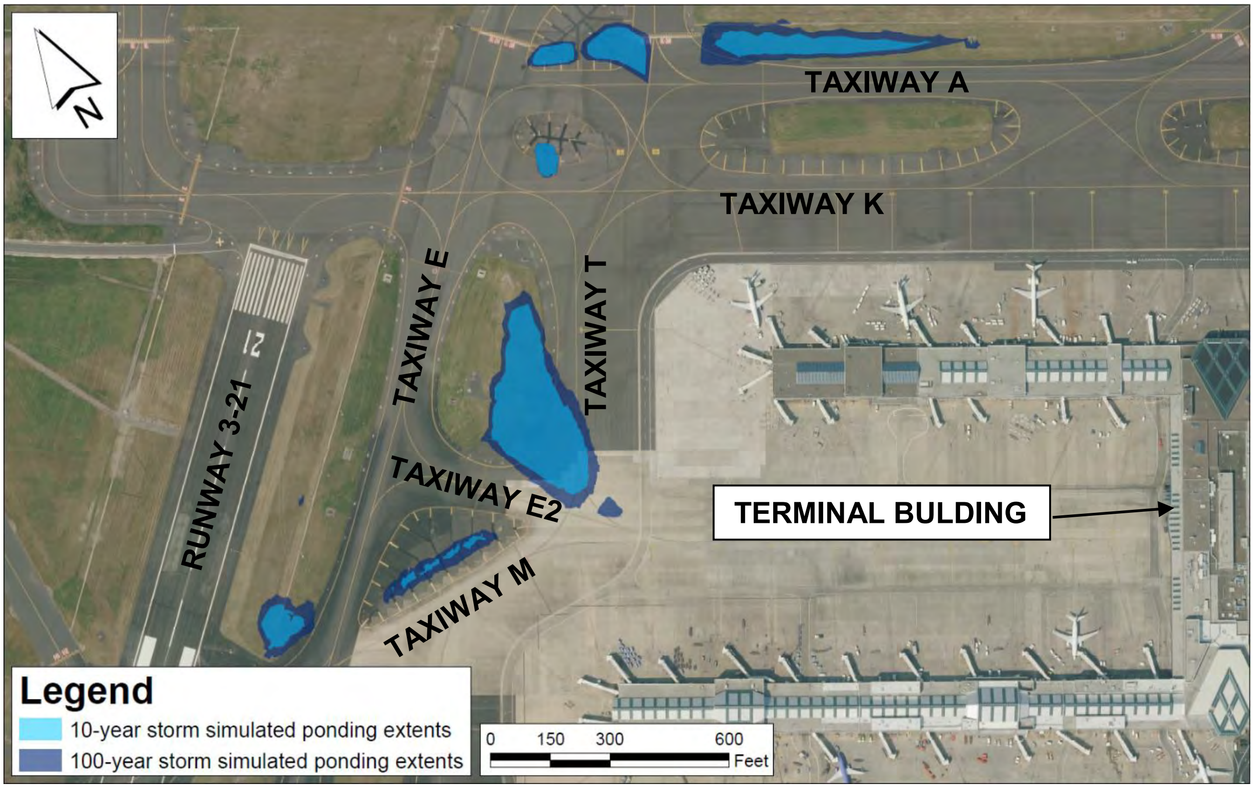


Figure 1: Plan View of Need

Regulatory Drivers for Stormwater Management Need

Driver	Description
FAA Hazardous Wildlife Attractant Criteria (FAA AC 150/5200-33)	Ponding at this location within the central area of the airfield increases the risk of attracting wildlife across the approach or departure airspace or into the Air Operations Area (AOA) of all three of the runways. According to FAA AC 150/5200-33, this poses a wildlife strike risk to aircraft.
FAA Airport Design Criteria (FAA AC 150/5300-13)	Ponding extends into the Runway 3-21 Runway Safety Area (RSA) for the 10-year, 24-hour storm event and potentially for more frequent events. This ponding presents an operational and safety need for improved drainage. According to FAA AC 150/5300-13, the RSA must be “drained by grading or storm sewers to prevent water accumulation.” Additionally, the RSA must be “capable, under dry conditions, of supporting snow removal equipment, Aircraft Rescue and Fire Fighting (ARFF) equipment, and the occasional passage of aircraft without causing damage to the aircraft.”
FAA Airport Drainage Design Criteria (FAA AC 150/5320-5)	Ponding extends over the Taxiway T centerline for the 10-year, 24-hour storm event and potentially for more frequent events, which can impede operations. According to the FAA AC 150/5320-5, the center 50% of taxiways must remain free from ponding. Additionally, the airport drainage system must “provide for safe passage of vehicles or operation of the facility.”

Consequence of Not Mitigating Stormwater Management Need

Item	Description
Operations	Ponding along Taxiway T could prevent safe passage of aircraft traffic around the terminal and hinder airport operations during the 10-year storm event. Additionally, saturated soil conditions in the Runway 3-21 and 10L-28R RSAs pose a risk to aircraft safety in the event of an excursion from the runway.
Wildlife Hazard Management	Standing water on the airfield poses an increased risk of hazardous wildlife attraction and for wildlife strikes.

Criteria to be Addressed by Stormwater Management Solutions

Item	Description
Flooding of Existing/Future Pavement	Eliminate ponding onto Taxiway T during the 10-year storm.
Flooding of Existing/Future Buildings	Not applicable.
Ponding in Unpaved Areas Identified as Critical for Ponding Reduction	Reduce the 10-year storm peak ponding elevation to the lowest known ground elevation.
Asset Management Criteria	Not applicable.
Water Quality Treatment Criteria	Not applicable.

SWM NEED FACT SHEET 1-3

Stormwater Management Need Tracking Information

SWM Need ID	Need Name	Issue Type	Author	Revision Date
1-3	Address Risk of Asset Failure for Basin 1 South Trunk Line	Asset Management	GS&P	June 2015

Stormwater Management Solutions Identified to Address Need

SWM Solution ID	Solution Name	Solution Type		
		New or Modified Infrastructure	Operational Change	Future Planning Considerations
1-B	Replace Portion of Basin 1 South Trunk Line	X		

Issue Characterization

Issue Type	Issue Description
Asset Management	The concrete pipes in the Basin 1 South trunk line (shown in orange in Figure 1) were constructed in 1941 and are among the oldest active storm sewers at PDX. Based on a useful life of 75 years that is typical for this pipe material,[1] the Basin 1 South trunk line has expended approximately 99% of its useful life as of the year 2015.The high percentage of useful life expended for these pipes creates a high risk of failure.

Notes:

1. The basis of this assumption is described in Appendix B of the *Port Stormwater Asset Management Assessment Report*, GS&P Team, July 2014.

Factors Potentially Contributing to Issue

Factor	Characterization Basis
Pipe Age & Material (Useful Life Expended)	Useful life expended is a simplified indicator for likelihood of failure and relies only on industry standards for expected pipe lifespan (based on pipe material) and a pipe's current age. With 99% of its useful life expended, the Basin 1 South trunk line will be more susceptible to deterioration and damage than newer pipes. The actual lifespan of a specific pipe can be affected by a variety of environmental and construction factors, including (but not limited to): • pipe-to-pipe joint design • pipe-to-structure joint design • construction quality • surface land use, including loads applied to the surface by buildings and vehicles • surrounding soil characteristics • groundwater presence and flow outside of the pipe • root growth • geotechnical stability • soil corrosivity • chemical degradation, especially in the presence of standing water containing biodegradable contaminants such as deicing chemicals
Pipe Defects	A majority of this line was video-inspected in 2009 with several defects in the form of pipe sag points observed. The specific defects are coded in the *South Runway Rehabilitation Project: Pipeline Video Reports* (Pacific Int-R-Tek, November 2009). The defect coding system adopted for this pipeline inspection program was not specified as conforming to industry-standard. Additionally, no quantification was made of the likelihood that the observed defects will contribute to pipe failure.

Recommendations to Further Characterize Issue and Define Need

The following are actions recommended for further characterizing the issue before designing and implementing the identified solution(s).

Action	Description
Coding of Inspection Defects	Results of the Basin 1 South trunk line video-inspection from November 2009 should be consolidated with defects coded to an industry-standard to facilitate future comparisons.
Inspections / Condition Assessment	A field inspection of the Basin 1 South trunk line (shown in orange in Figure 1) is recommended to determine if the pipe condition has declined since the November 2009 video-inspection. Defects should be coded with an industry-standard method.

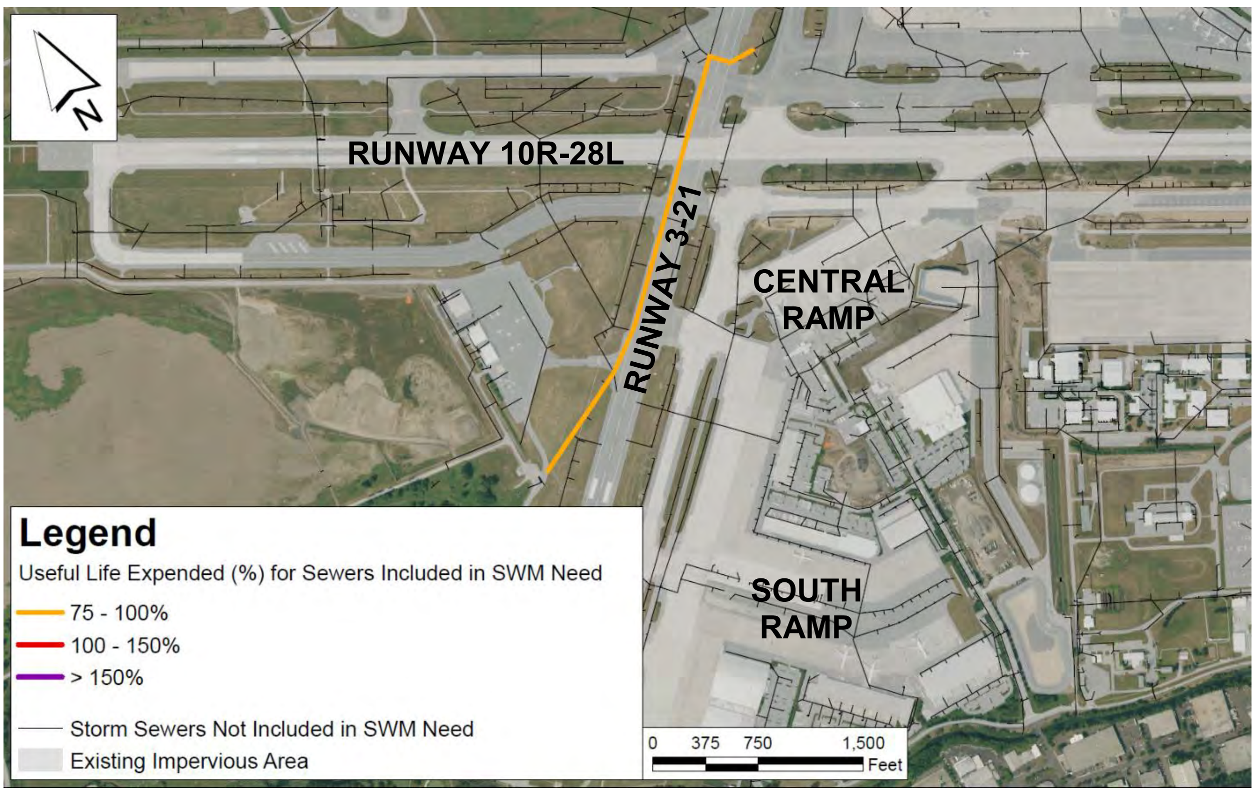


Figure 1: Plan View of Need

Regulatory Drivers for Stormwater Management Need

Driver	Description
FAA Hazardous Wildlife Attractant Criteria (FAA AC 150/5200-33)	If the Basin 1 South trunk line fails, extensive ponding along Runway 3-21 and along the western portion of Runway 10R-28L is certain for large storm events. Ponding at these locations has the potential to pose a hazardous wildlife attractant risk. According to FAA AC 150/5200-33, this poses a wildlife strike risk to aircraft landing on or departing from the PDX runways.
FAA Airport Design and Drainage Design Criteria (FAA ACs 150/5300-13,150/5320-5)	Failure of the Basin 1 South trunk line will create extensive ponding within the runway safety areas (RSAs) for Runways 10R-28L and 3-21. According to FAA AC 150/5300-13, the RSA must be “drained by grading or storm sewers to prevent water accumulation.” Failure of the trunk line would also increase the risk for ponding onto the airfield’s paved surfaces, such as Runway 3-21, Runway 10R-28L, Runway 10L-28R and Taxiways A, B, C, E, G, K, M and T. AC 150/5320-5 requires that airport drainage systems “provide for safe … operation of the facility” and “convey design flows… without surcharging inlets or otherwise causing surface flooding” in particular for runways, taxiways and aircraft aprons during the 5-year FAA drainage design storm. Additionally, the center 50% of runways and taxiways must remain free from ponding during the 10-year storm. Pipe failure has the potential to violate these criteria during smaller, more frequent storm events.

Consequence of Not Mitigating Stormwater Management Need

Item	Description
Operations	In the event of a pipe failure along the Basin 1 South trunk line, drainage from the following operational areas may be severely limited until the failed pipe(s) can be replaced: • Large portions of Runway 3-21 • Western end of Runway 10R-28L • Limited areas along Runway 10L-28R • Taxiway E North • Taxiway M • Portions of Taxiways A, B, C, G, K and T Additionally, the existing Basin 1 South trunk line crosses under Runways 10R-28L and 3-21, and runs along Runway 3-21 for approximately 2,500 feet. Since the foundations of two runways are built on top of the Basin 1 South trunk line, pipe failure along the trunk line may have negative structural impacts on one or both nearby runways.
Wildlife Hazard Management	In the event of a pipe failure along the Basin 1 South trunk line, the drainage system serving approximately 160 acres of the PDX airfield may be compromised, increasing the risk for prolonged ponding on the airfield, particularly in infield areas along Runway 3-21 and near the intersection of Runways 3-21 and 10R-28L. Prolonged ponding on the airfield may pose an increased risk for hazardous wildlife attraction and potential for wildlife strikes.

Criteria to be Addressed by Stormwater Management Solutions

Item	Description
Flooding of Existing/Future Pavement	Not applicable.
Flooding of Existing/Future Buildings	Not applicable.
Ponding in Unpaved Areas Identified as Critical for Ponding Reduction	Not applicable.
Asset Management Criteria	Reduce the likelihood of failure for active storm sewer pipes, focusing on pipes that have expended ≥75% of their estimated useful life and may have a potentially high consequence of failure.
Water Quality Treatment Criteria	Not applicable.

SWM NEED FACT SHEET 1-4

Stormwater Management Need Tracking Information

SWM Need ID	Need Name	Issue Type	Author	Revision Date
1-4	Address Ponding in Basin 1 South Infield Areas of South Runway (10R-28L)	Ponding	GS&P	June 2015

Stormwater Management Solutions Identified to Address Need

SWM Solution ID	Solution Name	Solution Type		
		New or Modified Infrastructure	Operational Change	Future Planning Considerations
1-C	Replace Pipe Serving South Runway (10R-28L) in Basin 1 South	X		

Issue Characterization

Issue Type	Issue Description
Ponding	Ponding has been observed by Port Natural Resources staff in the Runway 10R-28L Safety Area (RSA), just west of Runway 3-21. The ponding observations were verified by stormwater hydraulic modeling of the Basin 1 South drainage system for the 10-year and 100-year, 24-hour storm event. Figure 1 shows the estimated ponding extents north and south of Runway 10R-28L under future (2035) development conditions during both the 10-year and 100-year, 24-hour storm events (note, based upon 2005 LiDAR and is out of date in the location of the wildlife access road). The ponding creates risks for operations and hazardous wildlife attraction that the Port wants to mitigate.

Factors Potentially Contributing to Issue

Factor	Characterization Basis
Insufficient Drainage System Capacity	Assessments using the PDX stormwater hydraulic model indicate that ponding during the 10-year and 100-year storm events is created by insufficient flow and storage capacity in the Basin 1 South storm sewers south of Taxiway C West and in the Basin 1 South trunk line.
Potential Seasonal Variation in the Groundwater Table	Field observations of ponding between storm events suggest that a seasonally high groundwater table could contribute to ponding in this area.

Recommendations to Further Characterize Issue and Define Need

The following are actions recommended for further characterizing the issue before designing and implementing the identified solution(s).

Action	Description
Groundwater Analysis	A field study is recommended to characterize depth to groundwater and potential influence of groundwater on ponding. Seasonal and spatial variations in depth to groundwater should be characterized as part of this study.
Additional Technical Analysis	Based on the results of the groundwater analysis, changes to the Port's stormwater hydraulic model are recommended to update infiltration and hydrologic assumptions, update the extent of ponding, and confirm sizing of the corresponding solution.
Surveying / Field Data Collection	Metro is in the process of producing higher resolution LiDAR. A review of the Metro LiDAR is recommended after this data becomes available to better define the extents of ponding.

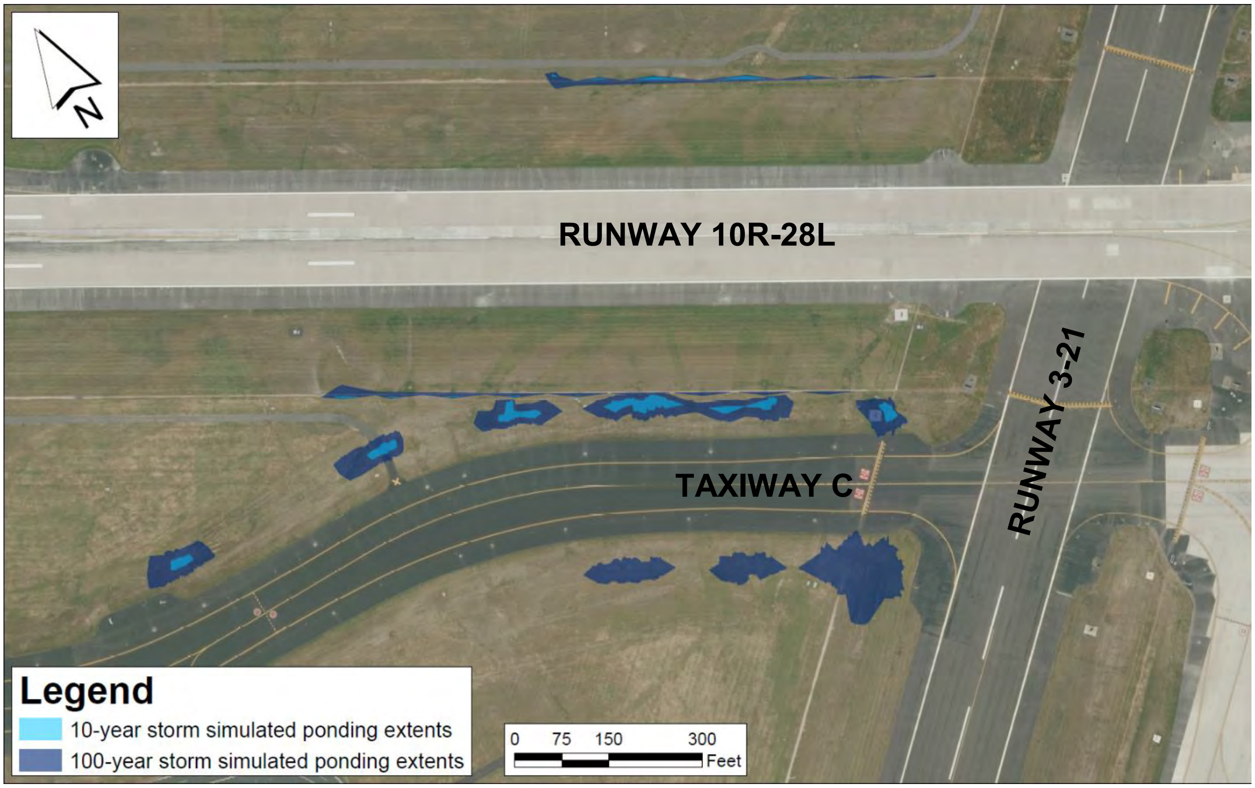


Figure 1: Plan View of Need

Regulatory Drivers for Stormwater Management Need

Driver	Description
FAA Hazardous Wildlife Attractant Criteria (FAA AC 150/5200-33)	Ponding in the infield areas near the intersection of Runway 10R-28L and Runway 3-21 creates a significant risk of hazardous wildlife attraction. Due to its proximity to the runways, ponding at this location may attract wildlife into the air operations area (AOA). According to FAA AC 150/5200-33, this poses a wildlife strike risk to aircraft.
FAA Airport Design Criteria (FAA AC 150/5300-13)	Ponding extends into the Runway 10R-28L and Runway 3-21 safety areas (RSAs) for the 10-year, 24-hour storm event and potentially for more frequent events. This ponding presents an operational and safety need for improved drainage. According to FAA AC 150/5300-13, the RSA must be “drained by grading or storm sewers to prevent water accumulation.” Additionally, the RSA must be “capable, under dry conditions, of supporting snow removal equipment, Aircraft Rescue and Fire Fighting (ARFF) equipment, and the occasional passage of aircraft without causing damage to the aircraft.”

Consequence of Not Mitigating Stormwater Management Need

Item	Description
Operations	Saturated soil conditions in the Runway 10R-28L and Runway 3-21 RSAs pose a risk to aircraft safety in the event of an excursion from the runway.
Wildlife Hazard Management	Standing water near Runway 10R-28L and Runway 3-21 poses an increased risk of hazardous wildlife attraction and for wildlife strikes.

Criteria to be Addressed by Stormwater Management Solutions

Item	Description
Flooding of Existing/Future Pavement	Not applicable.
Flooding of Existing/Future Buildings	Not applicable.
Ponding in Unpaved Areas Identified as Critical for Ponding Reduction	Reduce the 10-year storm peak ponding elevation to the lowest known ground elevation.
Asset Management Criteria	Not applicable.
Water Quality Treatment Criteria	Not applicable.

SWM NEED FACT SHEET 1-5

Stormwater Management Need Tracking Information

SWM Need ID	Need Name	Issue Type	Author	Revision Date
1-5	Address Risk of Asset Failure for Pipe Serving South Runway (10R-28L) in Basin 1 South	Asset Management	GS&P	June 2015

Stormwater Management Solutions Identified to Address Need

SWM Solution ID	Solution Name	Solution Type		
		New or Modified Infrastructure	Operational Change	Future Planning Considerations
1-C	Replace Pipe Serving South Runway (10R-28L) in Basin 1 South	X		

Issue Characterization

Issue Type	Issue Description
Asset Management	The concrete pipes serving Runway 10R-28L in Basin 1 South were constructed in 1941 and are among the oldest active storm sewers at PDX. Based on a useful life of 75 years that is typical for this pipe material,[1] the 1,400 feet of concrete pipe serving Runway 10R-28L in Basin 1 South (shown in orange in Figure 1) has expended approximately 99% of its useful life as of the year 2015. A 30-foot section of steel pipe just upstream of the aforementioned concrete pipes was also installed in 1941 and has expended 123% of its useful life as of 2015, based on a 60-year useful life for solid steel pipes.[1] This section of steel pipe is shown in red in Figure 1. The high percentage of useful life expended for these pipes creates a high risk of failure.

Notes:

1. The basis of this assumption is described in Appendix B of the *Port Stormwater Asset Management Assessment Report*, GS&P Team, July 2014.

Factors Potentially Contributing to Issue

Factor	Characterization Basis
Pipe Age & Material (Useful Life Expended)	Useful life expended is a simplified indicator for likelihood of failure and relies only on industry standards for expected pipe lifespan (based on pipe material) and a pipe's current age. With 99% and 123% of useful life expended for the concrete and steel pipes, respectively, the pipes will be more susceptible to deterioration and damage than newer pipes. The actual lifespan of a specific pipe can be affected by a variety of environmental and construction factors, including (but not limited to): • pipe-to-pipe joint design • pipe-to-structure joint design • construction quality • surface land use, including loads applied to the surface by buildings and vehicles • surrounding soil characteristics • groundwater presence and flow outside of the pipe • root growth • geotechnical stability • soil corrosivity • chemical degradation, especially in the presence of standing water containing biodegradable contaminants such as deicing chemicals
Pipe Defects	Inspections to assess the condition of these pipes have not been performed, and pipe defects have not been identified.

Recommendations to Further Characterize Issue and Define Need

The following are actions recommended for further characterizing the issue before designing and implementing the identified solution(s).

Action	Description
Inspections / Condition Assessment	A field inspection of the pipes denoted in orange and red in Figure 1 is recommended to determine the actual infrastructure condition. Defects should be coded with an industry-standard method.

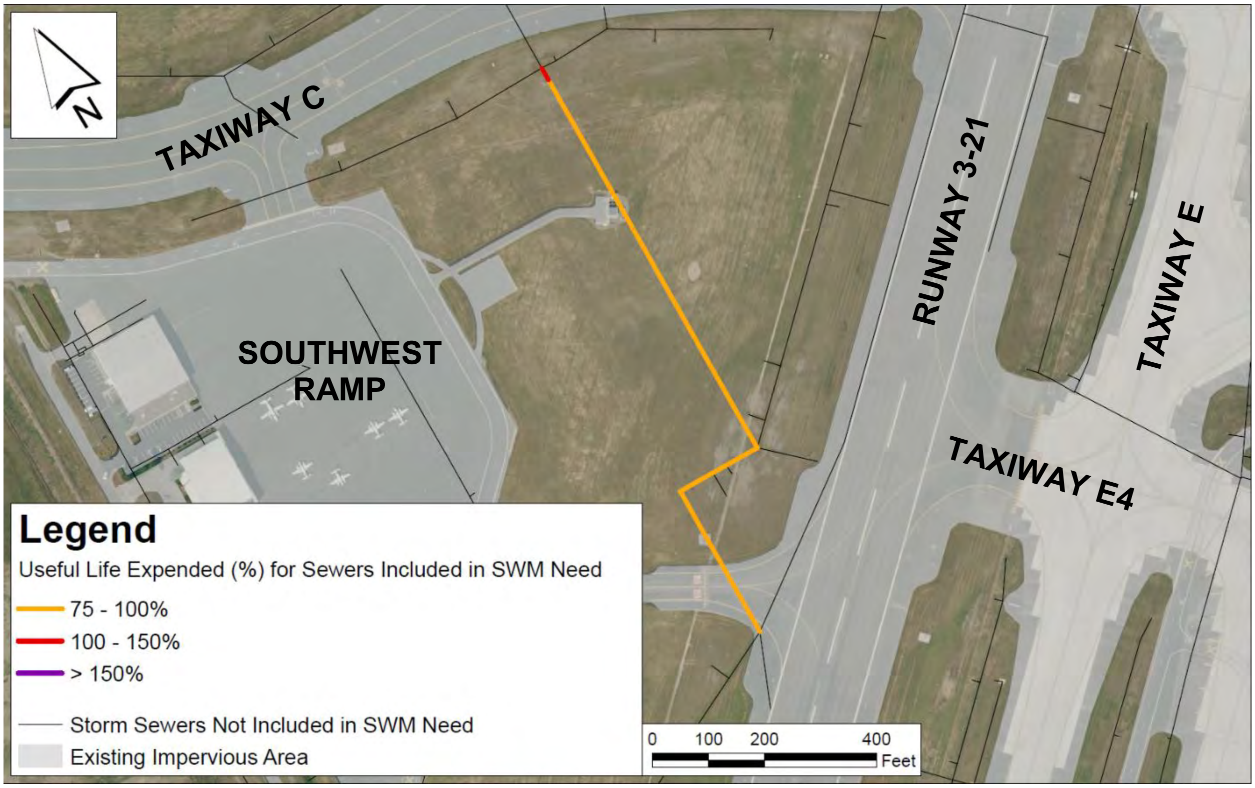


Figure 1: Plan View of Need

Regulatory Drivers for Stormwater Management Need

Driver	Description
FAA Hazardous Wildlife Attractant Criteria (FAA AC 150/5200-33)	Failure of storm sewers serving Runway 10R-28L in Basin 1 South will create extensive ponding along the western portion of Runway 10R-28L and along the central portion of Runway 3-21 during large storm events. Ponding at these locations has the potential to pose a hazardous wildlife attractant risk. According to FAA AC 150/5200-33, this poses a potential wildlife strike risk to aircraft landing on or departing from the PDX runways.
FAA Airport Design and Drainage Design Criteria (FAA ACs 150/5300-13, 150/5320-5)	Failure of storm sewers serving Runway 10R-28L in Basin 1 South will create extensive ponding within the Runway Safety Areas (RSAs) for Runways 10R-28L and 3-21. According to FAA AC 150/5300-13, the RSA must be "drained by grading or storm sewers to prevent water accumulation." Pipe failure at this location would also increase the risk for ponding onto the airfield's paved surfaces, such as Runway 10R-28L, Runway 3-21, and Taxiways B, C and G. AC 150/5320-5 requires that airport drainage systems "provide for safe…operation of the facility" and "convey design flows…without surcharging inlets or otherwise causing surface flooding," in particular for runways, taxiways and aircraft aprons during the 5-year FAA drainage design storm. Additionally, the center 50% of runways and taxiways must remain free from ponding during the 10-year storm. Pipe failure has the potential to violate these criteria during smaller, more frequent storm events.

Consequence of Not Mitigating Stormwater Management Need

Item	Description
Operations	In the event of a pipe failure along the lateral serving Runway 10R-28L in Basin 1 South, drainage from the following operational areas may be severely limited until the failed pipe(s) can be replaced: • Western end of Runway 10R-28L • Central portion of Runway 3-21 • Portions of Taxiways B, C and G Additionally, the lateral serving Runway 10R-28L in Basin 1 South lies directly below Taxiway G and may cause structural damage to the taxiway pavement in the event of a pipe failure.
Wildlife Hazard Management	In the event of a pipe failure along the lateral serving Runway 10R-28L in Basin 1 South, the drainage system for approximately 60 acres of the PDX airfield may be compromised, increasing the risk for prolonged ponding on the airfield, particularly in infield areas near the intersection of Runway 10R-28L and Runway 3-21. Prolonged ponding on the airfield may pose an increased risk for hazardous wildlife attraction and potential for wildlife strikes.

Criteria to be Addressed by Stormwater Management Solutions

Item	Description
Flooding of Existing/Future Pavement	Not applicable.
Flooding of Existing/Future Buildings	Not applicable.
Ponding in Unpaved Areas Identified as Critical for Ponding Reduction	Not applicable.
Asset Management Criteria	Reduce the likelihood of failure for active storm sewer pipes, focusing on pipes that have expended ≥75% of their estimated useful life and may have a potentially high consequence of failure.
Water Quality Treatment Criteria	Not applicable.

SWM NEED FACT SHEET 1-6

Stormwater Management Need Tracking Information

SWM Need ID	Need Name	Issue Type	Author	Revision Date
1-6	Address Ponding in Wetland North of Deicing Treatment System	Ponding	GS&P	June 2015

Stormwater Management Solutions Identified to Address Need

SWM Solution ID	Solution Name	Solution Type		
		New or Modified Infrastructure	Operational Change	Future Planning Considerations
1-D	Drainage Planning Recommendations for NE 33rd Drive Development			X

Issue Characterization

Issue Type	Issue Description
Ponding	Ponding has been regularly observed by Port Natural Resources staff in the grassy area north of the Deicing Treatment System. This area is a regulated wetland with portions of the wetland area in line with the runway approach for 10R-28L. The potential for ponding at this location was verified by a review of available stormwater infrastructure in the Basin 1 North drainage system, which was found to provide no outlet for drainage from this location. Ponding extents shown in Figure 1 for the 10-year and 100-year, 24-hour storm events are based solely on hydrologic assumptions given that a hydraulic analysis was not applicable for this location. Since groundwater elevations in Basin 1 are unknown, the extents shown in Figure 1 are based on an assumption that the wetland is dry prior to each rainfall event. The ponding observed at this location creates a risk of hazardous wildlife attraction at the approach for Runway 10R-28L that the Port wants to mitigate.

Factors Potentially Contributing to Issue

Factor	Characterization Basis
Lack of Drainage Infrastructure	Assessments using the PDX stormwater hydraulic model indicate that ponding during the 10-year and 100-year storm events is caused by stormwater runoff that collects and is retained in the low lying areas north of the Deicing Treatment System. The stormwater is retained due to a lack of a drainage infrastructure serving this area.
Potential Seasonal Variation in the Groundwater Table	Field observations of ponding between storm events suggest that a seasonally high groundwater table could contribute to ponding in this area.
Potential Grading Inconsistencies or Maintenance Needs	Grading inconsistencies may also contribute to ponding, even if stormwater drainage infrastructure is installed. This area has not been inspected to confirm the potential contribution of site grading to ponding.

Recommendations to Further Characterize Issue and Define Need

The following are actions recommended for further characterizing the issue before designing and implementing the identified solution(s).

Action	Description
Groundwater Analysis	A field study is recommended to characterize depth to groundwater and potential influence of groundwater on ponding. Seasonal and spatial variations in depth to groundwater should be characterized as part of this study.
Additional Technical Analysis	Based on the results of the groundwater analysis, changes to the Port's stormwater hydraulic model are recommended to update infiltration and hydrologic assumptions, update the extent of ponding, and confirm sizing of the corresponding solution.
Surveying / Field Data Collection	A site walk should occur to check for any inconsistencies in grading. If inconsistencies are observed, site surveying or updated topographic data collection (e.g., LiDAR) is recommended to determine if ponding areas have grading that creates localized pockets for surface storage. Fine grading may be necessary to facilitate drainage toward future storm sewer inlets, depending on findings.

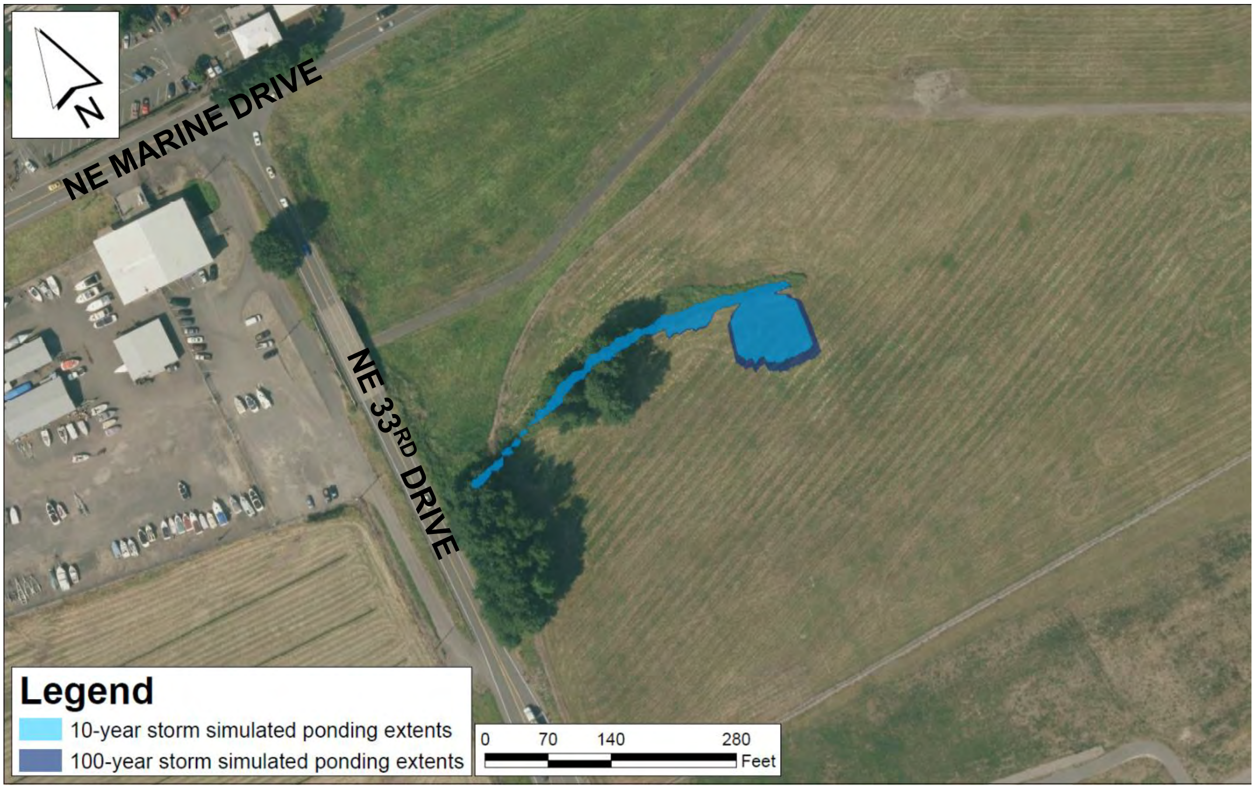


Figure 1: Plan View of Need

Regulatory Drivers for Stormwater Management Need

Driver	Description
FAA Hazardous Wildlife Attractant Criteria (FAA AC 150/5200-33)	Due to its proximity to PDX and location within the FAA 10,000 foot separation area, ponding at this location poses a risk for attracting wildlife into the runways' approach or departure airspace or into the Air Operations Area (AOA). According to FAA AC 150/5200-33, this poses a wildlife strike risk to aircraft.

Consequence of Not Mitigating Stormwater Management Need

Item	Description
Wildlife Hazard Management	Standing water north of the Deicing Treatment Facility and near the west end of Runway 10R-28L poses a significant risk of hazardous wildlife attraction and for wildlife strikes.

Criteria to be Addressed by Stormwater Management Solutions

Item	Description
Flooding of Existing/Future Pavement	Not applicable.
Flooding of Existing/Future Buildings	Not applicable.
Ponding in Unpaved Areas Identified as Critical for Ponding Reduction	Reduce the 10-year storm peak ponding elevation to the lowest known ground elevation.
Asset Management Criteria	Not applicable.
Water Quality Treatment Criteria	Not applicable.

SWM NEED FACT SHEET 1-7

Stormwater Management Need Tracking Information

SWM Need ID	Need Name	Issue Type	Author	Revision Date
1-7	Address Ponding in Planned Development Area West of NE 33rd Drive	Ponding	GS&P	June 2015

Stormwater Management Solutions Identified to Address Need

SWM Solution ID	Solution Name	Solution Type		
		New or Modified Infrastructure	Operational Change	Future Planning Considerations
1-D	Drainage Planning Recommendations for NE 33rd Drive Development			X

Issue Characterization

Issue Type	Issue Description
Ponding	Stormwater hydraulic modeling of the Basin 1 drainage system under future (2035) development conditions reveals that the large increase in impervious area will create excessive ponding in the proposed development area west of NE 33rd Drive during both the 10-year and 100-year, 24-hour storm events (as shown in Figure 1) if the drainage infrastructure is limited to the existing Basin 1 drainage system. This ponding will significantly hinder the ability to develop and use the site west of NE 33rd Drive.

Factors Potentially Contributing to Issue

Factor	Characterization Basis
Insufficient Drainage System Capacity	Assessments using the PDX stormwater hydraulic model indicate that ponding during the 10-year and 100-year storm events is created by insufficient drainage capacity in the City-owned storm sewers along NE 33rd Drive.
Potential Seasonal Variation in the Groundwater Table	There are multiple existing wetlands within the vicinity of the ponded area. This suggests the presence of a high groundwater table that could limit stormwater infiltration and contribute to ponding.

Recommendations to Further Characterize Issue and Define Need

The following are actions recommended for further characterizing the issue before designing and implementing the identified solution(s).

Action	Description
Groundwater Analysis	A field study is recommended to characterize depth to groundwater and potential influence of groundwater on ponding. Seasonal and spatial variations in depth to groundwater should be characterized as part of this study.
Additional Technical Analysis	Based on the results of the groundwater analysis, changes to the Port's stormwater hydraulic model are recommended to update infiltration and hydrologic assumptions, update the extent of ponding, and confirm sizing of the corresponding solution. Because this area is currently served by limited drainage infrastructure, the ponding extents shown in Figure 1 are highly conceptual and have been generated based on the existing site grade, existing drainage infrastructure and hydrologic conditions associated with future development. As site development plans and future drainage infrastructure are better defined, the stormwater hydraulic model should be updated to confirm that the proposed site drainage system meets the ponding criteria described in this fact sheet. For a list of the specific ponding criteria, refer to the section titled "Criteria to be Addressed by Stormwater Management Solutions."

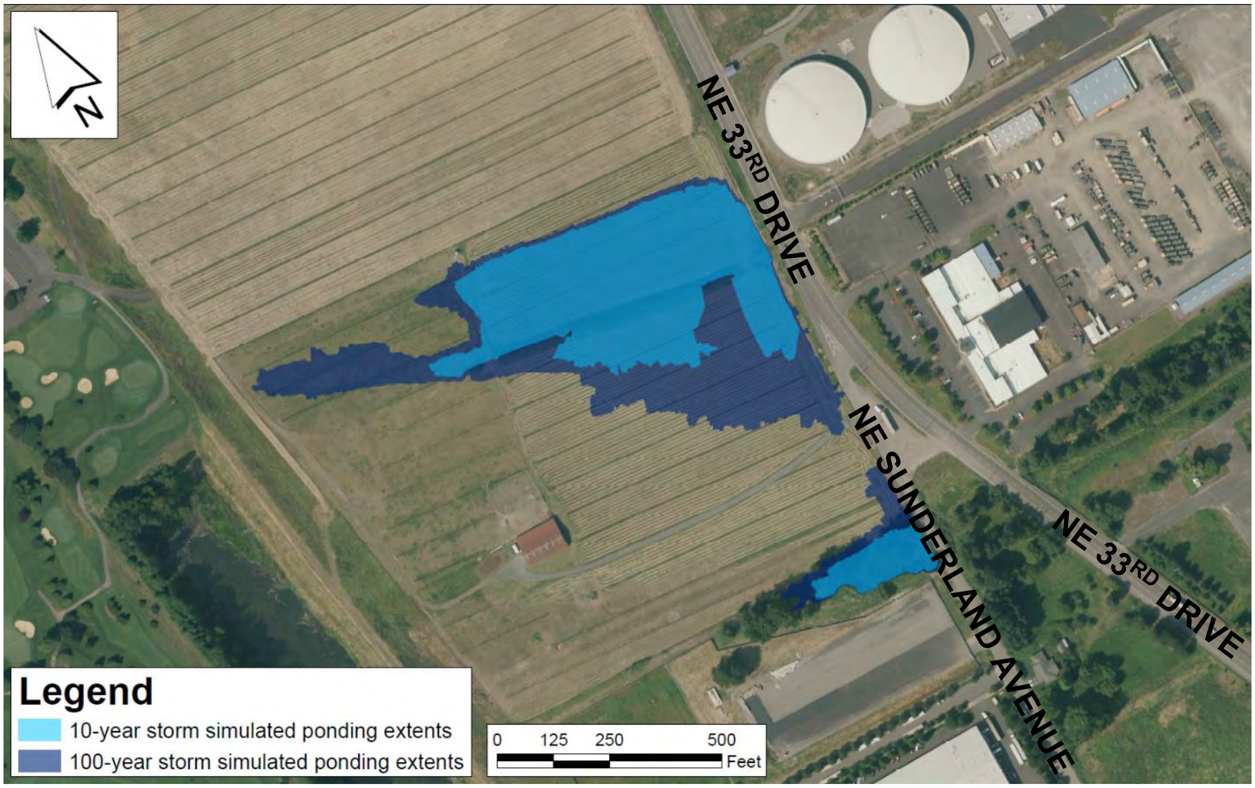


Figure 1: Plan View of Need

Regulatory Drivers for Stormwater Management Need

Driver	Description
FAA Hazardous Wildlife Attractant Criteria (FAA AC 150/5200-33)	Due to its proximity to PDX and location within the FAA 10,000 foot separation area, ponding at this location poses a risk for attracting wildlife into the runways' approach or departure airspace or into the Air Operations Area (AOA). According to FAA AC 150/5200-33, this poses a wildlife strike risk to aircraft.

Consequence of Not Mitigating Stormwater Management Need

Item	Description
Wildlife Hazard Management	Standing water in close proximity to the airport poses an increased risk of hazardous wildlife attraction and for wildlife strikes.
Planning and Development	The ponding overlaps with the future development extents of the NE 33rd & Marine Drive Development South project (#94).[1] If the need is not met, new pavement or buildings associated with the future development are at risk of flooding during the 10 and 100-year storm events.

Notes:

1. Project numbers were pulled from the Port's list of future development projects (Appendix A).

Criteria to be Addressed by Stormwater Management Solutions

Item	Description
Flooding of Existing/Future Pavement	Eliminate ponding onto the future development during the 10-year storm.
Flooding of Existing/Future Buildings	Eliminate risk of flooding future buildings during the 100-year storm.
Ponding in Unpaved Areas Identified as Critical for Ponding Reduction	Reduce the 10-year storm peak ponding elevation to the lowest known ground elevation.
Asset Management Criteria	Not applicable.
Water Quality Treatment Criteria	Not applicable.

SWM NEED FACT SHEET 1-8

Stormwater Management Need Tracking Information

SWM Need ID	Need Name	Issue Type	Author	Revision Date
1-8	Address Ponding Along MCDD Channels in Southwest Quad and Fazio Fields	Ponding	GS&P	June 2015

Stormwater Management Solutions Identified to Address Need

SWM Solution ID	Solution Name	Solution Type		
		New or Modified Infrastructure	Operational Change	Future Planning Considerations
1-E	Drainage Planning Recommendations for Southwest Quad and Fazio Fields			X

Issue Characterization

Issue Type	Issue Description
Ponding	The Southwest Quad and Fazio Fields are within the FEMA 100-year floodplain, and Port staff have observed ponding near these locations. Stormwater hydraulic modeling of the existing Basin 1 drainage system under existing (2015) development conditions indicates significant ponding within the Fazio Fields during the 10-year and 100-year, 24-hour storm events, but does not show significant ponding within Southwest Quad. Although ponding has been observed by the Port in the southern portion of Southwest Quad, this ponding it is not understood to be caused by localized underdrain failure. The stormwater hydraulic model does indicate ponding in both Fazio Fields and Southwest Quad during the 10 and 100-year storms under post-2035 conditions, at which point Southwest Quad is assumed to be fully developed. Figures 1 and 2 show the estimated ponding extents for these areas under 2035 and post-2035 conditions, respectively. Further investigation into the ponding extents at the Southwest Quad and Fazio Fields is warranted due to the current regulated FEMA floodplain boundaries, which may need to be updated to facilitate development in this area.

Factors Potentially Contributing to Issue

Factor	Characterization Basis
Insufficient Drainage System Capacity	Stormwater hydraulic modeling of the existing drainage system indicates that the ponding at Fazio Fields during the 10-year and 100-year storm events is caused by the limited drainage capacity at MCDD Pump Station #2 (PS #2).
Pump Operating Levels at MCDD Pump Station #2	Pump station operating setpoints (pre-storm settings) supplied by MCDD were evaluated in the stormwater hydraulic model and were determined to have a close relationship with water elevations in the Basin 1 drainage channels, which impact upstream ponding elevations, including the ponding elevations at Fazio Fields.
Potential Seasonal Variation in the Groundwater Table	Constant standing water observed in the Basin 1 drainage channels, as well as the presence of nearby wetlands and environmental zones suggests that a seasonally high groundwater table could contribute to ponding in this area.
Pipe Defects	Past pipe condition assessments have revealed portions of collapsed drainage tile at the Southwest Quad, which are likely the root cause of ponding observed by Port Natural Resources staff north of NE Elrod Road. The failed drainage tile will be replaced through an upcoming Port project (Project #89: Southwest Quad Drainage Improvements[1]) that should alleviate the drainage issues in Southwest Quad along NE Elrod Road.

Notes:

1. Project numbers are from the Port's list of future development projects (Appendix A).

Recommendations to Further Characterize Issue and Define Need

The following are actions recommended for further characterizing the issue before designing and implementing the identified solution(s).

Action	Description
Groundwater Analysis	A field study is recommended to characterize depth to groundwater and potential influence of groundwater on ponding. Seasonal and spatial variations in depth to groundwater should be characterized as part of this study.
Additional Technical Analysis	General updates to the Port's stormwater hydraulic model are recommended to incorporate: • Findings from the groundwater analysis, which will better inform the model's infiltration and hydrologic assumptions • Updated surface ponding allowances based on a review of the high resolution LiDAR being produced by Metro (after this data becomes available) Following the model updates, confirm the extent of ponding and the sizing of the corresponding solution.
Surveying / Field Data Collection	Metro is in the process of producing higher resolution LiDAR. A review of the Metro LiDAR is recommended after this data becomes available to better define the extents of ponding onto the Southwest Quad and Fazio Fields.

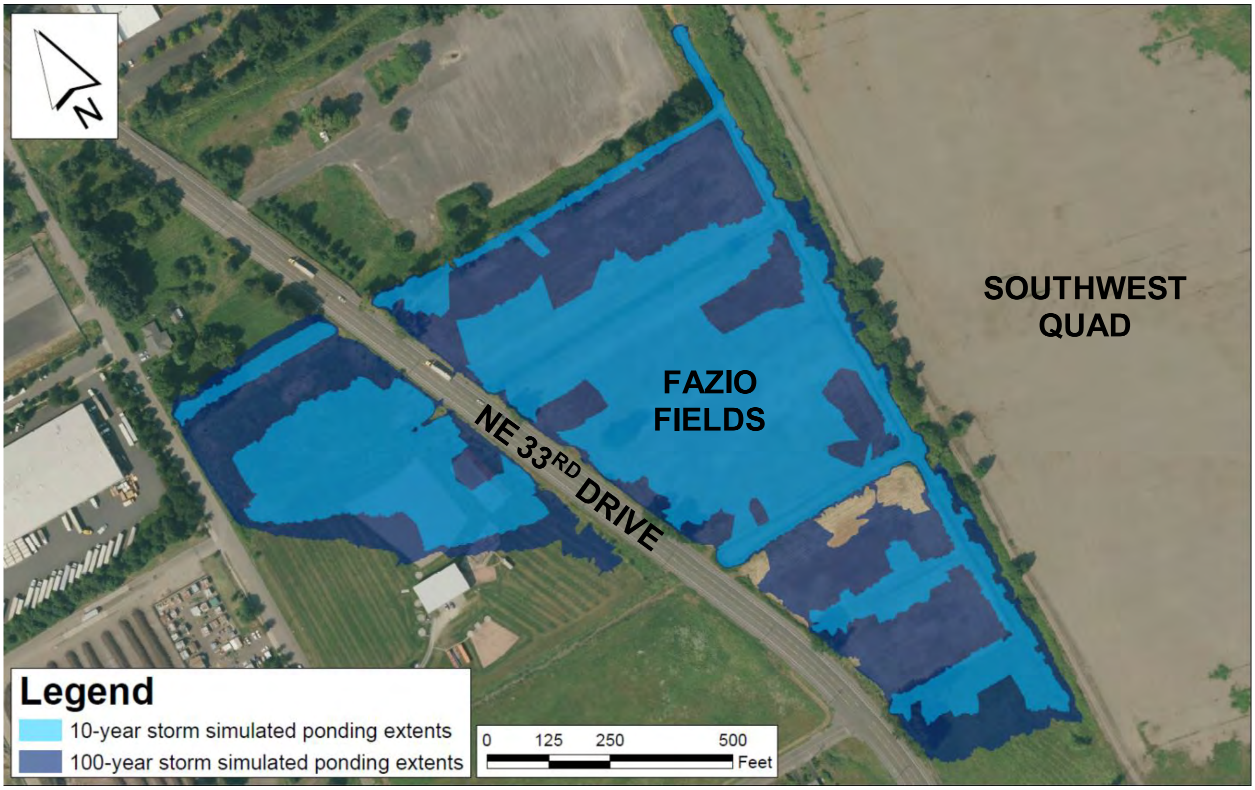


Figure 1: Plan View of Need Under 2035 Development Conditions

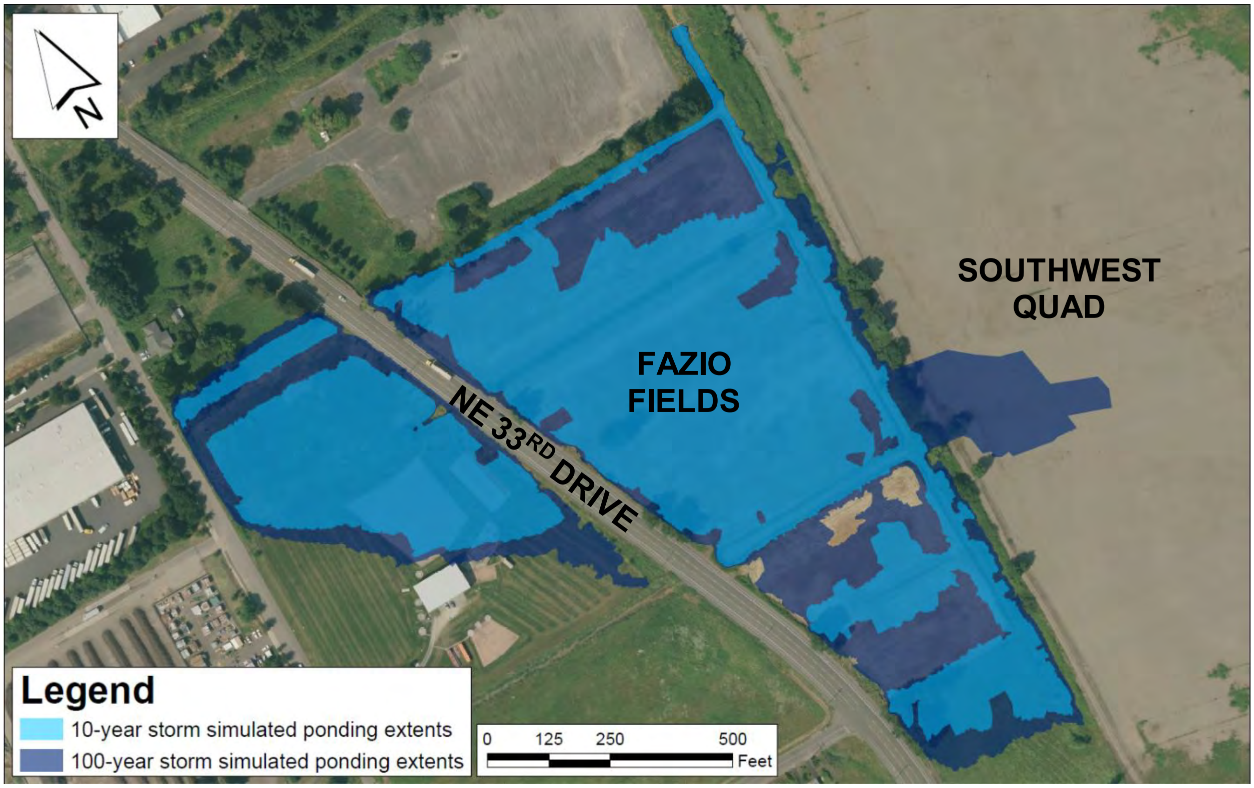


Figure 2: Plan View of Need Under Post-2035 Development Conditions

Regulatory Drivers for Stormwater Management Need

Driver	Description
FAA Hazardous Wildlife Attractant Criteria (FAA AC 150/5200-33)	Due to its proximity to PDX and location within the FAA 10,000 foot separation area, ponding at this location poses a risk for attracting wildlife into the runways' approach or departure airspace or into the air operations area (AOA). According to FAA AC 150/5200-33, this poses a wildlife strike risk to aircraft.

Consequence of Not Mitigating Stormwater Management Need

Item	Description
Operations	Ponding is not anticipated to impact airport operations at PDX during the 10-year or 100-year storm events. However, ponding during both storm events extends into the Concordia University Throw Center and may impact use of the facility.
Wildlife Hazard Management	Standing water in close proximity to the airport poses an increased risk of hazardous wildlife attraction and for wildlife strikes.
Planning and Development	The ponding extents as well as the FEMA 100-year floodplain overlap future development locations, including:[1] • Project #95: East side NE 33rd Development (unknown timeframe) • Project #100: Concordia Athletic Expansion (unknown timeframe) If the need is not met, new pavement or buildings associated with the future development are at risk of flooding during the 10 and 100-year storm events.

Notes:
1. Project numbers were pulled from the Port's list of future development projects (Appendix A).

Criteria to be Addressed by Stormwater Management Solutions

Item	Description
Flooding of Existing/Future Pavement	Eliminate ponding onto the future development during the 10-year storm.
Flooding of Existing/Future Buildings	Eliminate risk of flooding existing and future buildings during the 100-year storm.
Ponding in Unpaved Areas Identified as Critical for Ponding Reduction	Reduce the 10-year storm peak ponding elevation to the lowest known ground elevation.
Asset Management Criteria	Not applicable.
Water Quality Treatment Criteria	Not applicable.

SWM SOLUTION FACT SHEET 1-A

Stormwater Management Solution Tracking Information

SWM Solution ID	Solution Name	Capital Cost Summary	Anticipated Implementation Timeframe	Author	Revision Date
1-A	Replace Portion of Basin 1 North Trunk Line	$2,200,000	2016-2020	GS&P	June 2015

Stormwater Management Needs Addressed by Solution

SWM Need ID	Need Name	Need Type		
		Address Ponding and Facilitate Drainage	Address Risk of Stormwater Asset Failure	Provide Required Stormwater Controls
1-1	Address Ponding in Basin 1 North Infield Areas of South Runway (10R-28L)	X		

Solution Description

Solution Type	Summary Description
New or Modified Infrastructure	Replace a portion of the Basin 1 North trunk line to address the operational and safety risks posed by ponding in the Basin 1 North infield areas along the South Runway (10R-28L).

As shown in Figure 1, the proposed infrastructure upgrades associated with SWM Solution 1-A are located inside the Air Operations Area (AOA), southwest of the South Runway (10R-28L), within the infield area and extending across Taxiway C1. The solution is focused on the Basin 1 North trunk line just upstream of the deicing system pump station N (PS-N). It involves replacement of a portion of the existing Basin 1 North trunk line, which currently ranges in size from 48-inch to 54-inch, with new 72-inch diameter pipes. The proposed solution is based upon planned future development as provided by the Port in August 2014. The solution may need to be refined as development plans evolve.

SWM Solution 1-A addresses ponding of portions of the infield areas located north and south of Runway 10R-28L, east of Taxiway C1, south of Taxiway B, and north of Taxiway C under existing and future conditions. The ponding is the result of insufficient drainage capacity and relatively low ground elevations. The ponding creates operational and hazardous wildlife attractant risks.

The goal of SWM Solution 1-A is to provide additional drainage capacity in the Basin 1 North drainage system by creating more in-pipe storage for stormwater. SWM Solution 1-A is paired with SWM Solution 1-F, which involves continuous year-round operation of PS-N to route stormwater, up to the pump station capacity, to the deicing system Dilute Storage Tanks (DSTs) and ultimately to the Columbia River. If either solution is implemented without the other, stormwater-related ponding in the infield areas is not likely to be fully addressed, although it may be reduced.

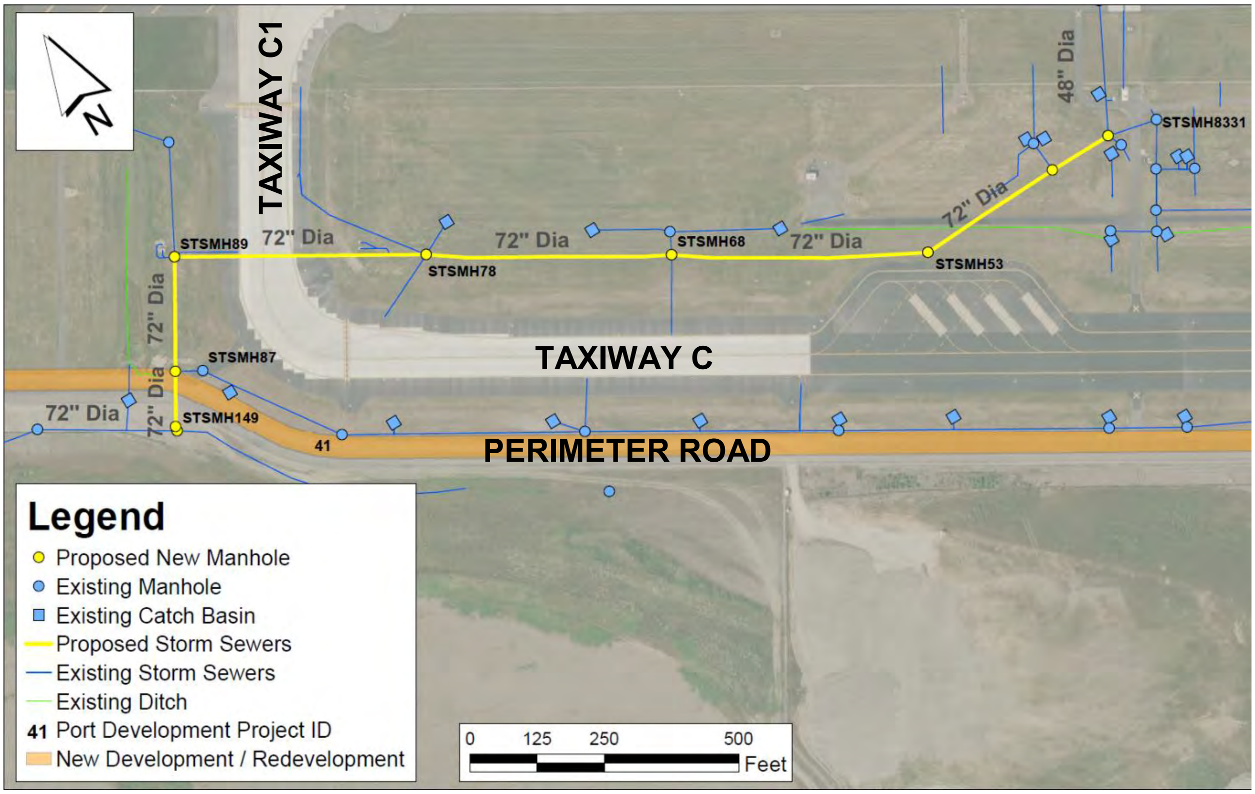


Figure 1: Plan View of Solution

Implementation Considerations

The following tables provide recommended considerations as the project moves from planning concept to implemented solution. The tables below address three phases of implementation, including planning and design, construction, and post-construction.

Planning and Design Considerations

Item	Description
Field Data Collection	• Underground utility location. • Geotechnical and hydrogeological studies may be needed to support detailed design. • Condition inspection of any existing structures where new pipe connections will be made.
Additional Technical Analysis	Update the PDX stormwater hydraulic model to confirm sizing of the solution following completion of the Port groundwater analysis.
Permitting	Verify that infield areas are not categorized as wetlands before design. Classification as jurisdictional wetlands would require Clean Water Act Section 404/401 permitting and potential mitigation.
Siting	During detailed design, review the SWM solution extents and layout (as shown in Figure 1) and adjust as necessary to optimize land use, minimize runway and taxiway impacts, minimize excavation, avoid utilities, meet setback requirements, as well as avoid interference with Runway 10R-28L operations.
Coordination with Elements of Other Projects	Coordinate the replacement of the pipe under the perimeter road with the Perimeter Road Rehabilitation project.
Enabling Projects	None identified.
Related Solutions	The effectiveness of SWM Solution 1-A to address ponding associated with SWM Need 1-1 relies on the implementation of SWM Solution 1-F.
Coordination with Port Departments	• Planning and Development - Charter and Business Case Development • Engineering - pipe sizing, utility relocation, design coordination • Operations - temporary closure of taxiway and South Runway • Maintenance - change in catch basins and manholes requiring routine maintenance • Asset Management - removal of existing assets, addition of new assets • Wildlife Management - Identify significance of current risk, change in future management techniques in area
Coordination with Tenants	Coordinate need for temporary closures of Taxiway C1 and Runway 10R-28L with airlines, and coordinate closure of the perimeter road with other tenants using the road for access.
Coordination with Outside Agencies	Coordinate with FAA regarding runway and taxiway closures, as well as potential crossings of FAA communication and electrical utilities.
Design Disciplines Involved	Civil, Structural, and others as needed to relocate utilities

Construction Considerations

Item	Description
Construction Components	• Demolish portions of trunk line and replace with proposed 72-inch pipe (and associated structures). • Maintain existing catch basins and storm sewer laterals, and connect to proposed 72-inch pipe. • Maintain existing pipes upstream and downstream of solution. • Demolish and reconstruct portions of Taxiway C1, the perimeter road, and affected access roads as needed to install solution. • Protect and/or relocate existing utilities as needed to install solution.
Airport Operational Impacts	• Consider planning phased and off-hour construction across Taxiway C1 and in vicinity of Runway 10R-28L to limit operational impacts. • If possible, coordinate the perimeter road crossing with the Perimeter Road Rehabilitation project, to minimize road closure time. • As the pipe needing to be replaced is upstream of PS-N, construction is recommended to take place outside of the deicing season to minimize impacts to operations (verify new line is flushed prior to starting pump station after construction).
Construction Challenges	• Tie-in of the replacement pipe into the trunk line may require bypass pumping of flows to minimize the potential for excessive ponding. • Identify contractor laydown area that avoids interference with airport operations. • Due to vicinity to runway, earthwork and equipment heights may need to be coordinated with FAA requirements. • A study is recommended to assess potential groundwater depths in this area and their potential influence on ponding. Results of this study should be coordinated with potential dewatering requirements.

Post-Construction Considerations

Item	Description
Post-Construction Coordination with Airport Operations	None identified.
Considerations for Operation and Maintenance (O&M) of the Solution	No change from current.

Potential Risks if Solution is Implemented / Risk Mitigation Strategies

Item	Description	Mitigation Strategy
Regulatory Compliance	There is a low risk to compliance with deicing NPDES permit. Solution has the potential to increase peak flows to deicing pump station PS-N, presenting a risk for overflows at PS-N and BOD load to bypass collection and discharge to the Columbia Slough.	An analysis of deicing system capacity revealed insignificant change in the risk of non-compliance with the deicing NPDES permit.
Airport or Tenant Operations	None identified.	Not applicable.
Aircraft Safety	None identified.	Not applicable.
Future Development Limitations	None identified.	Not applicable.

Schedule Analysis

Item	Description
Critical Schedule Drivers	Alignment of SWM Solution 1-A construction with the construction schedule for the following PDX development project may reduce costs and operational impacts:[1] • Project #41: Perimeter Road Rehabilitation (2017) Specific benefits of coordinating with this project are described in the Implementation Considerations section, under Planning and Design Considerations.
Target Construction Timeframe (2016-2020, 2021-2025, 2026-2035)	2016-2020 Timeframe based on significance of wildlife attractant risk, the construction timeframe for the Perimeter Road Rehabilitation project, and the ability to implement the related SWM Solution 1-F (Operate PS-N Continuously) immediately.
Planning and Design Lead Time (<6 months, 6-12 months, 12-24 months)	< 6 months

Notes:
1. Project numbers and timeframes are from the Port's list of future development projects (Appendix A).

Cost Analysis

Item	Description
Opinion of Probable Capital Cost (2015 Dollars)[1]	$2,200,000
Cost Estimate Class / Contingency (1-Bid received, 2-Construction, 3-Design, 4-Concept Design, 5- Screening/Planning)	5- Screening/Planning
Fixed Asset Modifications Excluded from Cost Estimate	Utility relocation costs not included.
Cost Assumptions	• Assumes reconstruction of airfield pavement will be coordinated with adjacent projects, where possible. • Assumes open cut of the perimeter road and Taxiway C1. • Includes 35% for hard cost contingency. • Includes 30% for soft cost contingency.
O&M Cost Considerations	No change from current.

Notes:
1. Supporting detailed cost tables are provided in Appendix B.

SWM SOLUTION FACT SHEET 1-B

Stormwater Management Solution Tracking Information

SWM Solution ID	Solution Name	Capital Cost Summary	Anticipated Implementation Timeframe	Author	Revision Date
1-B	Replace Portion of Basin 1 South Trunk Line	$3,200,000	2021-2025	GS&P	June 2015

Stormwater Management Needs Addressed by Solution

SWM Need ID	Need Name	Need Type		
		Address Ponding and Facilitate Drainage	Address Risk of Stormwater Asset Failure	Provide Required Stormwater Controls
1-2	Address Ponding West of Terminal Along Taxiway T	X		
1-3	Address Risk of Asset Failure for Basin 1 South Trunk Line		X	

Solution Description

Solution Type	Summary Description
New or Modified Infrastructure	Replace majority of the Basin 1 South trunk line to address the operational and safety risk from ponding west of the terminal along Taxiway T and the risk of asset failure.

As shown in Figure 1, the proposed infrastructure upgrades associated with SWM Solution 1-B are located inside the Air Operations Area (AOA), along the western edge of the Crosswinds Runway (3-21). The replacement storm sewer begins just east of Runway 3-21 and north of Taxiway B, continues west across Runway 3-21, and then south along the western edge of Runway 3-21 to Manhole 0001901, the structure just upstream of deicing pump station S (PS-S).

The storm sewer changes involve replacing majority of the existing trunk line, which currently ranges in size from 27-inch to 36-inch diameter and is inconsistent in grade and slope, with a new 48-inch diameter pipe with a consistent slope and grade. The proposed solution is based upon planned future development as provided by the Port in August 2014. The solution may need to be refined as development plans evolve.

SWM Solution 1-B addresses ponding near Taxiway T that is caused primarily by insufficient drainage capacity in the existing piping. The solution is paired with the storm sewer changes associated with the Taxiway Echo North Rehabilitation project. The proposed solution eliminates the current bottleneck along the trunk line under Runway 10R-28L, which is necessary to fully reduce the risk of ponding along Taxiway T (SWM Need 1-2). The solution also addresses the risk of asset failure for the trunk line, which has generally expended 99% of its expected useful life.

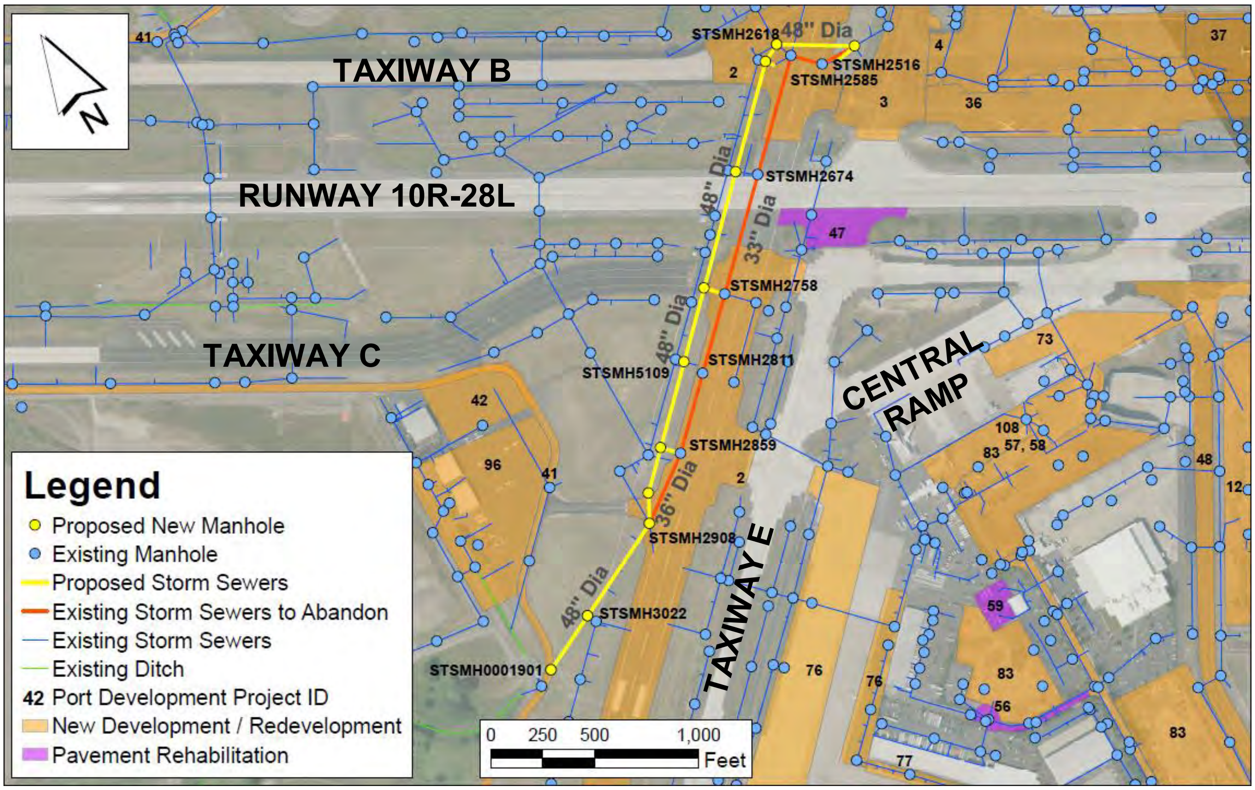


Figure 1: Plan View of Solution

Implementation Considerations

The following tables provide recommended considerations as the project moves from planning concept to implemented solution. The tables below address three phases of implementation, including planning and design, construction, and post-construction.

Planning and Design Considerations

Item	Description
Field Data Collection	• Underground utility location, particularly for FAA utilities. • Geotechnical and hydrogeological studies may be needed to support detailed design. • Condition inspection of any existing structures where new pipe connections will be made.
Additional Technical Analysis	Update the PDX stormwater hydraulic model to confirm sizing of the solution following completion of the Port groundwater analysis.
Permitting	None identified.
Siting	• Since the Basin 1 South trunk line runs closely along the western edge of Runway 3-21, it is recommended that the replacement trunk line be realigned to the west of the current pipe to minimize impacts to runway pavement (as shown in Figure 1). Siting of the storm sewers and drainage structures, however, could be impacted by the long-term plans for Runway 3-21. • During detailed design, review the solution extents and layout (as shown in Figure 1) and adjust as necessary to optimize land use, minimize runway and taxiway impacts, minimize excavation, avoid utilities, meet setback requirements, as well as avoid interference with runway operations.
Coordination with Elements of Other Projects	• Coordinate with future use / rehabilitation of Runway 3-21, which will be considered in the next PDX Master Plan update. If the runway will continue to be used, the storm sewer changes should be coordinated with the schedule for reconstruction of the Runway 3-21 pavement. If the decision is made to discontinue use of the runway, the location and size of the replacement pipe should be considered in the context of the future use of the runway area. • Coordinate with SWM Solutions 1-C and 1-L due to the potential for physical overlap between these projects. • This solution will need to tie into the manhole at the downstream end of the Taxiway E North Rehabilitation project.
Enabling Projects	None identified.
Related Solutions	None identified.

Item	Description
Coordination with Port Departments	• Planning and Development - Charter and Business Case Development • Engineering - pipe sizing, utility relocation, design coordination • Operations - closure of Runway 3-21 and temporary closure of Runway 10R-28L / taxiways • Maintenance - change in catch basins and manholes requiring routine maintenance • Asset Management - pipe and structure inspections, removal of existing assets, addition of new assets
Coordination with Tenants	• Coordinate need for temporary closures of taxiways and runways with airlines. • Coordinate potential closure of a portion of the perimeter road with tenants using the road.
Coordination with Outside Agencies	Coordinate with FAA regarding runway and taxiway closures, including the trenchless crossing of Runway 10R-28L. Also coordinate with FAA on potential crossings of FAA communication and electrical utilities.
Design Disciplines Involved	Civil, Structural, and others as needed to relocate utilities.

Construction Considerations

Item	Description
Construction Components	• Realign storm sewer trunk to minimize construction impacts to Runway 10R-28L and Runway 3-21. • Construct new 48-inch pipe to replace portions of existing trunk line pipe that ranges from 27-inch to 36-inch diameter, including associated structures. • Use a trenchless installation method such as jack and bore to install the portion of the replacement trunk line under Runway 10R-28L. • Use open cut of Runway 3-21 for pipe installation rather than trenchless crossing. Align with the long-term use and/or pavement replacement of Runway 3-21. • Abandon portions of existing storm sewers that are in close proximity to or under Runways 3-21 or 10R-28L. Fill abandoned pipes with controlled density fill prior to abandoning to address risk of structural failure. • Demolish portions of existing storm sewers that are being replaced by new pipe, as needed. • Maintain existing lateral sewers and catch basins and connect to proposed pipe. • Maintain existing trunk line immediately upstream and downstream of the solution and tie the new pipe into existing manholes, if possible. • Protect and avoid construction impacts to PS-S near the downstream end of the trunk line. • Demolish and reconstruct portions of Runway 3-21, Taxiway B, Taxiway C, Taxiway G, and the perimeter road, as needed to install solution. • Protect and/or relocate existing utilities as needed to install solution.
Airport Operational Impacts	• Construction of the trunk line may fall within the runway safety areas for both Runway 3-21 and 10R-28L. Consider planning phased and off-hour construction to limit operational impacts. • As the pipe needing to be replaced is upstream of PS-S, construction is recommended to take place outside of the deicing season to minimize impacts to deicer collection operations (verify new line is flushed prior to starting pump station after construction).
Construction Challenges	• Tie-in of the pipe into the trunk line may require temporary bypass pumping of flows. • Identify contractor laydown area that avoids interference with airport operations. • Due to vicinity to runway, earthwork and equipment heights may need to be coordinated with FAA requirements. • A study is recommended to assess groundwater depths in this area and their influence on ponding. Results of this study should be coordinated with potential dewatering requirements.

Post-Construction Considerations

Item	Description
Post-Construction Coordination with Airport Operations	None identified.
Considerations for Operation and Maintenance (O&M) of the Solution	No change from current.

Potential Risks if Solution is Implemented / Risk Mitigation Strategies

Item	Description	Mitigation Strategy
Regulatory Compliance	There is a low risk to compliance with deicing NPDES permit. Solution has the potential to increase peak flows to deicing pump station PS-S, presenting a risk for overflows at PS-S and BOD load to bypass collection and discharge to the Columbia Slough.	An analysis of deicing system capacity revealed insignificant change in the risk of non-compliance with the deicing NPDES permit.
Airport or Tenant Operations	None identified.	Not applicable.
Aircraft Safety	None identified.	Not applicable.
Future Development Limitations	None identified.	Not applicable.

Schedule Analysis

Item	Description
Critical Schedule Drivers	Alignment of SWM Solution 1-B construction with the construction schedules for the following PDX development projects may reduce costs and operational impacts:[1] • Project #2: Runway 3-21 and Taxiway M Rehabilitation (2021) • Airport Master Plan Update (2018-2019) • Project #3: Taxiway E North Rehabilitation (2015) • SWM Solution 1-C: Replace Pipe Serving South Runway (10R-28L) in Basin 1 South • SWM Solution 1-L: Provide Regional Water Quality Treatment for BMP Strategy Area (BMP SA)-1.6 Specific benefits of coordinating with each project listed above are described in the Implementation Considerations section, under Planning and Design Considerations.
Target Construction Timeframe (2016-2020, 2021-2025, 2026-2035)	2021-2025 Timeframe selected to allow completion of the Airport Master Plan Update, which will determine the timing of the Runway 3-21 pavement replacement. Although the pipe to be replaced is old (99% useful life expended) and the 2009 pipe inspection revealed sag points, the Port did not note imminent failure. An updated pipe inspection may help to refine the construction timeframe.
Planning and Design Lead Time (<6 months, 6-12 months, 12-24 months)	6-12 months

Notes:
1. Project numbers and timeframes are from the Port's list of future development projects (Appendix A).

Cost Analysis

Item	Description
Opinion of Probable Capital Cost (2015 Dollars)[1]	$3,200,000
Cost Estimate Class / Contingency (1-Bid received, 2-Construction, 3-Design, 4-Concept Design, 5- Screening/Planning)	5- Screening/Planning
Fixed Asset Modifications Excluded from Cost Estimate	Utility relocation costs not included.
Cost Assumptions	• Assumes portions of existing trunk line will be filled in place with controlled density fill to minimize impacts to Runway 3-21. • Assumes open cut of Taxiway C, Taxiway G, and Runway 3-21. • Assumes trenchless crossing of Runway 10R-28L. • Assumes no significant construction impact to existing drainage tile. • Does not include any cost savings that may be obtained by aligning SWM Solution 1-B and pavement work on Runway 3-21. • Includes 40% for hard cost contingency. • Includes 30% for soft cost contingency.
O&M Cost Considerations	No change from current.

Notes:
1. Supporting detailed cost tables are provided in Appendix B.

SWM SOLUTION FACT SHEET 1-C

Stormwater Management Solution Tracking Information

SWM Solution ID	Solution Name	Capital Cost Summary	Anticipated Implementation Timeframe	Author	Revision Date
1-C	Replace Pipe Serving South Runway (10R-28L) in Basin 1 South	$720,000	2021-2025	GS&P	June 2015

Stormwater Management Needs Addressed by Solution

SWM Need ID	Need Name	Need Type		
		Address Ponding and Facilitate Drainage	Address Risk of Stormwater Asset Failure	Provide Required Stormwater Controls
1-4	Address Ponding in Basin 1 South Infield Areas of South Runway	X		
1-5	Address Risk of Asset Failure for Pipe Serving South Runway (10R-28L) in Basin 1 South		X	

Solution Description

Solution Type	Summary Description
New or Modified Infrastructure	Replace the majority of the pipe serving the South Runway (10R-28L) infield area and tying into the Basin 1 South trunk, to address risk of asset failure as well as address ponding in two infield areas.

As shown in Figure 1, the proposed infrastructure upgrades associated with Solution 1-C are located inside the Air Operations Area (AOA), along the western edge of Runway 3-21. The replacement pipe begins east of the Southwest Ramp, west of the trunk line along Runway 3-21, and just south of Taxiway C, and continues south to the tie-in to the main Basin 1 South trunk line. The solution assumes a new alignment of the proposed 30-inch to 48-inch diameter pipe while abandoning and filling the existing 21-inch to 24-inch diameter pipe with controlled density fill.

The goal of SWM Solution 1-C is to provide additional drainage capacity in the Basin 1 South drainage system serving Runway 10R-28L. The additional capacity addresses the ponding in the infield areas between Taxiway B, Runway 10R-28L, and Taxiway C that are adjacent to Runway 3-21. Replacement of the pipe also mitigates the risk of asset failure for this section of pipe, which has generally expended 99% of its expected useful life.

The solution should be installed in conjunction with SWM Solution 1-B, which involves replacing majority of the Basin 1 South trunk line just upstream of the deicing system Pump Station S (PS-S). The proposed sizing for SWM Solution 1-C assumes that the downstream portion of SWM Solution 1-B has been implemented, or can be implemented. If either SWM Solution 1-B or SWM Solution 1-C are implemented without the other, stormwater-related ponding in the infield areas is not likely to be fully addressed, although it may be reduced. The proposed solution is also based upon planned future development as provided by the Port in August 2014. The solution may need to be refined as development plans evolve.

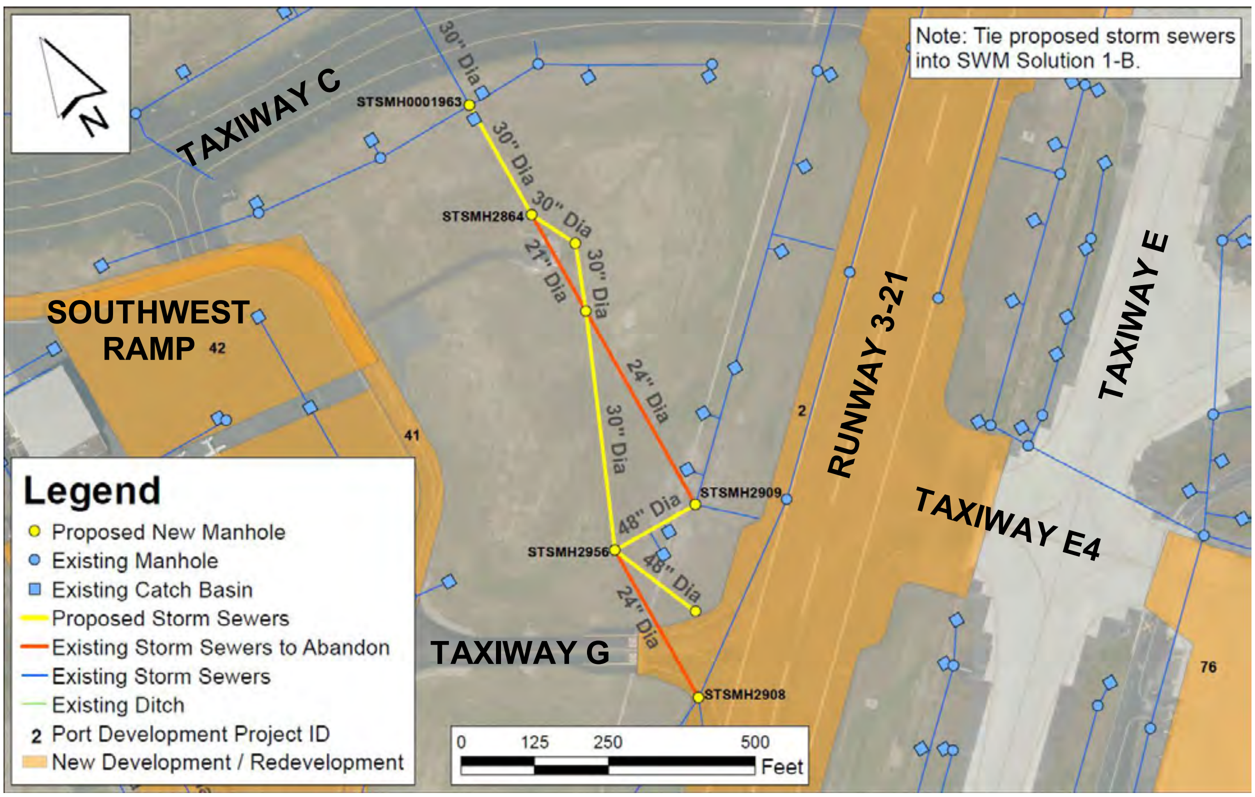


Figure 1: Plan View of Solution

Implementation Considerations

The following tables provide recommended considerations as the project moves from planning concept to implemented solution. The tables below address three phases of implementation, including planning and design, construction, and post-construction.

Planning and Design Considerations

Item	Description
Field Data Collection	• Underground utility location. • Geotechnical and hydrogeological studies may be needed to support detailed design. • Condition inspection of any existing structures where new pipe connections will be made.
Additional Technical Analysis	Update the PDX stormwater hydraulic model to confirm sizing of the solution following completion of the Port groundwater analysis.
Permitting	Verify that infield areas are not categorized as wetlands before design. Classification as jurisdictional wetlands would require Clean Water Act (CWA) Section 404/401 permitting and potential mitigation.

Siting	• During detailed design, review the SWM solution extents and layout (as shown in Figure 1), and adjust as necessary to minimize impacts to the following existing facilities:
	  ○ TACAN (tactical air navigation system), which is located immediately east of the Southwest Ramp and immediately west of the pipe being replaced
	  ○ Runway 3-21 Object Free Area (ROFA) along the west side of Runway 3-21
	  ○ Taxiway G, which the existing pipe crosses at an angle
	• The solution layout (as shown in Figure 1) should also be adjusted as necessary to optimize land use, minimize excavation, avoid utilities, meet setback requirements and avoid interference with airport operations.

Coordination with Elements of Other Projects	• Coordinate with future use / rehabilitation of Runway 3-21, which will be considered in the next Airport Master Plan Update. If the runway will continue to be used, the storm sewer changes should be coordinated with the schedule for reconstruction of the Runway 3-21 pavement. If the decision is made to discontinue use of the runway, the location and size of the replacement pipe should be considered in the context of the future use of the runway area. • Coordinate with SWM Solutions 1-B and 1-L due to the potential for physical overlap between these projects.
Enabling Projects	None identified.

Item	Description
Related Solutions	The effectiveness of SWM Solution 1-C to address ponding associated with SWM Need 1-4 relies on the implementation of SWM Solution 1- B.
Coordination with Port Departments	• Planning and Development - Charter and Business Case Development • Engineering - pipe sizing, siting, utility relocation, design coordination • Operations - temporary closure Runway 3-21 and Taxiway G, coordination on TACAN impacts • Maintenance - change in catch basins and manholes requiring routine maintenance • Asset Management - removal of existing assets, addition of new assets • Wildlife Management - identify significance of current risk, change in future management techniques in infield areas
Coordination with Tenants	Coordinate need for temporary closures of taxiways and runways with airlines.
Coordination with Outside Agencies	Coordinate with FAA regarding runway and taxiway closures, as well as potential crossings of FAA communication and electrical utilities.
Design Disciplines Involved	Civil, Structural, and others as needed to relocate utilities

Construction Considerations

Item	Description
Construction Components	• Realign storm sewer from existing configuration to minimize construction impacts to the Technical Air Navigation System (TACAN), Runway 3-21 ROFA, and Taxiway G. • Abandon any remaining portions of existing storm sewer in place and fill with controlled density fill to address risk of structural failure of aging pipe. • Demolish portions of existing pipe that are being replaced by new pipe, in locations where alignment is maintained. • Construct new 30-inch to 48-inch pipes to replace existing 21-inch to 24-inch pipes. • Maintain existing catch basins and storm sewer laterals, and connect to the replacement pipe. • Maintain existing pipe immediately upstream of the solution and tie into the replacement pipe. • Demolish and reconstruct portion of trunk line (or coordinate with replacement of trunk line, SWM Solution 1-B) as needed to tie in replacement pipe. • Protect and/or relocate existing utilities as needed to install solution.
Airport Operational Impacts	• Construction of downstream portions of this pipe approaching Runway 3-21 may require temporary runway closure. To the extent possible, it is recommended that construction be phased during off-hours to limit operational impacts. • Construction across Taxiway G will require closure of the taxiway, and alternate access routes (from Taxiway C, the perimeter road, and associated access roads) to the Southwest Ramp may need to be established on a temporary basis. • As the pipe needing to be replaced is upstream of PS-S, construction is recommended to take place outside of the deicing season to minimize impacts to deicer collection operations (verify new line is flushed prior to starting pump station after construction).
Construction Challenges	• Tie-in of the replacement pipe into the trunk line may require bypass pumping of flows to minimize the potential for excessive ponding. • Identify contractor laydown area that avoids interference with airport operations. • Due to vicinity to runway, earthwork and equipment heights may need to be coordinated with FAA requirements. • A study is recommended to assess potential groundwater depths in this area and their potential influence on ponding. Results of this study should be coordinated with potential dewatering requirements.

Post-Construction Considerations

Item	Description
Post-Construction Coordination with Airport Operations	None identified.
Considerations for Operation and Maintenance (O&M) of the Solution	No change from current.

Potential Risks if Solution is Implemented / Risk Mitigation Strategies

Item	Description	Mitigation Strategy
Regulatory Compliance	There is a low risk to compliance with deicing NPDES permit. Solution has the potential to increase peak flows to deicing pump station PS-S presenting a risk for overflows at PS-S and BOD load to bypass collection.	An analysis of deicing system capacity revealed insignificant change in the risk of non-compliance with the deicing NPDES permit.
Airport or Tenant Operations	None identified.	Not applicable.
Aircraft Safety	None identified.	Not applicable.
Future Development Limitations	None identified.	Not applicable.

Schedule Analysis

Item	Description
Critical Schedule Drivers	Alignment of SWM Solution 1-C construction with the construction schedules for the following PDX development projects may reduce costs and operational impacts:[1] • Project #2: Runway 3-21 and Taxiway M Rehabilitation (2021) • Airport Master Plan Update (2018-2019) • SWM Solution 1-B: Replace Portion of Basin 1 South Trunk Line • SWM Solution 1-L: Provide Regional Water Quality Treatment for BMP Strategy Area (BMP SA)-1.6 Specific benefits of coordinating with each project listed above are described in the Implementation Considerations section, under Planning and Design Considerations.
Target Construction Timeframe (2016-2020, 2021-2025, 2026-2035)	2021-2025 Timeframe selected to: • Allow completion of the Airport Master Plan Update, which will determine the timing of the Runway 3-21 pavement replacement. • Align with SWM Solution 1-B. A pipe inspection to assess the risk of asset failure may help to refine the construction timeframe.
Planning and Design Lead Time (<6 months, 6-12 months, 12-24 months)	< 6 months

Notes:

1. Project numbers and timeframes are from the Port's list of future development projects (Appendix A).

Cost Analysis

Item	Description
Opinion of Probable Capital Cost (2015 Dollars)[1]	$720,000
Cost Estimate Class / Contingency (1-Bid received, 2-Construction, 3-Design, 4-Concept Design, 5- Screening/Planning)	5- Screening/Planning
Fixed Asset Modifications Excluded from Cost Estimate	Utility relocation costs not included.
Cost Assumptions	• Assumes portions of existing pipe will be filled with controlled density fill and abandoned in place to minimize impacts to TACAN. • Assumes open cut of Taxiway G. • Assumes no significant construction impact to existing drainage tile. • Does not include cost savings by aligning SWM Solutions 1-B and 1-C, which share a common junction point. • Includes 40% for hard cost contingency. • Includes 30% for soft cost contingency.
O&M Cost Considerations	No change from current.

Notes:

1. Supporting detailed cost tables are provided in Appendix B.

SWM SOLUTION FACT SHEET 1-D

Stormwater Management Solution Tracking Information

SWM Solution ID	Solution Name	Capital Cost Summary	Anticipated Implementation Timeframe	Author	Revision Date
1-D	Drainage Planning Recommendations for NE 33rd Drive Development	Planning Guidance – No Costs Calculated	2016-2020	GS&P	June 2015

Stormwater Management Needs Addressed by Solution

SWM Need ID	Need Name	Need Type		
		Address Ponding and Facilitate Drainage	Address Risk of Stormwater Asset Failure	Provide Required Stormwater Controls
1-6	Address Ponding in Wetland North of Deicing Treatment Facility	X		
1-7	Address Ponding in Planned Development Area West of NE 33rd Drive	X		

Solution Description

Solution Type	Summary Description
Future Planning Consideration	SWM Solution 1-D provides recommendations for the future drainage system tie-ins associated with future development properties along NE 33rd Drive. The recommended solution is in the form of “future planning consideration” rather than a specific capital stormwater project because the ultimate development plans for the sites have a significant impact on the stormwater management solution details.

SWM Solution 1-D is associated with the future development of the properties along NE 33rd Drive on the west side of PDX. At this stage in the development planning process, the specifics of the development projects are unknown, including which portions of the sites will be developed, the layout of the sites, and when the development will occur.

The goal of SWM Solution 1-D is to provide drainage-related planning recommendations for Port-owned properties along NE 33rd Drive. The Port is planning to develop properties on the west side of NE 33rd Drive, north of the intersection with NE Sunderland Ave., and south of the intersection with NE Marine Drive (shown in Figure 1). Stormwater runoff from the site currently drains to a channel that discharges to a City of Portland (City) owned storm sewer along NE 33rd Drive. The City sewer conveys stormwater south to an existing channel located south of the Kliever Memorial Armory (Armory). The City sewer will not have sufficient capacity to convey the increased flow rates resulting from the development-driven increase in surface impervious area, and as a result, significant ponding within the future development site is likely to occur.

To support future development west of NE 33rd Drive, it is recommended that the Port install a dedicated on-site drainage network that drains the northern portion of the development sites south to an existing open channel located on the west side of NE Sunderland Avenue (within Project #99 extents). This existing channel drains to the east through existing culverts under both NE Sunderland Avenue and NE 33rd Drive, to an open channel to the east of NE 33rd Drive and south of the Armory. SWM Solution 1-D allows the Port to proceed with development without waiting on the City to perform modifications to the sewer system along NE 33rd Drive. However, it should be noted that existing site topography (i.e. 2005 LiDAR 2’ contours) suggests a relatively low elevation at the proposed development site, which may present a challenge when designing the proposed storm sewers to meet depth of cover requirements.

SWM Solution 1-D also includes installing a storm sewer that connects the wetland area bounded by the deicing treatment facility site, NE 33rd Drive, and NE Marine Drive to the new drainage network proposed west of NE 33rd Drive. Making this connection addresses SWM Need 1-6 (Hazardous Wildlife Attractant risk).

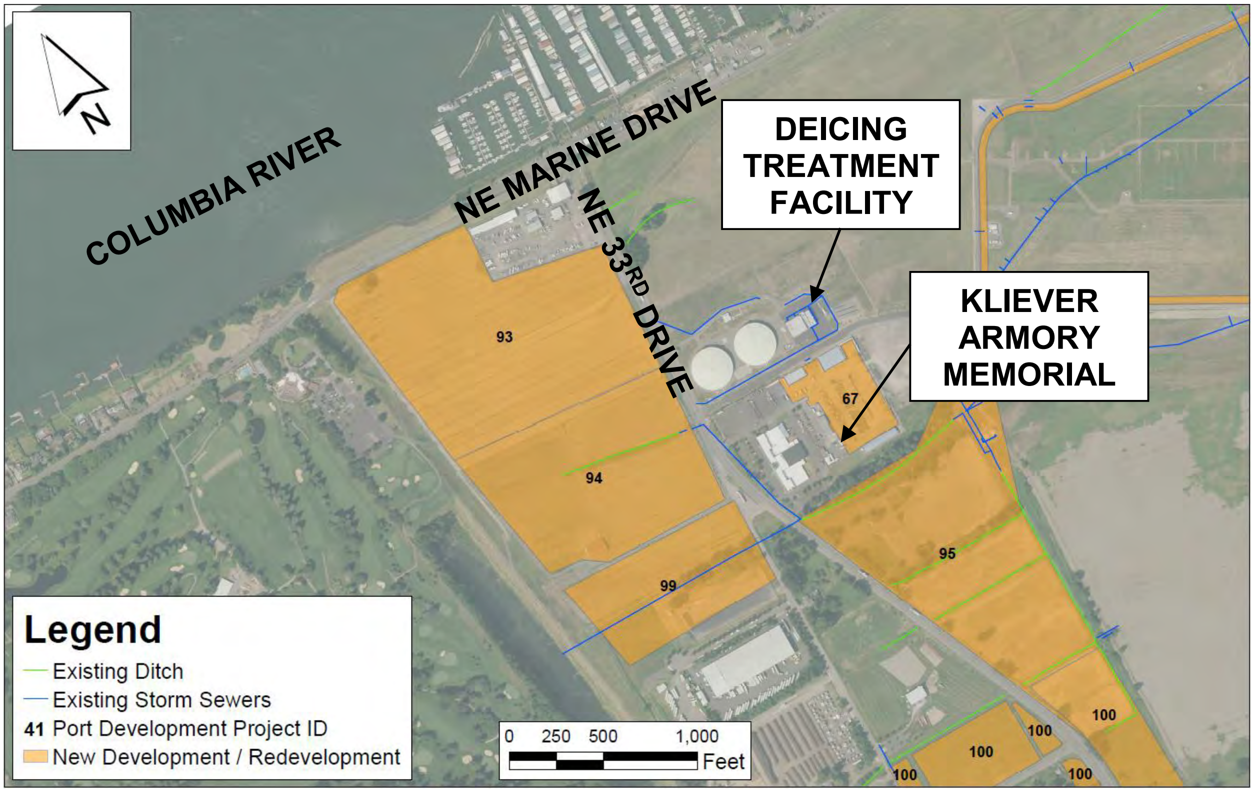


Figure 1: Plan View of Solution

Implementation Considerations

The following tables provide recommended considerations as the concepts for SWM Solution 1-D are further developed.

Planning and Design Considerations

Item	Description
Field Data Collection	• Underground utility location. • Geotechnical and hydrogeological studies may be needed to support detailed design. • Condition inspection of any existing structures where new pipe connections will be made. • Topographical surveying for the development sites, wetlands, and channels to confirm grading and storm sewer tie-ins.
Additional Technical Analysis	• Update the PDX stormwater hydraulic model to incorporate data from the Port groundwater analysis and determine sizes for new drainage infrastructure following identification of specific site layout plans. • Due to uneven grading on the site and uncertain receiving channel elevations, project designers should coordinate minimum site grade with required drainage system pipe sizes and minimum depths of cover.
Permitting	• Clean Water Act Section 401/404 permitting • National Marine Fisheries Service (NMFS) consultation • City Storm Sewer Connection Permit for any new drainage infrastructure connecting to the City storm sewer system • City of Portland Environmental Zones.
Siting	Align drainage system location with future development plans, required stormwater control BMPs, and discharge locations.

Coordination with Elements of Other Projects	• Coordinate solution with drainage infrastructure for the following planned development projects:
	  ○ Project #93: NE 33rd & Marine Drive Development North (2015)
	  ○ Project #94: NE 33rd & Marine Drive Development South (unknown timeframe)
	  ○ Project #99: Assumed Development (To Be Determined) (unknown timeframe)
	• Coordinate drainage system design for the development projects listed above with the planned water quality BMPs serving these development areas.

Enabling Projects	None identified.
Related Solutions	None identified.

Item	Description
Coordination with Port Departments	• Planning and Development - Identification and timing of development projects • Engineering - pipe sizing, utility relocation • Maintenance - new catch basins and manholes requiring routine maintenance • Asset Management - addition of new assets • Wildlife Management - change in future management techniques in area
Coordination with Tenants	Coordinate planning and design of drainage system with tenant development needs.
Coordination with Outside Agencies	• Coordinate with the City of Portland to confirm pipe ownership along NE 33rd Drive. • Any impacts to NE 33rd Drive or City-owned storm sewers should be coordinated with the City of Portland.
Design Disciplines Involved	Civil, and others as needed per development plans

Construction Considerations

Item	Description
Construction Components	• Specific drainage system elements to be determined at a later date based on development plans and site surveys. • Demolish and reconstruct or perform trenchless crossing of NE 33rd Drive to tie in drainage from east of the road. • Protect and/or relocate existing utilities as needed to install solution.
Airport Operational Impacts	• Installation of a drainage system within the wetland site will be outside of the North Runway (10L-28R) Runway Protection Zone (RPZ), but heights of construction equipment will need to be coordinated with FAA for potential conflicts with the navigable airspace. • Open cut of NE 33rd Drive may temporarily interfere with access to sites along NE 33rd Drive from NE Marine Drive, including the deicing treatment facility.
Construction Challenges	• Results of groundwater characterization studies should be considered for potential dewatering requirements. • Surface water dewatering will need to occur to allow the installation of a new outfall in the channel west of NE Sunderland Ave. Coordination with Multnomah County Drainage District (MCDD) to lower the pump settings at Pump Station #2 (PS-2) during construction may help to reduce dewatering costs.

Post-Construction Considerations

Item	Description
Post-Construction Coordination with Airport Operations	None identified.
Considerations for Operation and Maintenance (O&M) of the Solution	Increase in O&M for new drainage infrastructure.

Potential Risks if Solution is Implemented / Risk Mitigation Strategies

Item	Description	Mitigation Strategy
Regulatory Compliance	None identified.	Not applicable.
Airport or Tenant Operations	The tie-in of the wetland site will convey additional flows to the proposed development, which could increase risk of flooding.	Evaluate potential hydraulic impacts and performance of both systems as part of conceptual planning/design.
Aircraft Safety	None identified.	Not applicable.
Future Development Limitations	None identified.	Not applicable.

Schedule Analysis

Item	Description
Critical Schedule Drivers	Coordinate SWM Solution 1-D with the timeframes of the following development projects that are being served:[1] • Project #93: NE 33rd & Marine Drive Development North (2015) • Project #94: NE 33rd & Marine Drive Development South (unknown timeframe) • Project #99: Assumed Development (To Be Determined) (unknown timeframe)
Target Construction Timeframe (2016-2020, 2021-2025, 2026-2035)	2016-2020 Timeframe will depend upon the development schedule for the site.
Planning and Design Lead Time (<6 months, 6-12 months, 12-24 months)	6-12 months from beginning of development project design

Notes:

1. Project numbers and timeframes are from the Port's list of future development projects (Appendix A).

Cost Analysis

Item	Description
Opinion of Probable Capital Cost (2015 Dollars)	Not evaluated at this time due to conceptual nature of drainage system and development. It is assumed that drainage system costs will be incorporated into development project budgets.
Cost Estimate Class / Contingency (1-Bid received, 2-Construction, 3-Design, 4-Concept Design, 5- Screening/Planning)	Not applicable.
Fixed Asset Modifications Excluded from Cost Estimate	Not applicable.
Cost Assumptions	Not applicable.
O&M Cost Considerations	Not applicable.

SWM SOLUTION FACT SHEET 1-E

Stormwater Management Solution Tracking Information

SWM Solution ID	Solution Name	Capital Cost Summary	Anticipated Implementation Timeframe	Author	Revision Date
1-E	Drainage Planning Recommendations for Southwest Quad and Fazio Fields Development	Planning Guidance – No Costs Calculated	2026-2035	GS&P	June 2015

Stormwater Management Needs Addressed by Solution

SWM Need ID	Need Name	Need Type		
		Address Ponding and Facilitate Drainage	Address Risk of Stormwater Asset Failure	Provide Required Stormwater Controls
1-8	Address Ponding along MCDD Channels in Southwest Quad and Fazio Fields	X		

Solution Description

Solution Type	Summary Description
Future Planning Consideration	Consider recommendations for MCDD drainage system improvements while planning for future development at Southwest Quad and Fazio Fields. The recommended solution is in the form of a “future planning consideration”, rather than a specific capital stormwater project, because the ultimate development plans for the sites have a significant impact on the stormwater management solution details.

SWM Solution 1-E is associated with the future development of the Southwest Quad and Fazio Fields on the west side of PDX. At this stage in the development planning process, the specifics of the development project are unknown, including which portions of the sites will be developed, the site layout, and when the development will occur. Because of this uncertainty, Solution 1-E is presented as planning considerations rather than a specific capital project.

The goal of Solution 1-E is to provide drainage-related planning recommendations for the potential future development of the Southwest Quad and Fazio Fields areas, which are located east of NE 33rd Drive and southwest of South Runway (10R-28L), as shown in Figure 1. The details of development of both properties is undefined at present, but for analysis purposes it was assumed that the surfaces will be 100% impervious. Southwest Quad is expected to be developed sometime after 2035, while a timeframe for development of Fazio Fields has not yet been established. Stormwater from these properties currently drains to MCDD-managed channels, which convey the water to MCDD Pump Station #2 (MCDD PS #2) before it is pumped to the Columbia Slough. Due to limitations in pump station capacity at MCDD PS #2, stormwater backs up in the MCDD channels during large storm events and results in ponding at Fazio Fields and Southwest Quad. Both properties are currently within the 100-year floodplain defined by FEMA. Fazio Fields in particular is very low in elevation relative to the MCDD drainage channels and pump station settings, and this property is frequently inundated.

To support future development at these two sites, stormwater hydraulic modeling revealed that flow capacity would need to be added to the 56 cfs of current capacity at MCDD PS #2 in addition to diverting flows from Basin 1 North through the use of deicing pump station N (PS-N) (SWM Solution 1-F). While ponding is addressed within the Southwest Quad through implementation of SWM Solution 1-F, ponding within the Fazio Fields requires an additional 100 cfs capacity at MCDD PS#2. If the Port is only interested in developing Southwest Quad, there is no need for updates to PS#2. If the Port is interested in developing both the Southwest Quad and Fazio Fields, the total MCDD PS #2 capacity needed is 150 cfs. Such an upgrade would likely require a new structure for the intake, pump housing, controls and utilities, and new discharge pipe(s). Additionally, it may be necessary to evaluate upsizing existing culverts under NE 33rd Drive and NE Elrod Road to maximize the effectiveness of the pump station upgrade. The estimated capacity increase to PS#2 is highly subject to change depending on the nature, extents and elevation of the planned development.

The pump station capacity increase is highly influenced by the excessive ponding at Fazio Fields that is triggered by the low elevation of the site relative to the channels draining the site. The challenges of the low elevation of the site, frequent inundation, location within the 100-year floodplain, and the magnitude of infrastructure improvements required to address ponding will make Fazio Fields a very difficult site to develop for the Port.

The potential for using a larger MCDD PS #2 to address the ponding at Southwest Quad and Fazio Fields assumes that SWM Solution 1-F (Operate PS-N Continuously) is implemented. If that solution is not implemented, there will be more stormwater draining to the MCDD channels, and the magnitude of required improvements will increase. Additionally, the above capacity increase at PS#2 assumes upgrades to culverts within the MCDD channels to improve the efficiency of drainage to MCDD PS #2.

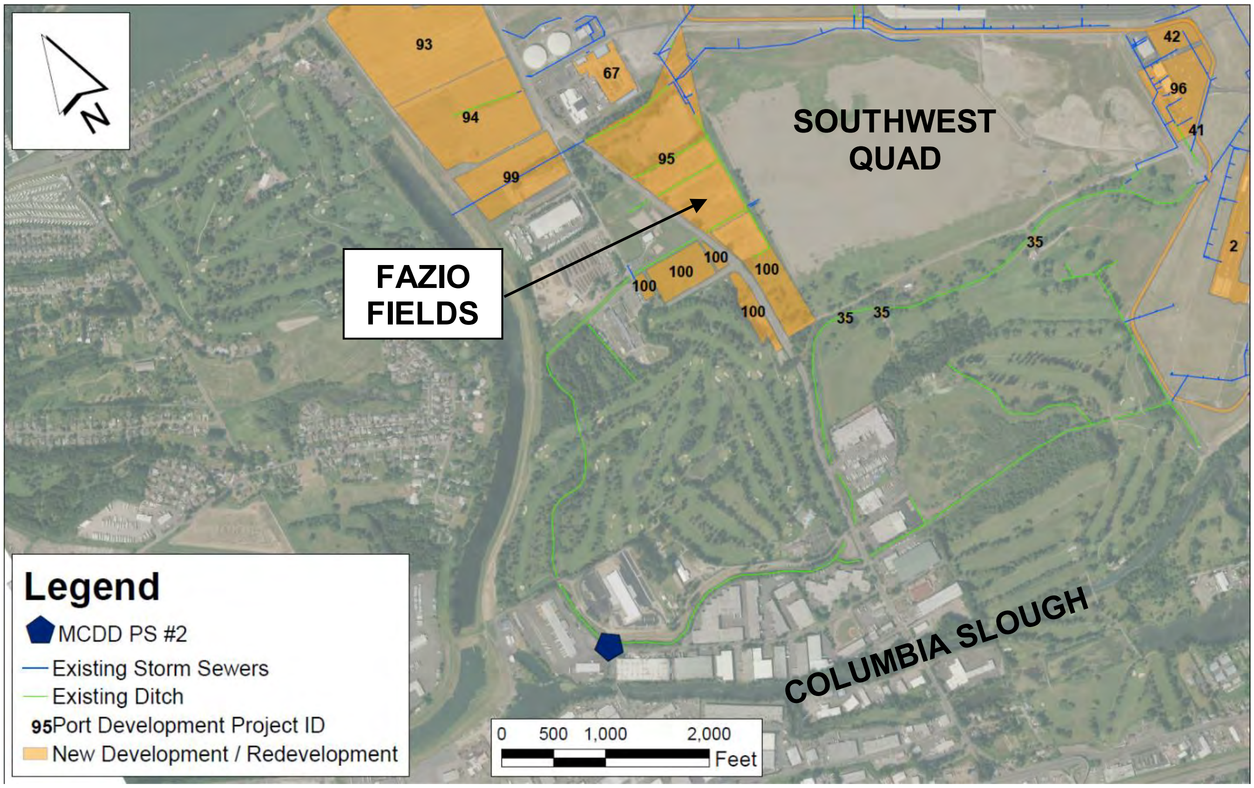


Figure 1: Plan View of Solution

Implementation Considerations

The following tables provide recommended considerations as the concepts for SWM Solution 1-E are further developed.

Planning and Design Considerations

Item	Description
Field Data Collection	• Underground utility location • Geotechnical and hydrogeological studies may be needed to support detailed design, including groundwater surface characterization. • Collection of detailed site topography to confirm site elevations and likelihood for flooding at Southwest Quad and Fazio Fields
Additional Technical Analysis	• Update the PDX stormwater hydraulic model to incorporate data from the Port groundwater analysis and determine sizes for new and modified drainage infrastructure following identification of specific site layout plans for Southwest Quad and/or Fazio Fields development. Also confirm the need to upgrade culverts under NE 33rd Drive and NE Elrod Road. • Analysis to support potential FEMA Letter of Map Revision (LOMR) or Conditional LOMR (CLOMR) for development within floodplain boundaries
Permitting	• Clean Water Act Section 401/404 permitting • National Marines Fisheries Services (NMFS) consultation • LOMR/CLOMR
Siting	• Consider siting initial development on higher ground to avoid floodplain boundaries. • Align drainage system locations serving the new development with future development plans, required stormwater control BMPs, and discharge locations

Coordination with Elements of Other Projects	• Determine if Fazio Fields will be developed (Projects #95 and #100).
	• Implement MCDD PS #2 changes before the following development projects receive Business Case approvals to avoid impacts on the development project schedules:
	  o Project #79: MP Southwest Quad Prep & Ramp Phase 1
	  o Project #82: Dredge/Fill Southwest Quad
	  o Project #95: East Side NE 33rd Development
	  o Project #100: Concordia Athletic Expansion
	• Coordinate drainage system design for the development projects listed above with the planned water quality BMPs serving these development areas.

Enabling Projects	None identified.

Item	Description
Related Solutions	The effectiveness of SWM Solution 1-E to address ponding associated with SWM Need 1-8 relies on the implementation of SWM Solution 1-F.
Coordination with Port Departments	• Planning and Development - identification and timing of development project • Engineering - hydraulics, utility relocation • Maintenance - change in catch basins and manholes requiring routine maintenance • Asset Management - new assets • Wildlife Management - change in management techniques in area
Coordination with Tenants	Coordinate planning and design of drainage system and upgraded pump station with tenant development needs.
Coordination with Outside Agencies	• Coordinate with MCDD on the scope, objectives, design and cost of modifications to MCDD PS #2. • Coordinate with FEMA to update the 100-year floodplain boundaries based on the modifications at MCDD PS #2.
Design Disciplines Involved	Civil, Structural, Architectural, Mechanical / Process, Electrical, and Instrumentation

Construction Considerations

Item	Description
Construction Components	• Construct upgrades to MCDD PS #2 - Details to be determined at a later date based on development plans and site surveys. • Demolish and reconstruct or perform trenchless crossings of NE 33rd Drive and NE Elrod Road to replace culverts. Sizing and details to be determined as part of additional technical analysis. • Construct new drainage elements for development. • Protect and/or relocate existing utilities as needed to install solution.
Airport Operational Impacts	None identified.
Construction Challenges	• The existing MCDD PS #2 will need to remain operational to the extent possible during construction, and bypass pumping may need to be provided when MCDD PS #2 is not operational. • Results of groundwater characterization studies should be considered for potential dewatering requirements. • Surface water dewatering may need to occur to allow the construction of pump station upgrades. Coordination with MCDD will be required to manage water levels at MCDD PS #2.

Post-Construction Considerations

Item	Description
Post-Construction Coordination with Airport Operations	None identified.
Considerations for Operation and Maintenance (O&M) of the Solution	Coordinate O&M of PS #2 with MCDD.

Potential Risks if Solution is Implemented / Risk Mitigation Strategies

Item	Description	Mitigation Strategy
Regulatory Compliance	None identified.	Not applicable.
Airport or Tenant Operations	None identified.	Not applicable.
Aircraft Safety	None identified.	Not applicable.
Future Development Limitations	None identified.	Not applicable.

Schedule Analysis

Item	Description
Critical Schedule Drivers	Coordinate the construction with the following development project timeframes:[1] • Project #79: MP Southwest Quad Prep & Ramp Phase 1 (2035+) • Project #82: Dredge/Fill Southwest Quad (2035+) • Project #95: East Side NE 33rd Development (unknown timeframe) • Project #100: Concordia Athletic Expansion (unknown timeframe) Specific benefits of coordinating with each project listed above are described in the Implementation Considerations section, under Planning and Design Considerations.
Target Construction Timeframe (2016-2020, 2021-2025, 2026-2035)	2026-2035
Planning and Design Lead Time (<6 months, 6-12 months, 12-24 months)	12-24 months

Notes:
1. Project numbers and timeframes are from the Port's list of future development projects (Appendix A).

Cost Analysis

Item	Description
Opinion of Probable Capital Cost (2015 Dollars)	Not evaluated at this time due to conceptual nature of development and undefined timeframe.
Cost Estimate Class / Contingency (1-Bid received, 2-Construction, 3-Design, 4-Concept Design, 5- Screening/Planning)	Not applicable.
Fixed Asset Modifications Excluded from Cost Estimate	Not applicable.
Cost Assumptions	Not applicable.
O&M Cost Considerations	Not applicable.

SWM SOLUTION FACT SHEET 1-F

Stormwater Management Solution Tracking Information

SWM Solution ID	Solution Name	Capital Cost Summary	Anticipated Implementation Timeframe	Author	Revision Date
1-F	Operate PS-N Continuously	$0	2016-2020	GS&P	June 2015

Stormwater Management Needs Addressed by Solution

SWM Need ID	Need Name	Need Type		
		Address Ponding and Facilitate Drainage	Address Risk of Stormwater Asset Failure	Provide Required Stormwater Controls
1-1	Address Ponding in Basin 1 North Infield Areas of South Runway (10R-28L)	X		

Solution Description

Solution Type	Summary Description
Operational Change	Change operation of existing dilute deicing pump station PS-N from winter-only with set Total Organic Carbon (TOC) diversion concentrations to year-round with no TOC diversion concentrations. Change assists in reducing ponding in western infield areas of South Runway along Basin 1 North trunk line.

Solution 1-F is strictly an operational change to the deicing system pump station N (PS-N). No capital expenditures are required as part of this solution, although the solution requires SWM Solution 1-A to be constructed to achieve its full effect of mitigating the ponding described in SWM Need 1-1. SWM Solution 1-F involves year-round operation of existing deicing pump station PS-N without TOC diversion concentration set points. The location of PS-N is shown on Figure 1.

Under existing conditions, PS-N is operational only during the deicing season between November and May, and collects deicer-impacted stormwater based on applicable “diversion concentration” thresholds for Total Organic Carbon (TOC). TOC concentrations are measured online. When TOC concentrations in the stormwater entering PS-N exceed the “pump on” diversion concentration (set at TOC equivalent of 30 mg/L BOD in 2015), PS-N turns on and routes stormwater to the Dilution Storage Tanks (DSTs) located at the deicing treatment facility. When the TOC diversion concentrations drops below the TOC equivalent of 17 mg/L BOD, PS-N turns off and stormwater bypasses the pump station for direct discharge toward the Columbia Slough. Stormwater in the DSTs is typically routed to the Columbia River in accordance with the deicing NPDES permit effluent limits for BOD daily mass load. Based on this operational protocol, PS-N collects stormwater during a large portion of a typical winter. During some portions of the winter and during all periods of June – October, stormwater with minor TOC concentration is routed to the Columbia Slough.

The goal of SWM Solution 1-F is to remove stormwater more quickly from the infield areas of Runway 10R-28L along the Basin 1 North trunk line (SWM Need 1-1). SWM Solution 1-F involves continuous year-round operation of PS-N to collect stormwater from the Basin 1 North trunk line, without TOC diversion concentrations applied. As a result of implementing this solution, all stormwater from Basin 1 North, up to the capacity of PS-N, would be diverted to the DSTs prior to discharging to the Columbia River. This solution has benefits to the Basin 1 North drainage system upstream of PS-N because it is improves the efficiency of drainage by removing the impact of tailwater from the downstream MCDD channels. In turn, the diversion of stormwater from Basin 1 North also has benefits to the downstream channels by reducing the volume of water discharged to the channels resulting in a reduction in the water levels in channels and ultimately the level of ponding downstream. As such, downstream solutions (SWM Solutions 1-E) were sized assuming that this solution had been implemented.

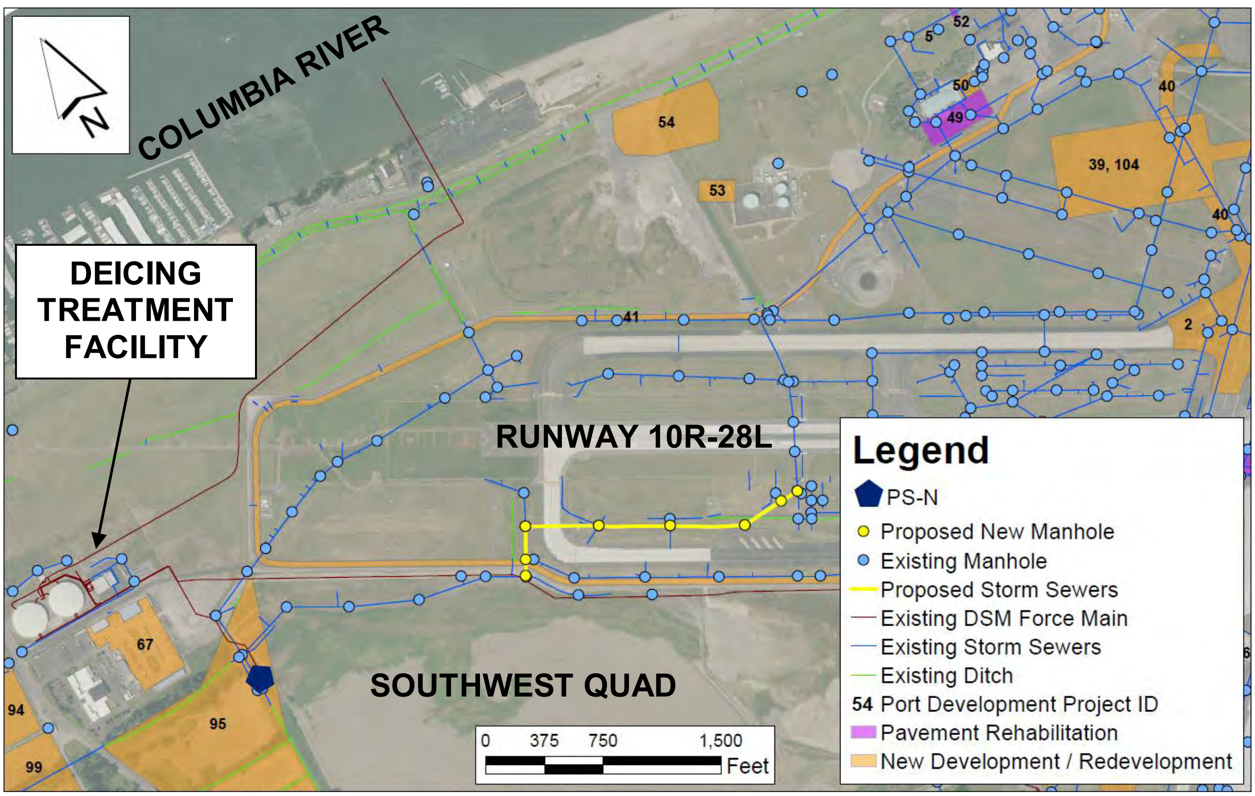


Figure 1: Plan View of Solution

Implementation Considerations

The following tables provide recommended considerations as the project moves from planning concept to implemented solution. The tables below address three phases of implementation, including planning and design, construction, and post-construction.

Planning and Design Considerations

Item	Description
Field Data Collection	None identified.
Additional Technical Analysis	Update the PDX stormwater hydraulic model following completion of the Port groundwater analysis to confirm use of PS-N in conjunction with SWM Solution 1-A.
Permitting	The deicing permit from DEQ needs to be modified to allow stormwater discharges year-round. The result of the change in operation in the deicing season will be a slight decrease in the BOD mass load discharged annually to the Columbia Slough and a slight increase in the BOD mass load discharged to the Columbia River.
Siting	None identified.
Coordination with Elements of Other Projects	Coordinate the deicing NPDES permit modification required for this solution with the permit modification required for SWM Solution 7-A.
Enabling Projects	None identified.
Related Solutions	The effectiveness of SWM Solution 1-F to address ponding associated with SWM Need 1-1 relies on the implementation of SWM Solution 1-A.
Coordination with Port Departments	• Environmental - change in NPDES permit and PS-N set points • Maintenance - change in PS-N set points, change in routine maintenance of PS-N and PS-P, and change in schedule of cleaning the DSTs • Engineering - relatively minor change in SCADA programming may be necessary for summer operation (need to verify)
Coordination with Tenants	None identified.
Coordination with Outside Agencies	None identified.
Design Disciplines Involved	Instrumentation (to perform programming updates at PS-N)

Construction Considerations

Item	Description
Construction Components	Not applicable.
Airport Operational Impacts	Not applicable.
Construction Challenges	Not applicable.

Post-Construction Considerations[1]

Item	Description
Post-Construction Coordination with Airport Operations	• Year-round operation of PS-N and PS-P, with accompanying increase in power consumption. • As described in the "Potential Risk" table below, an analysis indicated a low risk of this solution impacting the risk for exceedances of deicing permit. It is possible that unique combinations of deicing and stormwater conditions that were not captured in the analysis could result in the DSTs filling more frequently, which may result in the SCADA system triggering PS-N, PS-S, and PS-I to shut off. If necessary to reserve capacity in the DSTs, operators may need to revert to current operational set points for PS-N. This decision should be made in coordination with Port wildlife management staff, as it may result in ponding associated with SWM Need 1-1 not being fully addressed. • If maintenance conditions result in short-term inability to use PS-P, the collection of water via PS-N may need to be suspended for short periods.
Considerations for Operation and Maintenance (O&M) of the Solution	• Maintenance requirements for PS-N will increase and extend year-round. • Maintenance requirements for PS-P will increase and extend year-round. • Maintenance schedule and requirements for DST cleanout may change.

Notes:

1. Although solution does not involve construction, this section is used to cover long term operation and maintenance considerations which are applicable to the proposed operational change.

Potential Risks if Solution is Implemented / Risk Mitigation Strategies

Item	Description	Mitigation Strategy
Regulatory Compliance	There is a low risk to compliance with deicing permit. Solution has the potential to increase volumes sent to the DSTs which could result in greater frequency of reaching capacity of the tanks. When the tanks are full, collection at the upstream pump stations stop (PS-N, PS-S and PS-I). This presents a risk for BOD load to bypass collection and discharge to the Columbia Slough.	An analysis of deicing system capacity revealed insignificant change in the risk of non-compliance with the deicing permit. See the "Post-Construction Considerations" table above for operational considerations.
Airport or Tenant Operations	None identified..	Not applicable..
Aircraft Safety	None identified.	Not applicable.
Future Development Limitations	None identified.	Not applicable.

Schedule Analysis

Item	Description
Critical Schedule Drivers	Coordinate the implementation of SWM Solution 1-F with the following other SWM Solutions: • SWM Solution 7-A: Provide Pump Station to Address Basin 7 Capacity Limitations Specific benefits of coordinating with this project are described in the Implementation Considerations section, under Planning and Design Considerations.
Target Construction Timeframe (2016-2020, 2021-2025, 2026-2035)	2016-2020 Timeframe selected based on: • The physical ability to implement this solution immediately • Aligning with SWM Solution 7-A, which also requires a modification to the deicing permit.
Planning and Design Lead Time (<6 months, 6-12 months, 12-24 months)	< 6 months

Cost Analysis

Item	Description
Opinion of Probable Capital Cost (2015 Dollars)	Not applicable.
Cost Estimate Class / Contingency (1-Bid received, 2-Construction, 3-Design, 4-Concept Design, 5- Screening/Planning)	Not applicable.
Fixed Asset Modifications Excluded from Cost Estimate	Not applicable.
Cost Assumptions	Not applicable.
O&M Cost Considerations	Not applicable.

SWM SOLUTION FACT SHEET 1-G

Stormwater Management Solution Tracking Information

SWM Solution ID	Solution Name	Capital Cost Summary	Anticipated Implementation Timeframe	Author	Revision Date
1-G	Water Quality Planning Recommendations for BMP Strategy Area (BMP SA)-1.1	$4,100,000	2016-2020	GS&P and Geosyntec	June 2015

Stormwater Management Needs Addressed by Solution

SWM Need ID	Need Name	Need Type		
		Address Ponding and Facilitate Drainage	Address Risk of Stormwater Asset Failure	Provide Required Stormwater Controls
0-1	Post-Construction Stormwater Pollutant and Runoff Control			X

Development projects planned by the Port will trigger stormwater quality treatment requirements of the MS4 permit as outlined in the Port of Portland Stormwater Design Standards Manual (DSM) and described in SWM Need Fact Sheet 0-1. The proposed solution addresses the need to provide treatment for future development projects in this BMP Strategy Area (BMP SA-1.1), as summarized in the table below. The subsequent table provides a summary of the BMP sizing requirements, as calculated based on DSM criteria. Some of the future development projects lie outside the current boundary of DSM applicability and may need to follow the City of Portland's Stormwater Management Manual, namely Projects #93, #94, and #99.

Future Development Projects Treated by BMP

Project # [1]	Drainage Basin	Planned Development / Redevelopment Project Name	Acres Treated by BMP
93	1	NE 33rd & Marine Drive Development - North	29
94	1	NE 33rd & Marine Drive Development - South	20
95 [2]	1	East side NE 33rd Development	29
99	1	Assumed Development (To Be Determined)	11
100	1	Concordia Athletic Expansion	18
Total Acres of Development Treated			107

Notes:
1. Project numbers correspond to future development areas displayed on Figure 1, and included in the Port's list of future development projects (Appendix A).
2. Project crosses into an adjacent BMP Strategy Area. Acreage reflects portion in this BMP Strategy Area.

Water Quality Treatment BMP Sizing Basis

Area to be Treated	Impervious Acres to be Treated	Annual Runoff Volume (ac-ft)	WQ Design Flow Rate (cfs)[1]	WQ Design Volume (ac-ft)[2]
Planned Development/Redevelopment Area Only	107	254	9.0	2.3
Entire BMP Strategy Area [3]	139	333	11.8	3.0

Notes:
1. Based on 0.1 in/hr design intensity, per DSM requirements for offline flow-based BMPs.
2. Based on 0.45 inch design depth, per DSM requirements for volume based BMPs with 24-hr drawdown time.
3. Provided for planning purposes only. BMP sizing and costs based on Planned Development / Redevelopment Area Only.

Solution Description

Solution Type	Summary Description
Future Planning Considerations	Select and construct BMPs, such as planter boxes, bioretention, vegetated swales, and/or LID approaches, as part of construction activities for development projects within the BMP Strategy Area. Alternatively sub-regional BMP facilities can be used to address multiple projects. This solution does not include use of a regional treatment facility.

Figure 1 depicts the BMP Strategy Area with the planned future development projects. Proposed BMP locations are omitted since the proposed BMPs can be either distributed controls or sub-regional facilities whose locations are dependent on the type of development and the location and distribution of pervious areas within the development. A regional BMP is not practical to treat this BMP Strategy Area because the Strategy Area is divided by NE 33rd Drive and there is no existing centralized storm sewer infrastructure to cost-effectively route stormwater to a single regional BMP location. For building-based projects with roofs, parking lots, and landscaped areas (i.e., Projects #93, #94, #95, and #99), distributed stormwater controls such as planter box filters, bioretention facilities, infiltration trenches, vegetated swales, and/or other low impact development (LID) design elements can be used to reduce effective impervious areas and treat runoff. Alternatively, sub-regional facilities can be used to provide combined treatment for a few of the projects. For example, depending on site grading and drainage design, a single sub-regional BMP could potentially capture and treat stormwater runoff from Projects #93, #94, and #99 without pumping. Similarly, it may be possible to combine treatment for Project #95 and portions or all of Project #100. The location and size of the proposed BMPs can be determined once the extents of the improvements are known.

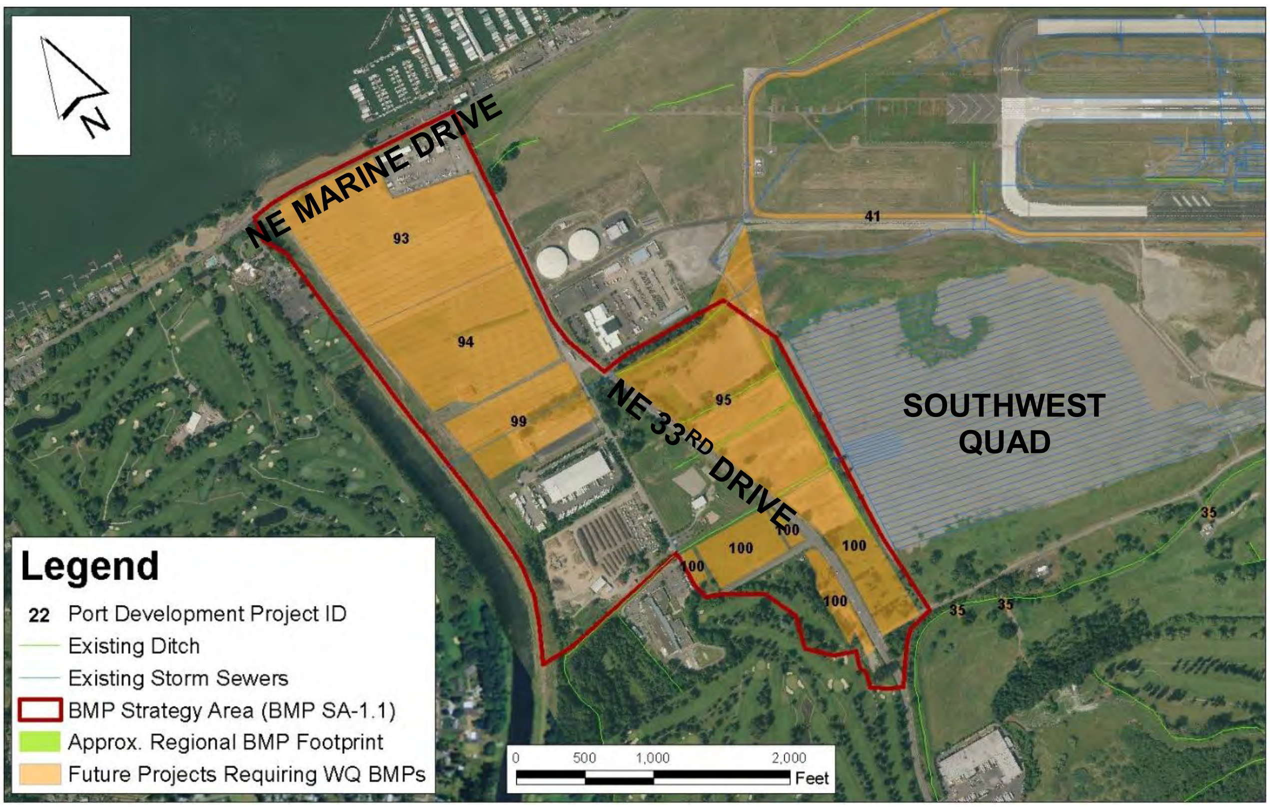


Figure 1: BMP SA-1.1 Vicinity

Implementation Considerations

The following tables provide recommended considerations as the project moves from planning concept to implemented solution. The tables below address three phases of implementation, including planning and design, construction, and post-construction.

Planning and Design Considerations

Item	Description
Field Data Collection	None identified.
Additional Technical Analysis	Individual BMP sizing needed once the type and location determined. Hydraulic analyses that considers influent flows, head losses, and tailwater conditions for the discharge.
Permitting	City of Portland, BES for Projects #93, #94, and #99
Siting	During detailed design, review the development project extents and layout, with subsequent adjustment as needed to optimize land use, avoid utilities and meet setback requirements.
Coordination with Elements of Other Projects	• Post-construction BMPs must be installed to address the MS4 permit requirements following completion of the associated development/redevelopment projects. • Coordinate with SWM Solution 1-D (Drainage Planning Recommendations for NE 33rd Drive Development) for storm sewer sizing and potential construction efficiency.
Enabling Projects	None identified.
Related Solutions	None identified.
Coordination with Port Departments	• Planning and Development - Charter and Business Case Development • Engineering - pipe sizing, utility relocation, design coordination • Maintenance - change in catch basins and manholes requiring routine maintenance • Asset Management - removal of existing assets, addition of new assets • Wildlife Management - identify significance of potential risks
Coordination with Tenants	Port to determine the timeline for construction of water quality treatment BMPs in coordination with the development projects in the BMP Strategy Area and their respective tenants.
Coordination with Outside Agencies	None identified.
Design Disciplines Involved	Civil, Landscape Architect, and others as needed depending on BMPs selected

Construction Considerations

Item	Description
Construction Components	Depends on BMPs selected.
Airport Operational Impacts	None identified.
Construction Challenges	Routing new gravity conveyance pipelines among project areas, BMPs, and existing stormwater conveyance may be challenging given conflicts with existing infrastructure and hydraulic needs.

Post-Construction Considerations

Item	Description
Post-Construction Coordination with Airport Operations	None identified.
Considerations for Operation and Maintenance (O&M) of the Solution	Depends on BMP selected. Refer to DSM Appendix O for guidance on O&M level of effort for various BMPs.

Potential Risks if Solution is Implemented / Risk Mitigation Strategies

Item	Description	Mitigation Strategy
Regulatory Compliance	Effectively tracking development project treatment needs and BMPs to which it is assigned	Develop BMP tracking tool.
Airport or Tenant Operations	None identified.	Not applicable.
Aircraft Safety	Risk of wildlife attraction	Selected BMP should not have exposed water surface to minimize wildlife attraction. Coordinate design features with Port Natural Resources staff.
Future Development Limitations	BMP footprint area will be unavailable for other development.	Coordinate siting with project planners to confirm location minimizes conflicts with future development.

Schedule Analysis

Item	Description
Critical Schedule Drivers	Coordinate the construction with the following project timeframes:[1] • Project #93: NE 33rd & Marine Drive Development – North (2015) • Project #94: NE 33rd & Marine Drive Development – South (unknown timeframe) • Project #95: East side NE 33rd Development (unknown timeframe) • Project #99: Assumed Development (To Be Determined) (unknown timeframe) • Project #100: Concordia Athletic Expansion (unknown timeframe) • SWM Solution 1-D: Drainage Planning Recommendations for NE 33rd Drive Development
Target Construction Timeframe (2016-2020, 2021-2025, 2026-2035)	2016-2020 Timeframe selected to be conservative based on above development projects with some unknown timeframes. Assumed that BMP will be installed by end of timeframe.
Planning and Design Lead Time (<6 months, 6-12 months, 12-24 months)	6-12 months from beginning of development project design

Notes:

1. Project numbers and timeframes are from the Port's list of future development projects (Appendix A).

Cost Analysis

Item	Description
Opinion of Probable Capital Cost (2015 Dollars)	$4,100,000
Cost Estimate Class / Contingency (1-Bid received, 2-Construction, 3-Design, 4-Concept Design, 5- Screening/Planning)	5- Screening/Planning
Fixed Asset Modifications Excluded from Cost Estimate	None identified.
Cost Assumptions	• Includes 30% for hard cost contingency. • Includes 30% for soft cost contingency. • Other relevant assumptions provided in “BMP Sizing Basis” section in this fact sheet. • Assumes bioretention BMPs as representative for cost planning purposes, using unit costs from DSM Appendix N.
O&M Cost Considerations	Reference DSM Appendix O for information on O&M level of effort for BMPs.

SWM SOLUTION FACT SHEET 1-H

Stormwater Management Solution Tracking Information

SWM Solution ID	Solution Name	Capital Cost Summary	Anticipated Implementation Timeframe	Author	Revision Date
1-H	Water Quality Planning Recommendations for BMP Strategy Area (BMP SA)-1.2	$690,000	2016-2020	GS&P and Geosyntec	June 2015

Stormwater Management Needs Addressed by Solution

SWM Need ID	Need Name	Need Type		
		Address Ponding and Facilitate Drainage	Address Risk of Stormwater Asset Failure	Provide Required Stormwater Controls
0-1	Post-Construction Stormwater Pollutant and Runoff Control			X

Development projects planned by the Port will trigger stormwater quality treatment requirements of the MS4 permit as outlined in the Port of Portland Stormwater Design Standards Manual (DSM) and described in SWM Need Fact Sheet 0-1. The proposed solution addresses the need to provide treatment for future development projects in this BMP Strategy Area (BMP SA-1.2), as summarized in the table below. The subsequent table provides a summary of the BMP sizing requirements, as calculated based on DSM criteria.

Future Development Projects Treated by BMP

Project # [1]	Drainage Basin	Planned Development / Redevelopment Project Name	Acres Treated by BMP
5	1	Public Safety & Security Garage Expansion	1.6
41[2]	1	Perimeter Road Rehabilitation	9.6
50	1	Future Planning - ARFF Expansion	0.4
53	1	Future Planning - Fuel Farm Expansion	0.8
54	1	Future Planning - GA Expansion	5.5
Total Acres of Development Treated			17.9

Notes:

1. Project numbers correspond to future development areas displayed on Figure 1, and included in the Port's list of future development projects (Appendix A).
2. Project crosses into an adjacent BMP Strategy Area. Acreage reflects portion in this BMP Strategy Area.

Water Quality Treatment BMP Sizing Basis

Area to be Treated	Impervious Acres to be Treated	Annual Runoff Volume (ac-ft)	WQ Design Flow Rate (cfs)[1]	WQ Design Volume (ac-ft)[2]
Planned Development/Redevelopment Area Only	17.9	42.5	1.5	0.4
Entire BMP Strategy Area [3]	73.7	186.0	6.6	1.7

Notes:

1. Based on 0.1 in/hr design intensity, per DSM requirements for offline flow-based BMPs.
2. Based on 0.45 inch design depth, per DSM requirements for volume based BMPs with 24-hr drawdown time.
3. Provided for planning purposes only. BMP sizing and costs based on Planned Development / Redevelopment Area Only.

Solution Description

Solution Type	Summary Description
Future Planning Considerations	Select and construct BMPs, such as planter boxes, bioretention, vegetated swales, and/or LID approaches as part of development project construction activities for projects within the strategy area. This solution does not include use of a regional treatment facility.

Figure 1 depicts the BMP Strategy Area with the planned future development projects. Proposed BMP locations are omitted since the proposed BMPs can be either distributed controls or sub-regional facilities whose locations are dependent on the type of development and the location and distribution of pervious areas within the development. For building-based projects with roofs, parking lots, and landscaped areas distributed stormwater controls such as planter box filters, bioretention facilities, infiltration trenches, vegetated swales, and/or other low impact development (LID) design elements can be used to reduce effective impervious areas and treat runoff. The Perimeter Road Rehabilitation project may be best served by infiltration trenches or filter strips. A regional facility is not recommended here due to the distance between future development projects and the length of new pipe that would be needed to consolidate treatment at a single facility. The location and size of the proposed BMPs can be determined once the extents of the improvements are known.

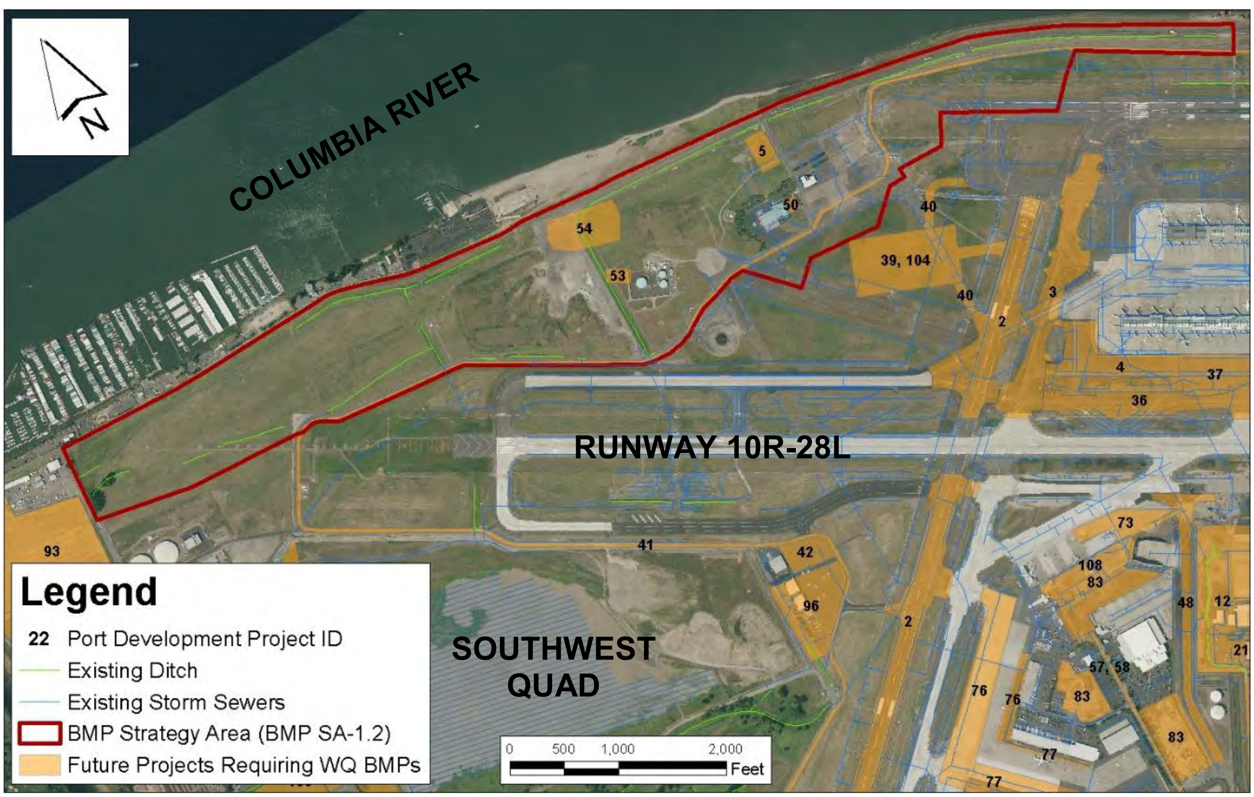


Figure 1: BMP SA-1.2 Vicinity

Implementation Considerations

The following tables provide recommended considerations as the project moves from planning concept to implemented solution. The tables summarize considerations three phases of implementation, including planning and design, construction, and post-construction.

Planning and Design Considerations

Item	Description
Field Data Collection	None identified.
Additional Technical Analysis	Individual BMP sizing needed once the type and location determined. Hydraulic analyses that considers influent flows, head losses, and tailwater conditions for the discharge.
Permitting	None identified.
Siting	During detailed design, review the development project extents and layout, with subsequent adjustment as needed to optimize land use, avoid utilities and meet setback requirements.
Coordination with Elements of Other Projects	Post-construction BMPs must be installed to address the MS4 permit requirements following completion of the associated development/redevelopment projects.
Enabling Projects	None identified.
Related Solutions	None identified.
Coordination with Port Departments	• Planning and Development - Charter and Business Case Development • Engineering - pipe sizing, utility relocation, design coordination • Maintenance - change in catch basins and manholes requiring routine maintenance • Asset Management - removal of existing assets, addition of new assets • Wildlife Management - identify significance of potential risks
Coordination with Tenants	Port to determine the timeline for construction of treatment BMPs in coordination with the development projects in the BMP Strategy Area.
Coordination with Outside Agencies	None identified.
Design Disciplines Involved	Civil and others as needed depending on BMPs selected

Construction Considerations

Item	Description
Construction Components	Depends on BMPs selected.
Airport Operational Impacts	None identified.
Construction Challenges	Routing new gravity conveyance pipelines among project areas, BMPs, and existing stormwater conveyance may be challenging given conflicts with existing infrastructure and hydraulic needs.

Post-Construction Considerations

Item	Description
Post-Construction Coordination with Airport Operations	None identified.
Considerations for Operation and Maintenance (O&M) of the Solution	Depends on BMP selected. Refer to DSM Appendix O for guidance on O&M level of effort for various BMPs.

Potential Risks if Solution is Implemented / Risk Mitigation Strategies

Item	Description	Mitigation Strategy
Regulatory Compliance	Effectively tracking development project treatment needs and BMPs to which it is assigned.	Develop BMP tracking tool.
Airport or Tenant Operations	None identified.	Not applicable.
Aircraft Safety	Risk of wildlife attraction	Selected BMPs should not have exposed water surface to minimize wildlife attraction. Coordinate design features with Port Natural Resources staff.
Future Development Limitations	BMP footprint area will be unavailable for other development.	Coordinate siting with project planners to confirm location minimizes conflicts with future development.

Schedule Analysis

Item	Description
Critical Schedule Drivers	Coordinate the construction with the following project timeframes:[1] • Project #5: Public Safety & Security Garage Expansion (2015) • Project #41: Perimeter Road Rehabilitation (2017) • Project #50: Future Planning - ARFF Expansion (unknown timeframe) • Project #53: Future Planning - Fuel Farm Expansion (unknown timeframe) • Project #54: Future Planning - GA Expansion (unknown timeframe)
Target Construction Timeframe (2016-2020, 2021-2025, 2026-2035)	2016-2020 Timeframe selected to correspond with above development projects. Assumed that BMP will be installed by end of timeframe.
Planning and Design Lead Time (<6 months, 6-12 months, 12-24 months)	6-12 months from beginning of development project design

Notes:

1. Project numbers and timeframes are from the Port's list of future development projects (Appendix A).

Cost Analysis

Item	Description
Opinion of Probable Capital Cost (2015 Dollars)	$690,000
Cost Estimate Class / Contingency (1-Bid received, 2-Construction, 3-Design, 4-Concept Design, 5- Screening/Planning)	5- Screening/Planning
Fixed Asset Modifications Excluded from Cost Estimate	None identified.
Cost Assumptions	• Includes 30% for hard cost contingency. • Includes 30% for soft cost contingency. • Other relevant assumptions provided in "BMP Sizing Basis" section in this fact sheet. • Assumes bioretention BMPs as representative for cost planning purposes, using unit costs from DSM Appendix N.
O&M Cost Considerations	Reference DSM Appendix O for information on O&M level of effort for BMPs.

SWM SOLUTION FACT SHEET 1-I

Stormwater Management Solution Tracking Information

SWM Solution ID	Solution Name	Capital Cost Summary	Anticipated Implementation Timeframe	Author	Revision Date
1-I	Provide Regional Water Quality Treatment for BMP Strategy Area (BMP SA)-1.3	$1,400,000	2016-2020	GS&P and Geosyntec	June 2015

Stormwater Management Needs Addressed by Solution

SWM Need ID	Need Name	Need Type		
		Address Ponding and Facilitate Drainage	Address Risk of Stormwater Asset Failure	Provide Required Stormwater Controls
0-1	Post-Construction Stormwater Pollutant and Runoff Control			X

Development projects planned by the Port will trigger stormwater quality treatment requirements of the MS4 permit as outlined in the Port of Portland Stormwater Design Standards Manual (DSM) and described in SWM Need Fact Sheet 0-1. The proposed solution addresses the need to provide treatment for future development projects in this BMP Strategy Area (BMP SA-1.3), as summarized in the table below. The subsequent table provides a summary of the BMP sizing requirements, as calculated based on DSM criteria.

Future Development Projects Treated by BMP

Project # [1]	Drainage Basin	Planned Development / Redevelopment Project Name	Acres Treated by BMP
2 [2]	1	Runway 3-21 & Taxiway M Rehabilitation	3.4
3 [2]	1	Taxiway E North Rehabilitation	0.6
40	1	Taxiway H Rehabilitation	2.0
41	1	Perimeter Road Rehabilitation	1.5
39	1	NW Ramp Relocation	13.4
104	1	MP RON Aircraft Parking Phase 2 (DD RON NE Ramp Expansion)	
Total Acres of Development Treated			20.9

Notes:
1. Project numbers correspond to future development areas displayed on Figure 1, and included in the Port's list of future development projects (Appendix A).
2. Project crosses into an adjacent BMP Strategy Area. Acreage reflects portion in this BMP Strategy Area.

Water Quality Treatment BMP Sizing Basis

Area to be Treated	Impervious Acres to be Treated	Annual Runoff Volume (ac-ft)	WQ Design Flow Rate (cfs)[1]	WQ Design Volume (ac-ft)[2]
Planned Development/Redevelopment Area Only	20.9	49.7	1.8	0.7
Entire BMP Strategy Area [3]	52.6	128.9	4.5	1.7

Notes:
1. Based on 0.1 in/hr design intensity, per DSM requirements for offline flow-based BMPs.
2. Based on 0.45 inch design depth, per DSM requirements for volume-based BMPs with 24-hr drawdown time.
3. Provided for planning purposes only. BMP sizing and costs based on Planned Development / Redevelopment Area Only.

Solution Description

Solution Type	Summary Description
New or Modified Infrastructure	Construction of subsurface flow (SSF) wetland, cartridge filter, and lift station.

Figure 1 is a vicinity map showing the Strategy Area boundary, future projects requiring water quality BMPs, and location of the proposed BMP. Figure 2 shows the BMP footprint, existing storm drains, new diversion structures, and lift station. The proposed project will divert runoff from the 36-inch HDPE trunk line (STSLN0014322) upstream of STSMH0001683 to a lift station. A force main from the lift station will route runoff to a pretreatment vault containing cartridge filter units (or similar). Pretreated runoff will be routed to a subsurface flow (SSF) wetland via gravity flow for final treatment and polishing. Runoff will then be returned to the storm sewer trunk line via gravity flow at STSMH0001683.

While a variety of alternative treatment solutions are possible at this location that could meet the Port’s treatment requirements, the proposed solution was selected to provide reliable treatment for multiple pollutants while minimizing potential wildlife attractants and interactions with groundwater. The need for cartridge filters for pretreatment depends on pollutant loadings, but pretreatment is generally recommended to increase the life of the SSF wetland. Characterization of typical TSS concentrations and loads at this location is recommended prior to conceptual design.

The Port could choose to install the BMP solution in phases, starting with the lift station and cartridge filter while reserving the space for future installation of the SSF wetland to treat additional pollutants if required by future regulations or deemed necessary through monitoring.

Figure 3 illustrates a cross section of the proposed solution. Assuming treatment would only be provided for the planned development/redevelopment area only, the lift station and cartridge filters were preliminarily sized using the water quality design flow rate and the SSF wetlands were preliminary sized using the water quality design volume with an assumed 3-foot gravel depth.

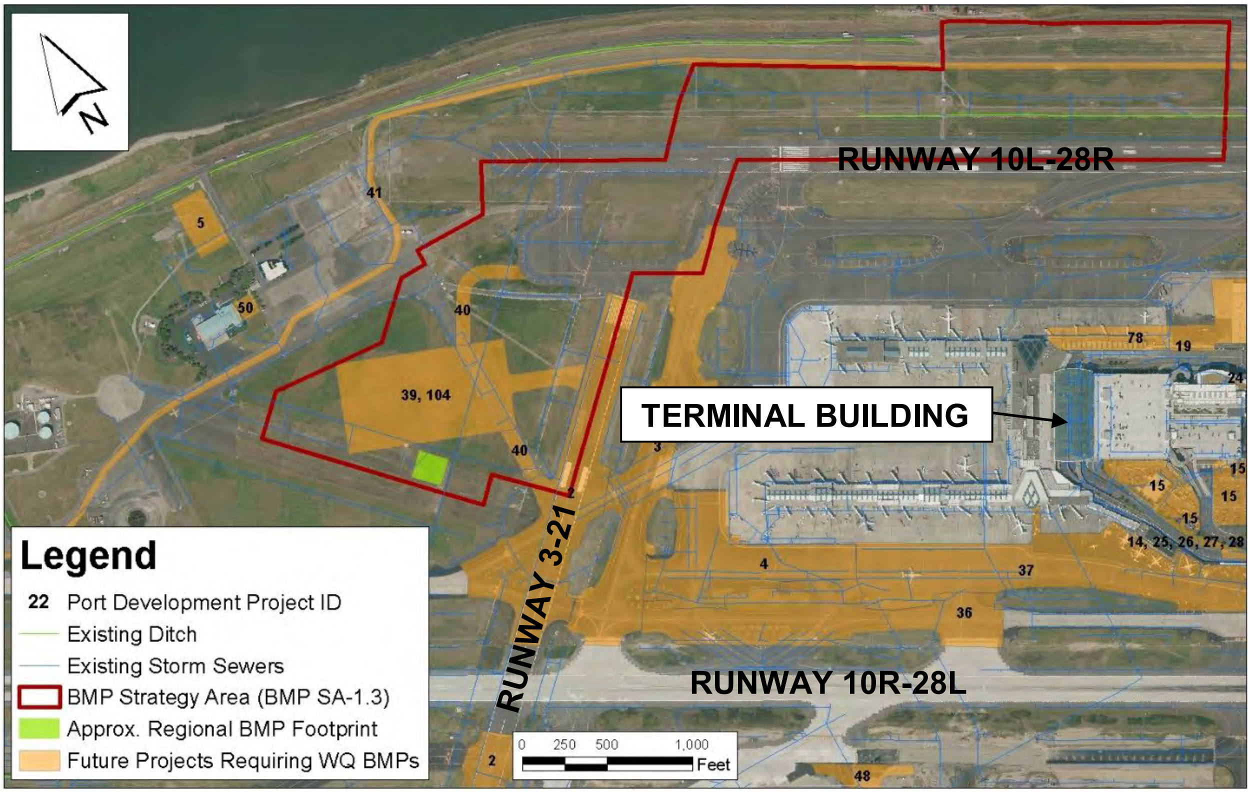


Figure 1: BMP SA-1.3 Vicinity

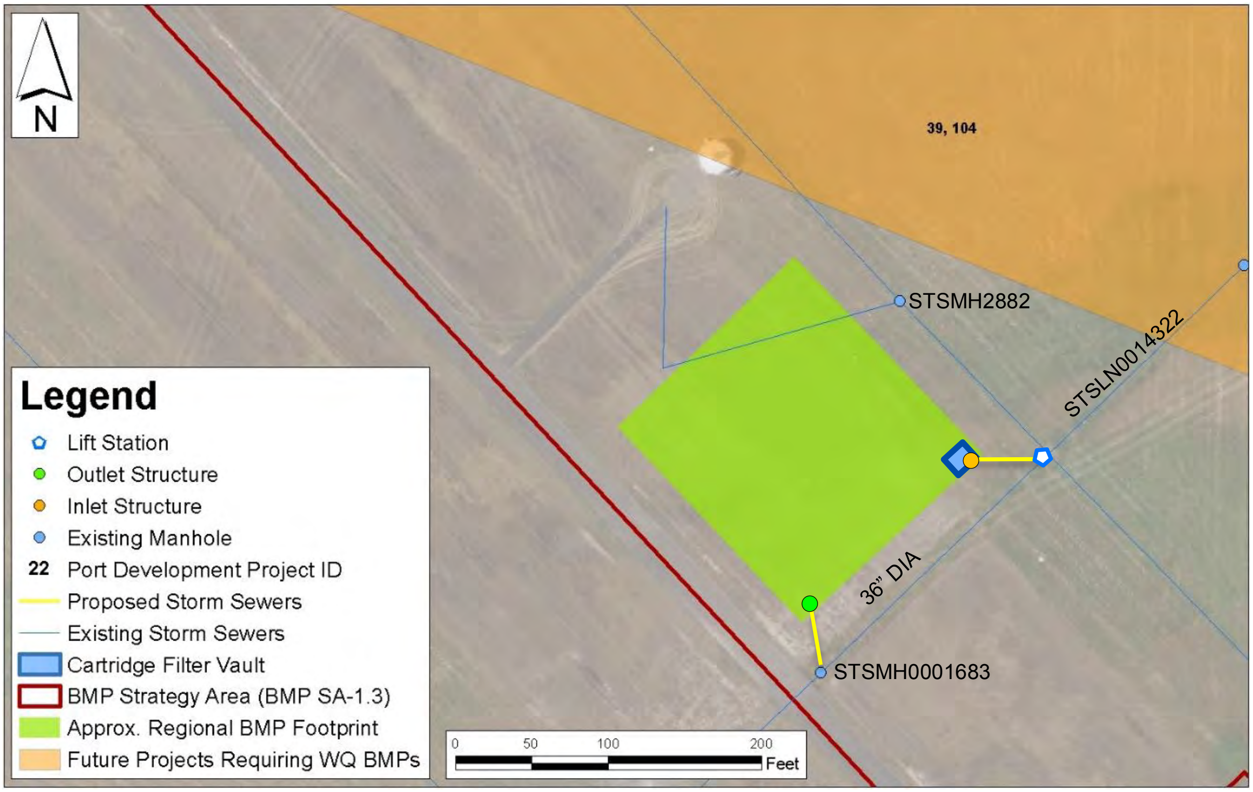


Figure 2: Layout of Proposed Cartridge Filter and SSF Wetland for BMP SA–1.3

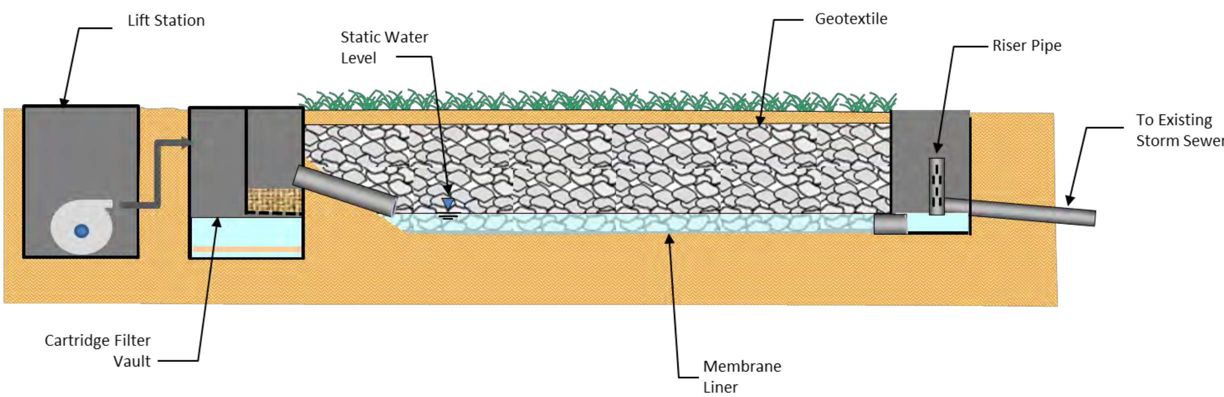


Figure 3: Cross-Section of Proposed SSF Wetland

Implementation Considerations

The following tables provide recommended considerations as the project moves from planning concept to implemented solution. The tables below address three phases of implementation, including; planning and design, construction, and post-construction.

Planning and Design Considerations

Item	Description
Field Data Collection	• Underground utility location • Local topographic surface to support design • Local groundwater elevations to support structural design • Stormwater sampling for TSS and flows to determine if pretreatment is needed for the SSF wetland
Additional Technical Analysis	• Geotechnical and hydrogeological studies may be needed to support detailed design. • Detailed analysis of the proposed system using the PDX stormwater hydraulic model is recommended prior to design to assess hydraulic feasibility and conveyance mechanisms.
Permitting	No permits needed for installation.
Siting	During detailed design, review the extents and layout and adjust as necessary to optimize land use, avoid utilities and meet setback requirements. Provide access to site for maintenance.
Coordination with Elements of Other Projects	• Post-construction BMPs must be installed to address the MS4 permit requirements following completion of the associated development/redevelopment projects. • Coordinate design and construction with SWM Solution 1-A (Replace Portion of Basin 1 North Trunk Line).
Enabling Projects	None identified.
Related Solutions	None identified.
Coordination with Port Departments	• Environmental - MS4 compliance and BMP tracking • Planning and Development - Charter and Business Case Development • Engineering - pipe sizing, utility relocation, design coordination • Maintenance - regular maintenance of cartridge filter for media change, wetlands for plant management, and pump • Asset Management - addition of new assets • Wildlife Management - coordination on wetland plants, observation of wildlife as SSF wetland develops
Coordination with Tenants	None identified.
Coordination with Outside Agencies	None identified.

Item	Description
Design Disciplines Involved	Civil, Structural, Mechanical, Electrical, others as needed to relocate utilities

Construction Considerations

Item	Description
Construction Components	• Connect to existing storm sewers at two locations • Construct a 1.8 cfs lift station • Construct a 1.8 cfs cartridge filter unit • Construct 0.6 acres of SSF wetland • Demolish storm sewer within BMP footprint • Protect and/or relocate existing utilities as needed to install solution
Airport Operational Impacts	• Construction access within the Air Operations Area (AOA) is required. Construction is planned near aircraft movement areas, including the Crosswinds Runway (3-21) and Northwest Ramp. • Trenching across an access road at one location. • Truck traffic and heavy equipment operation is anticipated during construction.
Construction Challenges	• An estimated 4,800 CY of excavation spoils would need to be exported and stockpiled / disposed of and 3,000 CY of stone aggregate imported. • Equipment and material staging areas would need to be identified as well as soil and aggregate stockpile areas. • Line power is required for lift station operation.

Post-Construction Considerations

Item	Description
Post-Construction Coordination with Airport Operations	None identified.
Considerations for Operation and Maintenance (O&M) of the Solution	• Access for scheduled maintenance of lift station, cartridge filters, and SSF wetland will be needed. • Maintain emerging vegetation.

Potential Risks if Solution is Implemented / Risk Mitigation Strategies

Item	Description	Mitigation Strategy
Regulatory Compliance	Effectively tracking development project treatment needs and BMPs to which it is assigned	Develop BMP tracking tool.
Airport or Tenant Operations	None identified.	Not applicable.
Aircraft Safety	None identified.	Not applicable.
Future Development Limitations	BMP footprint area will be unavailable for other development.	Coordinate siting with project planners to confirm location minimizes conflicts with future development.

Schedule Analysis

Item	Description
Critical Schedule Drivers	Coordinate the construction with the following project timeframes:[1] • Project #2: Runway 3-21 & Taxiway M Rehabilitation (2021) • Project #3: Taxiway E North Rehabilitation (2015) • Project #39: NW Ramp Relocation (2017) • Project #40: Taxiway H Rehabilitation (2017) • Project #41: ATC Pavement Rehabilitation Phase 2 (2017) • Project #104: MP Airtrans Ramp Construction / DD RON NE Ramp Expansion (2022) • SWM Solution 1-A: Replace Portion of Basin 1 North Trunk Line
Target Construction Timeframe (2016-2020, 2021-2025, 2026-2035)	2016-2020 Timeframe selected to correspond with above development projects. Assumed that BMP will be installed by end of timeframe.
Planning and Design Lead Time (<6 months, 6-12 months, 12-24 months)	12-24 months to allow for water quality monitoring and SSF wetland pilot testing prior to full scale design

Notes:

1. Project numbers and timeframes are from the Port's list of future development projects (Appendix A).

Cost Analysis

Item	Description
Opinion of Probable Capital Cost (2015 Dollars)[1]	$1,400,000
Cost Estimate Class / Contingency (1-Bid received, 2-Construction, 3-Design, 4-Concept Design, 5- Screening/Planning)	5- Screening/Planning
Fixed Asset Modifications Excluded from Cost Estimate	None identified.
Cost Assumptions	• Includes 40% for hard cost contingency. • Includes 30% for soft cost contingency. • Other relevant assumptions provided in "BMP Sizing Basis" and "Construction Considerations" sections in this fact sheet.
O&M Cost Considerations	• Pump replacement at 5-10 years • Estimated annual O&M labor for SSFW 50 mhr/year[2] • Estimated annual O&M labor for Cartridge Filter at 24 mhr/year[2]

Notes:
1. Supporting detailed cost tables are provided in Appendix B.
2. O&M level of effort estimated based on DSM Appendix O values.

SWM SOLUTION FACT SHEET 1-J

Stormwater Management Solution Tracking Information

SWM Solution ID	Solution Name	Capital Cost Summary	Anticipated Implementation Timeframe	Author	Revision Date
1-J	Water Quality Planning Recommendations for BMP Strategy Area (BMP SA)-1.4	$330,000	2016-2020	GS&P and Geosyntec	June 2015

Stormwater Management Needs Addressed by Solution

SWM Need ID	Need Name	Need Type		
		Address Ponding and Facilitate Drainage	Address Risk of Stormwater Asset Failure	Provide Required Stormwater Controls
0-1	Post-Construction Stormwater Pollutant and Runoff Control			X

Development projects planned by the Port will trigger stormwater quality treatment requirements of the MS4 permit as outlined in the Port of Portland Stormwater Design Standards Manual (DSM) and described in SWM Need Fact Sheet 0-1. The proposed solution addresses the need to provide treatment for future development projects in this BMP Strategy Area (BMP SA-1.4), as summarized in the table below. The subsequent table provides a summary of the BMP sizing requirements, as calculated based on DSM criteria.

Future Development Projects Treated by BMP

Project # [1]	Drainage Basin	Planned Development / Redevelopment Project Name	Acres Treated by BMP
2 [2]	1	Runway 3-21 & Taxiway M Rehabilitation	0.2
41 [2]	1	Perimeter Road Rehabilitation	4.9
95 [2]	1	East side NE 33rd Development	3.3
Total Acres of Development Treated			8.4

Notes:
1. Project numbers correspond to future development areas displayed on Figure 1, and included in the Port's list of future development projects (Appendix A).
2. Project crosses into an adjacent BMP Strategy Area. Acreage reflects portion in this BMP Strategy Area.

Water Quality Treatment BMP Sizing Basis

Area to be Treated	Impervious Acres to be Treated	Annual Runoff Volume (ac-ft)	WQ Design Flow Rate (cfs)[1]	WQ Design Volume (ac-ft)[2]
Planned Development/Redevelopment Area Only	8.4	19.8	0.7	0.2
Entire BMP Strategy Area [3]	80.3	201.4	7.1	1.8

Notes:
1. Based on 0.1 in/hr design intensity, per DSM requirements for offline flow-based BMP.
2. Based on 0.45 inch design depth, per DSM requirements for volume based BMPs with 24-hr drawdown time.
3. Provided for planning purposes only. BMP sizing and costs based on Planned Development / Redevelopment Area Only.

Solution Description

Solution Type	Summary Description
Future Planning Considerations	Select and construct BMPs such as planter boxes, bioretention, vegetated swales, and/or LID approaches as part of development project construction activities for projects within the BMP strategy area. This solution does not include use of a regional treatment facility.

Figure 1 depicts the BMP Strategy Area with the planned future development projects. Proposed BMP locations are omitted since the proposed BMPs can be either distributed controls or sub-regional facilities whose locations are dependent on the type of development and the location and distribution of pervious areas within the development. For building-based projects with roofs, parking lots, and landscaped areas, distributed stormwater controls such as planter box filters, bioretention facilities, infiltration trenches, vegetated swales, and/or other low impact development (LID) design elements can be used to reduce effective impervious areas and treat runoff. The Perimeter Road Rehabilitation project may be best served by infiltration trenches or filter strips. Regional facilities are not recommended here due to the limited number of future development projects within this Strategy Area. The location and size of the proposed BMPs can be determined once the extents of the improvements are known.

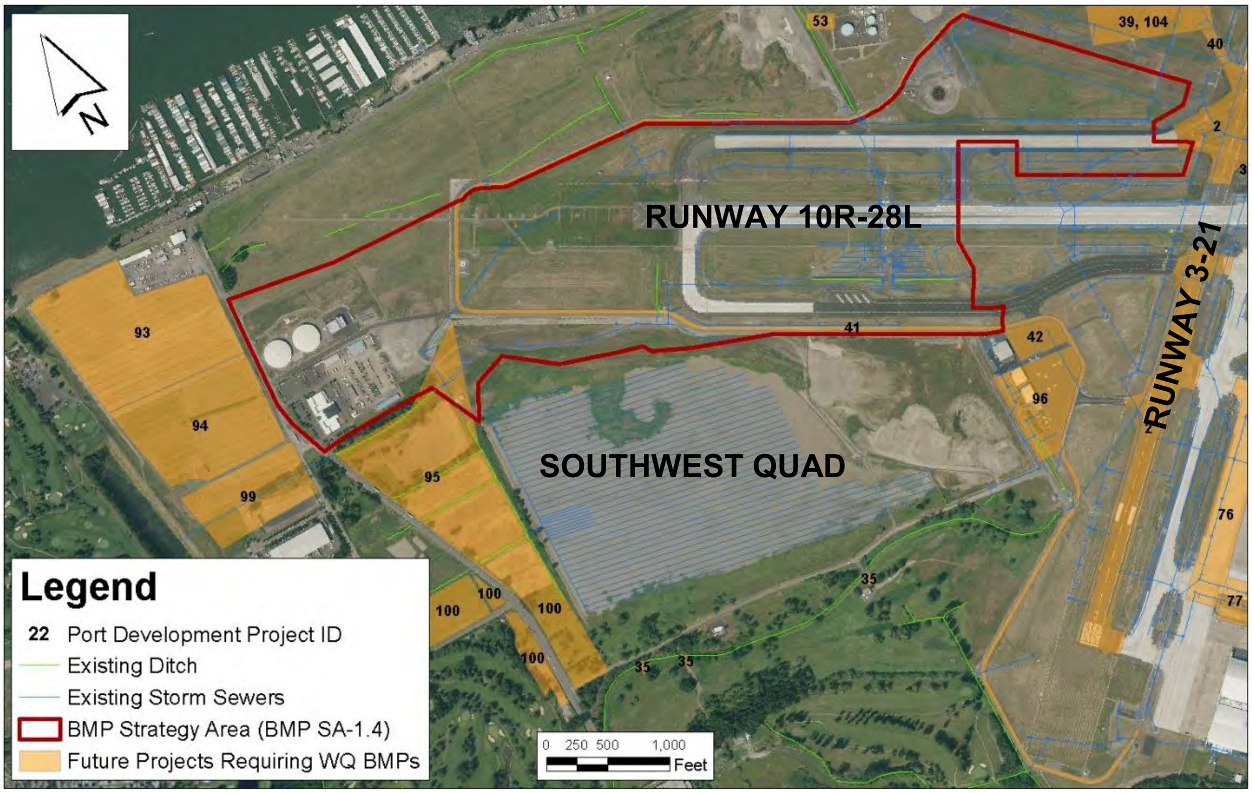


Figure 1: BMP SA-1.4 Vicinity

Implementation Considerations

The following tables provide recommended considerations as the project moves from planning concept to implemented solution. The tables below address implementation considerations for planning and design, construction, and post-construction.

Planning and Design Considerations

Item	Description
Field Data Collection	None identified.
Additional Technical Analysis	Individual BMP sizing needed once the type and location determined. Hydraulic analyses that considers influent flows, head losses, and tailwater conditions for the discharge.
Permitting	None identified.
Siting	During detailed design, review the development project extents and layout, with subsequent adjustment as needed to optimize land use, avoid utilities and meet setback requirements
Coordination with Elements of Other Projects	• Post-construction BMPs must be installed to address the MS4 permit requirements following completion of the associated development/redevelopment projects. • Coordinate design and construction with SWM Solution 1-A (Replace Portion of Basin 1 North Trunk Line) because the projects are adjacent and may intersect.
Enabling Projects	None identified.
Related Solutions	None identified.
Coordination with Port Departments	• Planning and Development - Charter and Business Case Development • Engineering - pipe sizing, utility relocation, design coordination • Maintenance - change in catch basins and manholes requiring routine maintenance • Asset Management - removal of existing assets, addition of new assets • Wildlife Management - identify significance of potential risks
Coordination with Tenants	Port to determine the timeline for construction of treatment BMPs in coordination with the development projects in the BMP Strategy Area.
Coordination with Outside Agencies	None identified.
Design Disciplines Involved	Civil and others as needed depending on BMPs selected

Construction Considerations

Item	Description
Construction Components	Depends on BMPs selected.
Airport Operational Impacts	None identified.
Construction Challenges	Connections to existing storm sewers may be needed at multiple locations, which may be challenging given conflicts with existing infrastructure and hydraulic needs.

Post-Construction Considerations

Item	Description
Post-Construction Coordination with Airport Operations	None identified.
Considerations for Operation and Maintenance (O&M) of the Solution	Depends on BMP selected. Refer to DSM Appendix O for guidance on O&M level of effort for various BMPs.

Potential Risks if Solution is Implemented / Risk Mitigation Strategies

Item	Description	Mitigation Strategy
Regulatory Compliance	Effectively tracking development project treatment needs and BMPs to which it is assigned.	Develop BMP tracking tool.
Airport or Tenant Operations	None identified.	Not applicable.
Aircraft Safety	Risk of wildlife attraction	Selected BMP should not have exposed water surface to minimize wildlife attraction. Coordinate design features with Port Natural Resources staff.
Future Development Limitations	BMP footprint area will be unavailable for other development.	Coordinate siting with project planners to confirm location minimizes conflicts with future development.

Schedule Analysis

Item	Description
Critical Schedule Drivers	Coordinate the construction with the following project timeframes:[1] • Project #2: Runway 3-21 & Taxiway M Rehabilitation (2021) • Project #41: Perimeter Road Rehabilitation (2017) • Project #95: East side NE 33rd Development (unknown timeframe) • SWM Solution 1-A: Replace Portion of Basin 1 North Trunk Line
Target Construction Timeframe (2016-2020, 2021-2025, 2026-2035)	2016-2020 Timeframe selected to correspond with above development projects and SWM Solution 1-A. Assumed that BMP will be installed by end of timeframe.
Planning and Design Lead Time (<6 months, 6-12 months, 12-24 months)	6-12 months from beginning of development project design

Notes:
1. Project numbers and timeframes are from the Port's list of future development projects (Appendix A).

Cost Analysis

Item	Description
Opinion of Probable Capital Cost (2015 Dollars)	$330,000
Cost Estimate Class / Contingency (1-Bid received, 2-Construction, 3-Design, 4-Concept Design, 5- Screening/Planning)	5- Screening/Planning
Fixed Asset Modifications Excluded from Cost Estimate	None identified.
Cost Assumptions	• Includes 30% for hard cost contingency. • Includes 30% for soft cost contingency. • Other relevant assumptions provided in "BMP Sizing Basis" section in this fact sheet. • Assumes bioretention BMPs as representative for cost planning purposes, using unit costs from DSM Appendix N.
O&M Cost Considerations	Reference DSM Appendix O for information on O&M level of effort for BMPs.

SWM SOLUTION FACT SHEET 1-K

Stormwater Management Solution Tracking Information

SWM Solution ID	Solution Name	Capital Cost Summary	Anticipated Implementation Timeframe	Author	Revision Date
1-K	Water Quality Planning Recommendations for BMP Strategy Area (BMP SA)-1.5	$15,000	2016-2020	GS&P and Geosyntec	June 2015

Stormwater Management Needs Addressed by Solution

SWM Need ID	Need Name	Need Type		
		Address Ponding and Facilitate Drainage	Address Risk of Stormwater Asset Failure	Provide Required Stormwater Controls
0-1	Post-Construction Stormwater Pollutant and Runoff Control			X

Development projects planned by the Port will trigger stormwater quality treatment requirements of the MS4 permit as outlined in the Port of Portland Stormwater Design Standards Manual (DSM) and described in SWM Need Fact Sheet 0-1. The proposed solution addresses the need to provide treatment for future development projects in this BMP Strategy Area (BMP SA-1.5), as summarized in the table below. The subsequent table provides a summary of the BMP sizing requirements, as calculated based on DSM criteria.

Future Development Projects Treated by BMP

Project # [1]	Drainage Basin	Planned Development / Redevelopment Project Name	Acres Treated by BMP
35	1	Repair NE Elrod Road Ditch Crossings	0.4
Total Acres of Development Treated			0.4

Notes:
1. Project numbers correspond to future development areas displayed on Figure 1, and included in the Port's list of future development projects (Appendix A).

Water Quality Treatment BMP Sizing Basis

Area to be Treated	Impervious Acres to be Treated	Annual Runoff Volume (ac-ft)	WQ Design Flow Rate (cfs) [1]	WQ Design Volume (ac-ft) [2]
Planned Development/Redevelopment Area Only	0.4	1.0	0.03	0.01
Entire BMP Strategy Area [3]	2.3	16.4	0.6	0.1

Notes:
1. Based on 0.1 in/hr design intensity, per DSM requirements for offline flow-based BMP.
2. Based on 0.45 inch design depth, per DSM requirements for volume based BMPs with 24-hr drawdown time.
3. Provided for planning purposes only. BMP sizing and costs based on Planned Development / Redevelopment Area Only.

Solution Description

Solution Type	Summary Description
Future Planning Considerations	Construction of small bioretention areas or vegetated swales to treat bridge runoff prior to discharging into Elrod Ditch. This solution does not include use of a regional treatment facility.

Figure 1 depicts the BMP Strategy Area with the single planned future development project (Project #35). Proposed BMP locations would be immediately adjacent to the new impervious area. The precise location and size of the BMPs can be determined once the extents of the improvements are known.

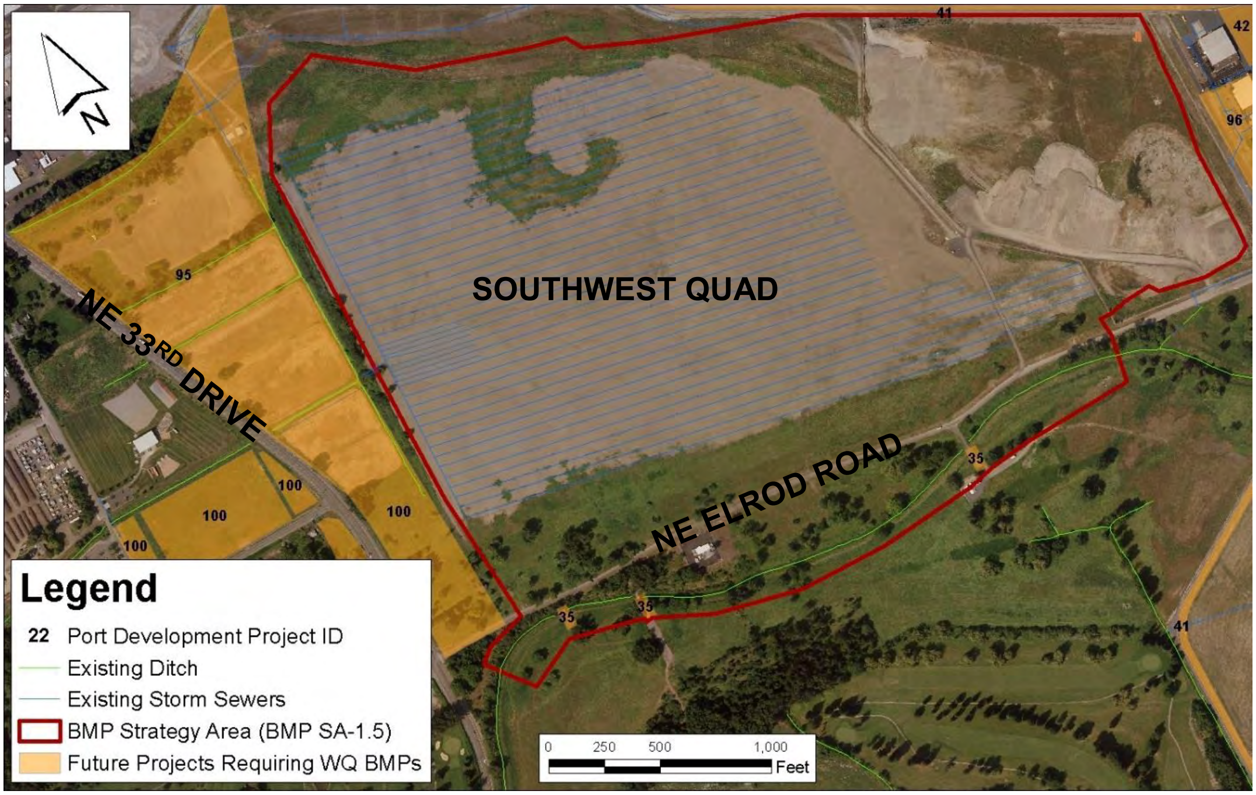


Figure 1: BMP SA-1.5 Vicinity

Implementation Considerations

The following tables provide recommended considerations as the project moves from planning concept to implemented solution. The tables below address implementation considerations for planning and design, construction, and post-construction.

Planning and Design Considerations

Item	Description
Field Data Collection	None identified.
Additional Technical Analysis	Individual BMP sizing needed once the type and location determined.
Permitting	None identified.
Siting	During detailed design, review the development project extents and layout, with subsequent adjustment as needed to optimize land use, avoid utilities and meet setback requirements
Coordination with Elements of Other Projects	Post-construction BMPs must be installed to address the MS4 permit requirements following completion of the associated development/redevelopment projects.
Enabling Projects	None identified.
Related Solutions	None identified.
Coordination with Port Departments	• Planning and Development - Charter and Business Case Development • Engineering - design coordination • Maintenance - primarily vegetation • Asset Management - addition of new assets • Wildlife Management - identify significance of potential risks
Coordination with Tenants	None identified.
Coordination with Outside Agencies	None identified.
Design Disciplines Involved	Civil, Landscape Architect, and others as needed depending on BMPs selected

Construction Considerations

Item	Description
Construction Components	Depends on BMPs selected.
Airport Operational Impacts	None identified.
Construction Challenges	None identified.

Post-Construction Considerations

Item	Description
Post-Construction Coordination with Airport Operations	None identified.
Considerations for Operation and Maintenance (O&M) of the Solution	Depends on BMP selected. Refer to DSM Appendix O for guidance on O&M level of effort for various BMPs.

Potential Risks if Solution is Implemented / Risk Mitigation Strategies

Item	Description	Mitigation Strategy
Regulatory Compliance	Effectively tracking development project treatment needs and BMPs to which it is assigned.	Develop BMP tracking tool.
Airport or Tenant Operations	None identified.	Not applicable.
Aircraft Safety	Risk of wildlife attraction	Selected BMPs should not have exposed water surface to minimize wildlife attraction. Coordinate design features with Port Natural Resources staff.
Future Development Limitations	BMP footprint area will be unavailable for other development.	Coordinate siting with project planners to confirm location minimizes conflicts with future development.

Schedule Analysis

Item	Description
Critical Schedule Drivers	Coordinate the construction with the following project timeframe:[1] • Project #35: Repair NE Elrod Road Ditch Crossings (2015)
Target Construction Timeframe (2016-2020, 2021-2025, 2026-2035)	2016-2020 Timeframe selected to correspond with above development projects. Assumed that BMP will be installed by end of timeframe.
Planning and Design Lead Time (<6 months, 6-12 months, 12-24 months)	6-12 months from beginning of development project design

Notes:

1. Project numbers and timeframes are from the Port's list of future development projects (Appendix A).

Cost Analysis

Item	Description
Opinion of Probable Capital Cost (2015 Dollars)	$15,000
Cost Estimate Class / Contingency (1-Bid received, 2-Construction, 3-Design, 4-Concept Design, 5- Screening/Planning)	5- Screening/Planning
Fixed Asset Modifications Excluded from Cost Estimate	None identified.
Cost Assumptions	• Includes 30% for hard cost contingency. • Includes 30% for soft cost contingency. • Other relevant assumptions provided in “BMP Sizing Basis” section in this fact sheet. • Assumes bioretention BMPs as representative for cost planning purposes, using unit costs from DSM Appendix N.
O&M Cost Considerations	Reference DSM Appendix O for information on O&M level of effort.

SWM SOLUTION FACT SHEET 1-L

Stormwater Management Solution Tracking Information

SWM Solution ID	Solution Name	Capital Cost Summary	Anticipated Implementation Timeframe Summary	Author	Revision Date
1-L	Provide Regional Water Quality Treatment for BMP Strategy Area (BMP SA)-1.6	$2,900,000	2021-2025	GS&P and Geosyntec	June 2015

Stormwater Management Needs Addressed by Solution

SWM Need ID	Need Name	Need Type		
		Address Ponding and Facilitate Drainage	Address Risk of Stormwater Asset Failure	Provide Required Stormwater Controls
0-1	Post-Construction Stormwater Pollutant and Runoff Control			X

Development projects planned by the Port will trigger stormwater quality treatment requirements of the MS4 permit as outlined in the Port of Portland Stormwater Design Standards Manual (DSM) and described in SWM Need Fact Sheet 0-1. The proposed solution addresses the need to provide treatment for future development projects in this BMP Strategy Area (BMP SA-1.6), as summarized in the table below. The subsequent table provides a summary of the BMP sizing requirements, as calculated based on DSM criteria.

Future Development Projects Treated by BMP

Project # [1]	Drainage Basin	Planned Development / Redevelopment Project Name	Acres Treated by BMP
2 [2]	1	Runway 3-21 & Taxiway M Rehabilitation	20.5
3 [2]	1	Taxiway E North Rehabilitation	11.2
41 [2]	1	Perimeter Road Rehabilitation	2.5
42	1	Assumed Development (To Be Determined)	2.9
96	1	Ameriflight Redevelopment	9.1
Total Acres of Development Treated			46.2

Notes:
1. Project numbers correspond to future development areas displayed on Figure 1, and included in the Port's list of future development projects (Appendix A).
2. Project crosses into an adjacent BMP Strategy Area. Acreage reflects portion in this BMP Strategy Area.

Water Quality Treatment BMP Sizing Basis

Area to be Treated	Impervious Acres to be Treated	Annual Runoff Volume (ac-ft)	WQ Design Flow Rate (cfs)[1]	WQ Design Volume (ac-ft)[2]
Planned Development/Redevelopment Area Only	46.2	110.4	3.9	1.5
Entire BMP Strategy Area [3]	99.6	242.1	8.6	3.2

Notes:
1. Based on 0.1 in/hr design intensity, per DSM requirements for offline flow-based BMPs.
2. Based on 0.45 inch design depth, per DSM requirements for volume-based BMPs with 24-hr drawdown time.
3. Provided for planning purposes only. BMP sizing and costs based on Planned Development / Redevelopment Area Only.

Solution Description

Solution Type	Summary Description
New or Modified Infrastructure	Construction of subsurface flow wetlands (SSF) wetlands, cartridge filters, and lift station.

Figure 1 is vicinity map showing Strategy Area boundary, future projects requiring water quality BMPs, and location of the proposed BMP. Figure 2 shows the approximate footprint of the proposed BMP with associated facilities. Lift stations will be installed to divert runoff from two separate storm sewers to cartridge filters for pretreatment. Pretreated runoff from both cartridge filters will be routed to a common subsurface flow (SSF) wetland via gravity flow for final treatment and polishing. Runoff will then be returned to the storm sewer though a gravity flow pipe connecting the wetland outlet to a new manhole downstream of STSMH3022. While a variety of alternative treatment solutions are possible at this location that could meet the Port’s treatment requirements, the proposed solution was selected to provide reliable treatment for multiple pollutants while minimizing potential wildlife attractants and interactions with groundwater. The need for cartridge filters for pretreatment depends on pollutant loadings, but pretreatment is generally recommended to increase the life of the SSF wetland. Characterization of typical TSS concentrations and loads at this location is recommended prior to conceptual design.

The Port could choose to install the BMP solution in phases, starting with the lift station and cartridge filter while reserving the space for future installation of the SSF wetland to treat additional pollutants if required by future regulations or deemed necessary through monitoring. An alternative location for the SSF wetland could be downstream of the outfall to the Elrod Road Ditch. This alternative would eliminate the need for a pump station and the cartridge filter could be replaced by a pretreatment forebay. However, the alternative would require filling in a portion of the ditch which may require additional permitting and wetland mitigation.

Figure 3 is typical cross section for a SSF wetland with a lift station. Assuming treatment would only be provided for the planned development/redevelopment area only, the lift station and cartridge filters were preliminarily sized using the water quality design flow rate and the SSF wetlands were preliminary sized using the water quality design volume with an assumed 4-foot gravel depth.

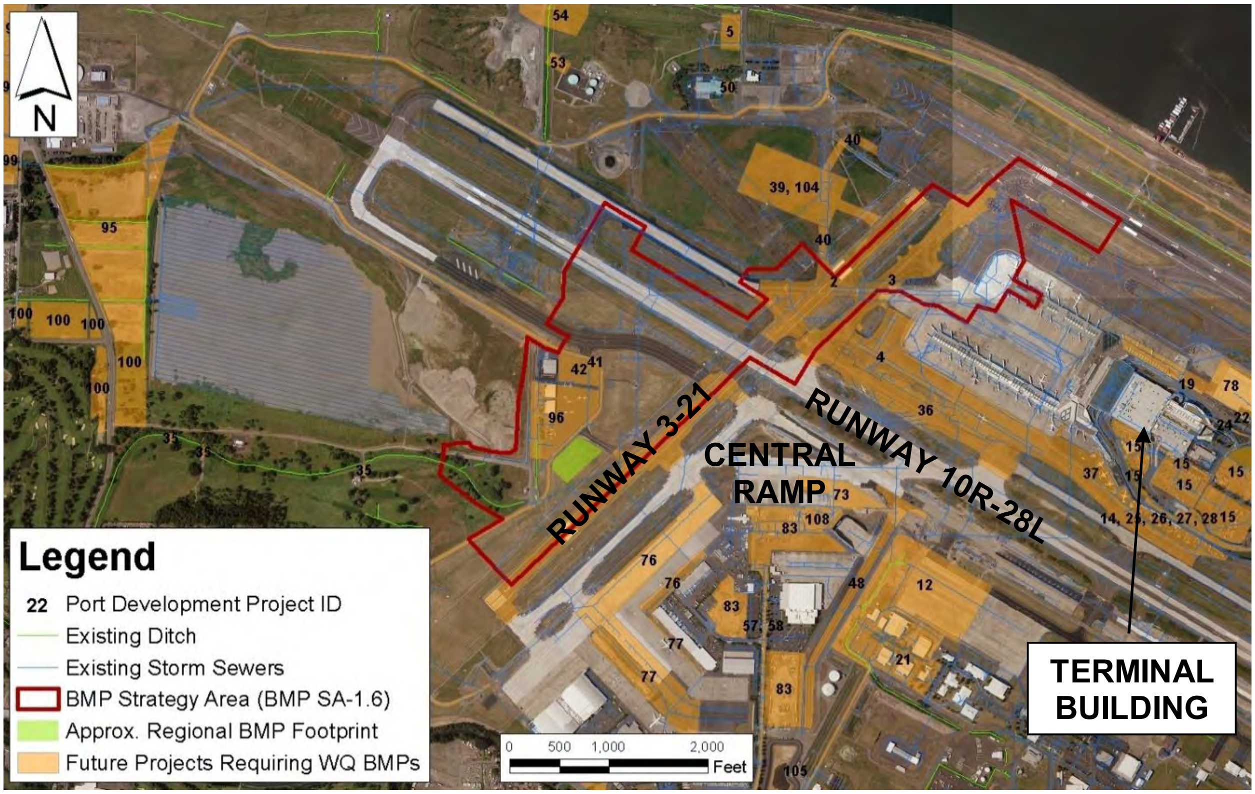


Figure 1: BMP SA-1.6 Vicinity

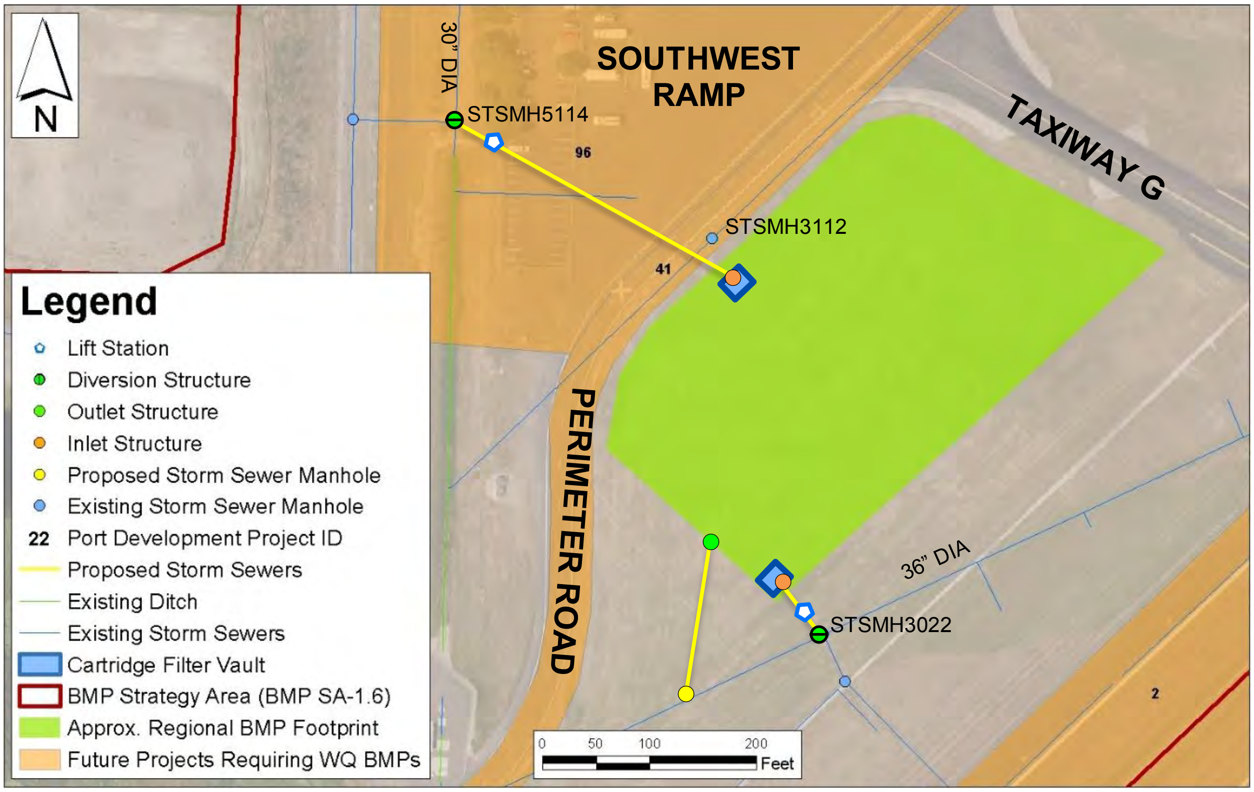


Figure 2: Proposed Layout of Cartridge Filter and Subsurface Flow Wetland for BMP SA-1.6

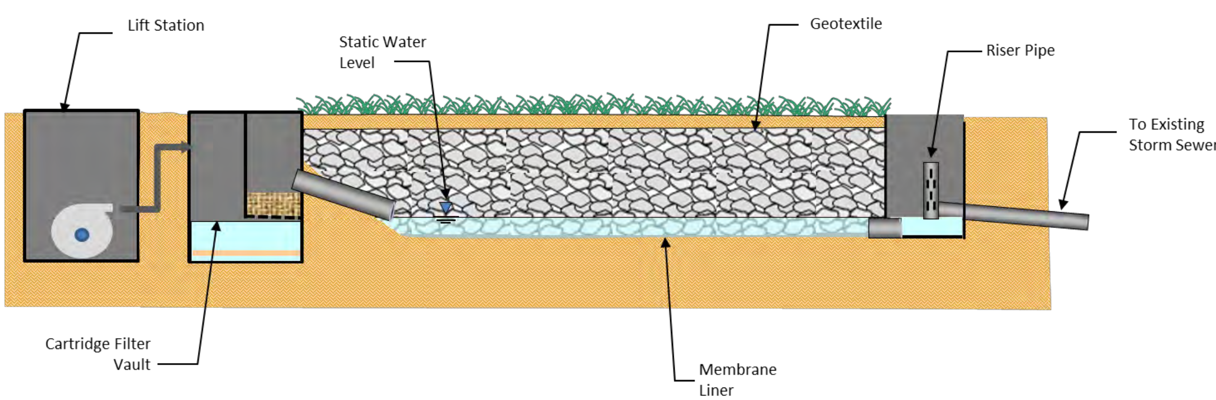


Figure 3: Cross-Section of Subsurface Flow Treatment Wetland with Lift Station

Implementation Considerations

The following tables provide recommended considerations as the project moves from planning concept to implemented solution. The tables below address three phases of implementation, including planning and design, construction, and post-construction.

Planning and Design Considerations

Item	Description
Field Data Collection	• Underground utility location • Local topographic surface to support design • Local groundwater elevations to support structural design • Stormwater sampling for TSS and flows to determine if pretreatment needed for SSF wetland
Additional Technical Analysis	• Geotechnical and hydrogeological studies may be needed to support detailed design. • Detailed analysis of the proposed system using the PDX stormwater model is recommended prior to design to assess hydraulic impacts.
Permitting	None identified.
Siting	During detailed design, review the extents and layout and adjust as necessary to optimize land use, avoid utilities and meet setback requirements
Coordination with Elements of Other Projects	• Post-construction BMPs must be installed to address the MS4 permit requirements following completion of the associated development/redevelopment projects. • Coordinate with SWM Solutions 1-B and 1-C because the projects are adjacent and may intersect.
Enabling Projects	None identified.
Related Solutions	None identified.
Coordination with Port Departments	• Planning and Development - Charter and Business Case Development • Engineering - pipe sizing, utility relocation, design coordination • Maintenance - change in catch basins and manholes requiring routine maintenance • Asset Management - removal of existing assets, addition of new assets • Wildlife Management - identify significance of potential risks
Coordination with Tenants	Port to determine the timeline for construction of sub-regional water quality treatment BMPs in coordination with the development projects in the BMP Strategy Area and their respective tenants.
Coordination with Outside Agencies	None identified.

Item	Description
Design Disciplines Involved	Civil, Structural, Mechanical, Electrical, others as needed to relocate utilities

Construction Considerations

Item	Description
Construction Components	• Construct 0.9 acres of SSF wetland. • Construct two cartridge filters with combined capacity of 3.9 cfs. • Construct two lift stations with combined capacity of 3.9 cfs. • Construct 150 LF of new gravity storm sewer.
Airport Operational Impacts	• Construction access within the Air Operations Area (AOA) is required. • Construction is planned near aircraft movement areas including: the Crosswinds Runway (3-21), the Southwest Ramp, and Taxiways C and G. • Trenching across access road to Southwest Apron in one location • Truck traffic and heavy equipment operation is anticipated during construction.
Construction Challenges	• An estimated 8,800 CY of excavation spoils would need to be exported and disposed of and 5800 CY of stone aggregate imported. • Equipment and material staging areas would need to be identified as well as soil and aggregate stockpile areas.

Post-Construction Considerations

Item	Description
Post-Construction Coordination with Airport Operations	None identified.
Considerations for Operation and Maintenance (O&M) of the Solution	• Access to lift station for scheduled maintenance • Access to cartridge filters for scheduled maintenance

Potential Risks if Solution is Implemented / Risk Mitigation Strategies

Item	Description	Mitigation Strategy
Regulatory Compliance	Effectively tracking development project treatment needs and BMPs to which it is assigned.	Develop BMP tracking tool.
Airport or Tenant Operations	None identified.	Not applicable.
Aircraft Safety	Risk of wildlife attraction	Selected BMP will not have exposed water surface to minimize wildlife attraction. Coordinate design features with Port Natural Resources staff.
Future Development Limitations	BMP footprint area will be unavailable for other development.	Coordinate siting with project planners to confirm location and minimize conflicts with future development.

Schedule Analysis

Item	Description
Critical Schedule Drivers	Coordinate the construction with the following project timeframes:[1] • Project #2: Runway 3-21 & Taxiway M Rehabilitation (2021) • Project #3: Taxiway E North Rehabilitation (2015) • Project #41: Perimeter Road Rehabilitation (2017) • Project #42: Assumed Development (To Be Determined) (unknown timeframe) • Project #96: AmeriFlight Redevelopment (unknown timeframe) • SWM Solution 1-B: Replace Portion of Basin 1 South Trunk Line • SWM Solution 1-C: Replace Pipe Serving South Runway (10R-28L) in Basin 1 South
Target Construction Timeframe (2016-2020, 2021-2025, 2026-2035)	2021-2025 Timeframe selected to correspond with above development projects. Assumed that BMP will be installed by end of timeframe.
Planning and Design Lead Time (<6 months, 6-12 months, 12-24 months)	12-24 months to allow for water quality monitoring and SSF wetland pilot testing prior to full scale design

Notes:
1. Project numbers and timeframes are from the Port's list of future development projects (Appendix A).

Cost Analysis

Item	Description
Opinion of Probable Capital Cost (2015 Dollars)[1]	$2,900,000
Cost Estimate Class / Contingency (1-Bid received, 2-Construction, 3-Design, 4-Concept Design, 5- Screening/Planning)	5- Screening/Planning
Fixed Asset Modifications Excluded from Cost Estimate	None identified.
Cost Assumptions	• Includes 40% for hard cost contingency. • Includes 30% for soft cost contingency. • Other relevant assumptions provided in “BMP Sizing Basis” and “Construction Considerations” sections in this fact sheet.
O&M Cost Considerations	• Pump replacement at 5-10 years • Estimated annual O&M labor for SSFW 50 mhr/year [2] • Estimated annual O&M labor for Cartridge Filter at 24 mhr/year [2]

Notes:
1. Supporting detailed cost tables are provided in Appendix B.
2. O&M level of effort estimated based on DSM Appendix O values.

BASIN 2 STORMWATER MANAGEMENT FACT SHEETS

BASIN 2 STORMWATER MANAGEMENT FACT SHEETS

A few SWM needs were identified in Basin 2, associated with ponding and water quality treatment requirement issues. SWM needs in Basin 2 are summarized in Table 11 below, and SWM solutions proposed to address these needs are described in Table 12. Both tables indicate how the SWM solutions align with each SWM need, and vice versa. Basin 2 SWM need and solution fact sheets immediately follow the tables.

SWM solutions for Basin 2 are associated with a desire to decrease the ponding at the end of Runway 3-21 by improving drainage capacity and by the requirement for water quality treatment BMPs to meet planned development. The proposed BMP treatment for Basin 2 acts as a regional BMP treatment facility for the basin. The regional BMP in Basin 2 is intended only for planned development in Basin 2 and will serve all of the planned developments in Basin 2. It is intended not to reduce the existing storage capacity in the West Detention Basin.

Table 11 – Basin 2 SWM Needs

SWM Need ID	Issue Type	Need Description	Corresponding SWM Solution ID
0-1	Stormwater Controls	Address Requirement for Post-Construction Stormwater Pollutant and Runoff Control	2-B
2-1	Ponding	Address Ponding South of Crosswinds Runway (3-21)	2-A

Table 12 – Basin 2 SWM Solutions

SWM Solution ID	Solution Type	Solution Description	Corresponding SWM Need ID
2-A	New or Modified Infrastructure	Replace Basin 2 Outfall Pipe and Portion of Basin 2 Trunk Line	2-1
2-B	New or Modified Infrastructure	Provide Regional Water Quality Treatment for BMP Strategy Area (BMP SA)-2.1	0-1

SWM NEED FACT SHEET 2-1

Stormwater Management Need Tracking Information

SWM Need ID	Need Name	Issue Type	Author	Revision Date
2-1	Address Ponding South of Crosswinds Runway (3-21)	Ponding	GS&P	June 2015

Stormwater Management Solutions Identified to Address Need

SWM Solution ID	Solution Name	Solution Type		
		New or Modified Infrastructure	Operational Change	Future Planning Considerations
2-A	Replace Basin 2 Outfall Pipe and Portion of Basin 2 Trunk Line	X		

Issue Characterization

Issue Type	Issue Description
Ponding	Ponding has regularly been observed by Port Natural Resources staff in the grassy area south of Runway 3-21 and extending into the southern portion of the Runway 3-21 Safety Area (RSA). Stormwater hydraulic modeling of the Basin 2 drainage system suggests that stormwater is a significant contributor to ponding in this area during storm events, with a potential for ponding to extend onto the perimeter road. See Figure 1 for the simulated ponding extents during both the 10-year and 100-year, 24-hour storm events. Since very limited development is planned to occur in Basin 2 between 2015 and 2035, the ponding extents shown in Figure 1 reflect both existing (2015) and future (2035) development conditions. The ponding creates risks for operations and hazardous wildlife attraction that the Port wants to mitigate.

Factors Potentially Contributing to Issue

Factor	Characterization Basis
Insufficient Drainage System Capacity	Stormwater hydraulic modeling of the existing Basin 2 drainage system shows that ponding during the 10-year and 100-year storm events is due to insufficient storm sewer capacity downstream of the West Detention Basin and upstream of PDX Outfall 2.
Pump Operating Levels at Broadmoor Pump Station	Pump station operating set points (pre-storm settings) supplied by MCDD were evaluated in the stormwater hydraulic model and were determined to have a close relationship with water elevations in the Broadmoor Golf Course drainage channels as well as ponding elevations inside the perimeter road.
Potential Seasonal Variation in the Groundwater Table	Field observations of ponding between storm events suggest that a seasonally high groundwater table could contribute to ponding in this area.
Potential Grading Inconsistencies or Maintenance Needs	Field observations and record drawing review suggest that some adjacent local areas of ponding observed by Port Natural Resources staff (i.e. north of the West Quiescent Basin and southwest of the Runway 3-21 RSA) may be caused by inconsistent grading or buried catch basins.

Recommendations to Further Characterize Issue and Define Need

The following are actions recommended for further characterizing the issue before designing and implementing the identified solution(s).

Action	Description
Groundwater Analysis	A field study is recommended to characterize depth to groundwater and potential influence of groundwater on ponding. Seasonal and spatial variations in depth to groundwater should be characterized as part of this study.
Additional Technical Analysis	Updates to the Port's stormwater hydraulic model are recommended to incorporate: • Findings from the groundwater analysis, which will better inform the model's infiltration and hydrologic assumptions • Updated surface ponding allowances based on a review of the higher resolution Metro LiDAR (being produced) Following the model updates, confirm the extent of ponding and the sizing of the corresponding solution.
Surveying / Field Data Collection	• Metro is in the process of producing higher resolution LiDAR. A review of the Metro LiDAR is recommended after this data becomes available to better define the extents of ponding, particularly onto the perimeter road. • A site walk is recommended to check for any inconsistencies in grading. If inconsistencies are observed, site surveying or a review of updated topographic data (e.g., Metro LiDAR) is recommended to determine if ponding areas have grading that creates localized pockets for surface storage. Fine grading may be necessary to facilitate drainage, depending on findings.
Inspections / Condition Assessment	Regular catch basin inspection and maintenance is recommended to remove storm sewer grate obstructions such as grass, soil and other debris that may inhibit effective drainage.

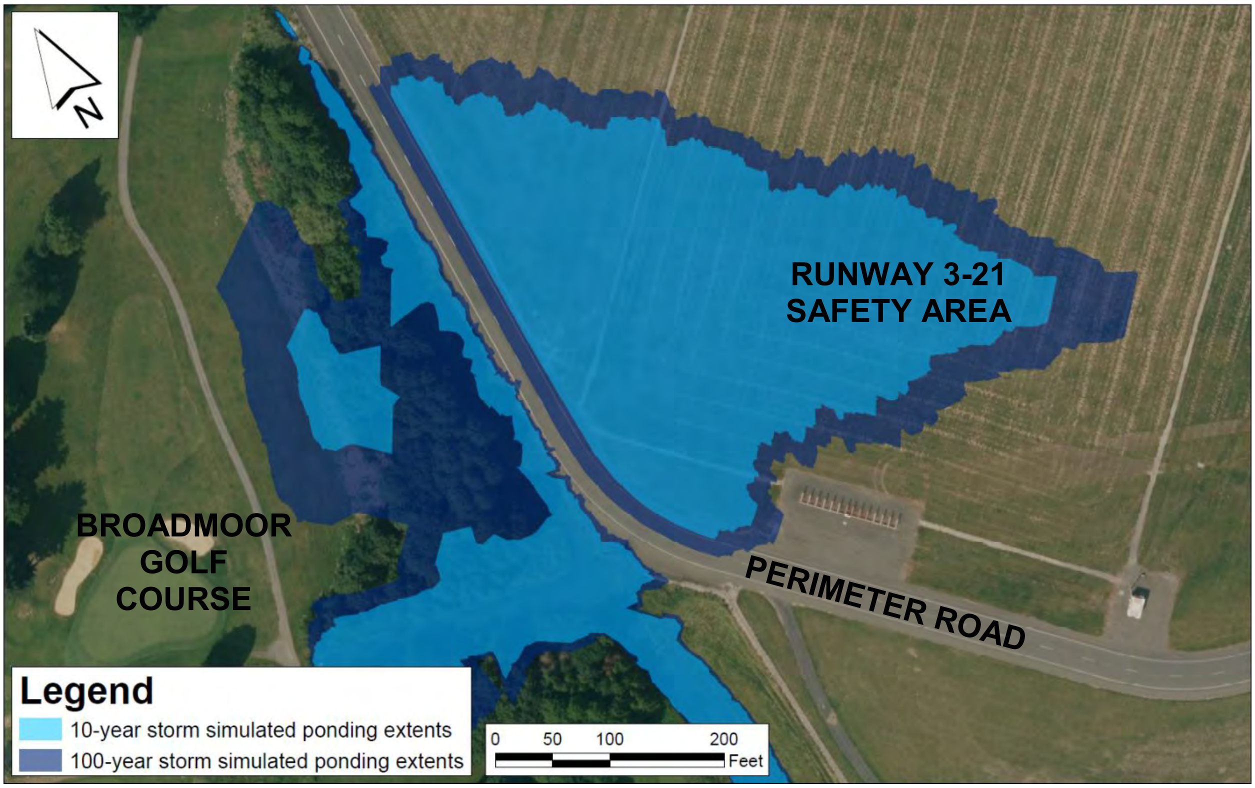


Figure 1: Plan View of Need

Regulatory Drivers for Stormwater Management Need

Driver	Description
FAA Hazardous Wildlife Attractant Criteria (FAA AC 150/5200-33)	Due to its proximity to the runway, ponding at this location may attract wildlife into the runway's approach or departure airspace or into the Air Operations Area (AOA). According to FAA AC 150/5200-33, this poses a wildlife strike risk to aircraft.
FAA Airport Design Criteria (FAA AC 150/5300-13)	Ponding extends into the Runway 3-21 RSA for the 10-year, 24-hour storm event and potentially for more frequent events. This ponding presents an operational and safety need for improved drainage. According to FAA AC 150/5300-13, the RSA must be "drained by grading or storm sewers to prevent water accumulation." Additionally, the RSA must be "capable, under dry conditions, of supporting snow removal equipment, Aircraft Rescue and Fire Fighting (ARFF) equipment, and the occasional passage of aircraft without causing damage to the aircraft."
FAA Airport Drainage Design Criteria (FAA AC 150/5320-5)	Stormwater hydraulic modeling indicates a potential for ponding onto the perimeter road south of Runway 3-21 for the 10-year, 24-hour storm event and potentially for more frequent storm events. This roadway serves as an access route for airport operational vehicles. According to FAA AC 150/55320-5, "the objective of storm drainage design is to provide for safe passage of vehicles or operation of the facility during the design storm event." Therefore, the need to address ponding south of Runway 3-21 is driven by a regulatory need to provide for safe vehicle passage along the perimeter road.

Consequence of Not Mitigating Stormwater Management Need

Item	Description
Operations	Saturated soil conditions in the Runway 3-21 RSA pose a risk to aircraft safety in the event of undershoot, overshoot, or excursion from the runway. Additionally, ponding at this location may extend onto the perimeter road during the 10-year storm. Ponding onto the roadway may compromise the safety of airport operational vehicles traveling along the roadway during storm events. The ponding may result in damage to passing vehicles or may interfere with airport operations because vehicles are required to travel via alternate routes.
Wildlife Hazard Management	Standing water near the end of Runway 3-21 poses an increased risk of hazardous wildlife attraction and for wildlife strikes.

Criteria to be Addressed by Stormwater Management Solutions

Item	Description
Flooding of Existing / Future Pavement	Eliminate ponding onto the Perimeter Road during the 10-year storm.
Flooding of Existing / Future Buildings	Not applicable.
Ponding in Unpaved Areas Identified as Critical for Ponding Reduction	Reduce the 10-year storm peak ponding elevation to the lowest known ground elevation.
Asset Management Criteria	Not applicable.
Water Quality Treatment Criteria	Not applicable.

SWM SOLUTION FACT SHEET 2-A

Stormwater Management Solution Tracking Information

SWM Solution ID	Solution Name	Capital Cost Summary	Anticipated Implementation Timeframe	Author	Revision Date
2-A	Replace Basin 2 Outfall Pipe and Portion of Basin 2 Trunk Line	$1,400,000	2016-2020	GS&P	June 2015

Stormwater Management Needs Addressed by Solution

SWM Need ID	Need Name	Need Type		
		Address Ponding and Facilitate Drainage	Address Risk of Stormwater Asset Failure	Provide Required Stormwater Controls
2-1	Address Ponding South of Crosswinds Runway (3-21)	X		

Solution Description

Solution Type	Summary Description
New or Modified Infrastructure	Increase the Port's storm sewer capacity along the existing Basin 2 trunk line between the West Detention Basin and PDX Outfall 2.

As shown in Figure 1, SWM Solution 2-A is located in the PDX Air Operations Area (AOA), partially inside the Runway 3-21 safety area (RSA). The solution involves replacement of existing 24-inch pipes along the Basin 2 trunk line from STSMH3017 to PDX Outfall 2, including replacement of the 12-inch adjoining lateral between STSMH3176 and STSMH3145. A short segment of the proposed solution (approximately 10 feet of pipeline) extends south of the AOA fence line into a system of open channels serving as drainage for Broadmoor Golf Course. To provide additional drainage capacity in this downstream portion of the Basin 2 storm sewer system and meet required depth of cover while maintaining the existing grade, it is recommended for the existing pipes to be replaced with rectangular pipes having a maximum height of 2 feet.

This solution involves replacing the existing 12-inch and 24-inch diameter pipes between the 15-inch West Detention Basin outlet and PDX Outfall 2 with a combination of the following:

- 600 linear feet of 2-feet by 4-feet rectangular pipe
- 290 linear feet of 2-feet by 6-feet rectangular pipe

The solution also includes an upgrade to PDX Outfall 2 to replace the existing 24-inch circular outfall with a 2-feet by 6-feet rectangular outfall with structural concrete wingwall. The sizing of this proposed infrastructure is based upon planned future development as provided by the Port in August 2014. The solution may need to be refined as development plans evolve.

Drainage through PDX Outfall 2 is closely associated with pump operating levels at MCDD's Broadmoor Pump Station. The pump station controls the water elevation in the channel receiving flow from Outfall 2. Although the proposed infrastructure (described above) was sized to address SWM Need 2-1 with MCDD's current pump station operational settings, lowering of the pump on/off level settings may provide further drainage benefit. The Port is currently performing an analysis of groundwater levels and is investigating the effect of pump station settings on the local groundwater table.

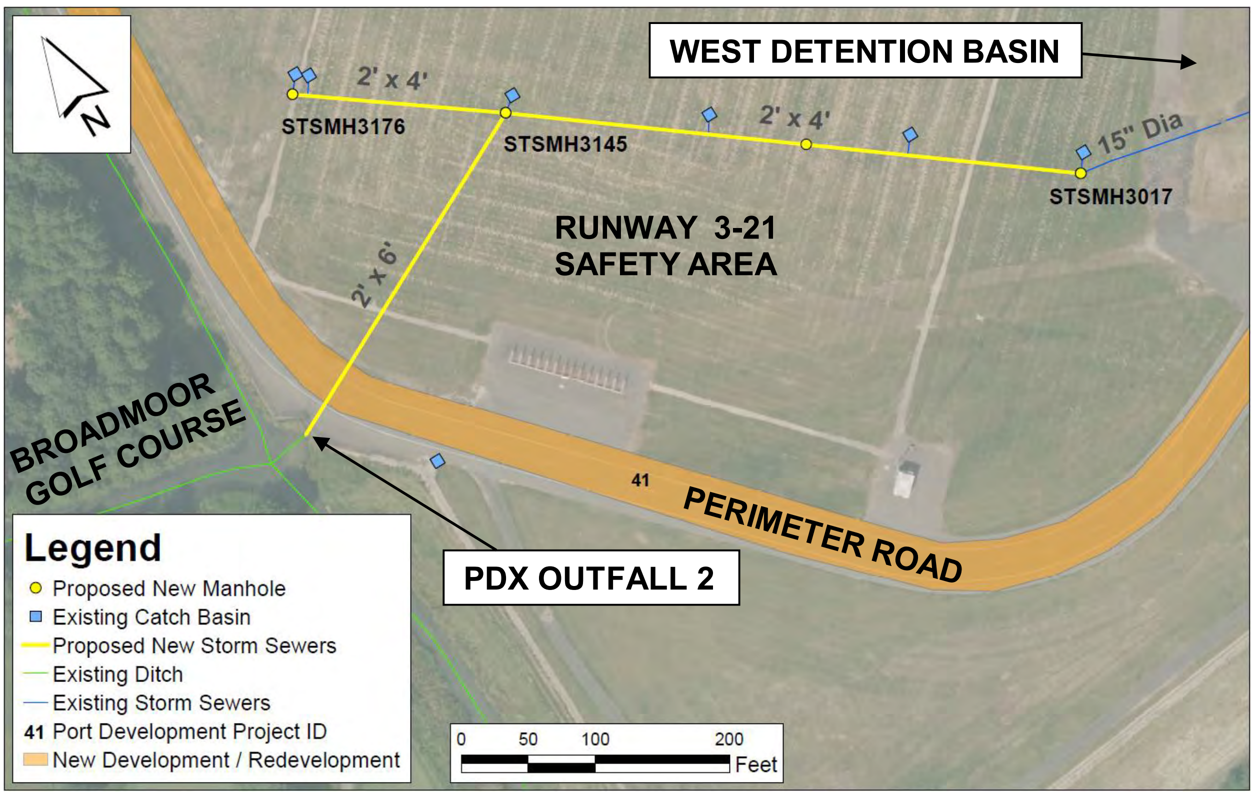


Figure 1: Plan View of Solution

Implementation Considerations

The following tables provide recommended considerations as the project moves from planning concept to implemented solution. The tables below address three phases of implementation, including planning and design, construction, and post-construction.

Planning and Design Considerations

Item	Description
Data Collection	• Underground utility location • Geotechnical and hydrogeological studies may be needed to support detailed design.
Additional Technical Analysis	Update the PDX stormwater hydraulic model to confirm sizing of the solution following completion of the Port groundwater analysis.
Permitting	• Clean Water Act Section 401/404 permitting • National Marine Fisheries Service (NMFS) consultation • Potential need for National Environmental Policy Act (NEPA) approval • City of Portland Environmental Zones
Siting	During detailed design, review the SWM solution extents and layout (as shown in Figure 1) and adjust as necessary to optimize land use, minimize RSA impacts, minimize excavation, avoid utilities, meet setback requirements, and avoid interference with Runway 3-21 operations.
Coordination with Elements of Other Projects	• Coordinate SWM Solution 2-A with SWM Solution 2-B because the projects are adjacent and may intersect. • Coordinate with future use / rehabilitation of Runway 3-21, which will be considered in the next PDX Master Plan update. If the runway will continue to be used, the storm sewer changes could be coordinated with the schedule for reconstruction of the Runway 3-21 pavement, which will reduce the net closure duration for the runway. • Coordinate with the Perimeter Road Rehabilitation project which will involve full reconstruction in some areas where needed. The Port has indicated that there is funding in this project to perform a full depth reconstruction of the perimeter road at the location of the pipe crossing.
Enabling Projects	None identified.
Related Solutions	None identified.

Item	Description
Coordination with Port Departments	• Environmental - outfall modification • Planning and Development - Charter and Business Case Development • Engineering - pipe sizing, utility relocation, design coordination • Operations - temporary closure of Runway 3-21 • Maintenance - change in catch basins and manholes requiring routine maintenance • Asset Management - removal of existing assets, addition of new assets • Wildlife Management - identify significance of current risk, change in future management techniques in area
Coordination with Tenants	• Coordinate closure of the perimeter road with tenants using road. • Coordinate the need for a temporary closure of Runway 3-21 with airlines.
Coordination with Outside Agencies	• Coordinate with MCDD to determine if the pump operating levels at Broadmoor Pump Station can be lowered. • Coordinate with FAA regarding runway closures, as well as potential crossings of FAA communication and electrical utilities.
Design Disciplines Involved	Civil, Structural, and others as needed to relocate utilities

Construction Considerations

Item	Description
Construction Components	• Maintain existing 15-inch pipe discharging from the West Detention Basin. • Demolish existing 12-inch and 24-inch pipes (and associated structures) between the 15-inch West Detention Basin outlet and PDX Outfall 2, and replace these existing pipes with a combination of 2-feet by 4-feet and 2-feet by 6-feet rectangular pipes with associated structures. • Maintain existing sewer laterals and existing catch basins, and connect to proposed pipes. • Demolish and reconstruct the perimeter road as needed to install solution. • Remove and replace the existing AOA security fence as needed to install solution. • Protect and/or relocate existing utilities as needed to install solution.
Airport Operational Impacts	• Construction in the Runway 3-21 RSA will require temporary runway closure. • Pipe installation will involve open cut of the perimeter road, requiring the Port to designate an alternate route for vehicular traffic.
Construction Challenges	• Earthwork within the RSA will need to be performed in accordance with FAA requirements. • Identify contractor laydown area that avoids interference with airport operations. • A study is underway to assess potential groundwater depths in this area and their potential influence on ponding. Results of this study should be considered for potential dewatering requirements. • Surface water dewatering will need to occur to allow the replacement of PDX Outfall 2, which is occasionally submerged. Coordination with MCDD to lower the pump settings at Broadmoor Pump Station during construction may help to reduce dewatering costs. • Coordination with the Transportation Security Administration (TSA) will be required when crossing the AOA security fence.

Post-Construction Considerations

Item	Description
Post-Construction Coordination with Airport Operations	None identified.
Considerations for Operation and Maintenance (O&M) of the Solution	No change from current.

Potential Risks if Solution is Implemented / Risk Mitigation Strategies

Item	Description	Mitigation Strategy
Regulatory Compliance	None identified.	Not applicable.
Airport or Tenant Operations	None identified.	Not applicable.
Aircraft Safety	None identified.	Not applicable.
Future Development Limitations	None identified.	Not applicable.

Schedule Analysis

Item	Description
Critical Schedule Drivers	Coordinate the construction with the following development project timeframes:[1] • Project #2: Runway 3-21 & Taxiway M Rehabilitation (2021) • Project #41: Perimeter Road Rehabilitation (2017) • Airport Master Plan Update (2018-2019) • SWM Solution 2-B: Provide Regional Water Quality Treatment for BMP Strategy Area (BMP SA)-2.1 Specific benefits of coordinating with each project listed above are described in the Implementation Considerations section, under Planning and Design Considerations.
Target Construction Timeframe (2016-2020, 2021-2025, 2026-2035)	2016-2020 Timeframe selected based on: • significance of risk for hazardous wildlife attraction • the relatively small scope of the project • alignment with the Perimeter Road Rehabilitation project
Planning and Design Lead Time (<6 months, 6-12 months, 12-24 months)	6-12 months Plan to define permitting and mitigation requirements for outfall reconstruction well before project design starts.

Notes:

1. Project numbers and timeframes are from the Port's list of future development projects (Appendix A).

Cost Analysis

Item	Description
Opinion of Probable Capital Cost (2015 Dollars)[1]	$1,400,000
Cost Estimate Class / Contingency (1-Bid received, 2-Construction, 3-Design, 4-Concept Design, 5- Screening/Planning)	5- Screening/Planning
Fixed Asset Modifications Excluded from Cost Estimate	None identified.
Cost Assumptions	• Assumes open cut of the perimeter road. • Traffic control and roadway rehabilitation costs assumed to be covered by the Perimeter Road Rehabilitation project. • Includes 40% for hard cost contingency. • Includes 30% for soft cost contingency.
O&M Cost Considerations	No change from current.

Notes:
1. Supporting detailed cost tables are provided in Appendix B.

SWM SOLUTION FACT SHEET 2-B

Stormwater Management Solution Tracking Information

SWM Solution ID	Solution Name	Capital Cost Summary	Anticipated Implementation Timeframe Summary	Author	Revision Date
2-B	Provide Regional Water Quality Treatment for BMP Strategy Area (BMP SA)-2.1	$1,400,000	2016-2020	GS&P and Geosyntec	June 2015

Stormwater Management Needs Addressed by Solution

SWM Need ID	Need Name	Need Type		
		Address Ponding and Facilitate Drainage	Address Risk of Stormwater Asset Failure	Provide Required Stormwater Controls
0-1	Post-Construction Stormwater Pollutant and Runoff Control			X

Development projects planned by the Port will trigger stormwater quality treatment requirements of the MS4 permit as outlined in the Port of Portland Stormwater Design Standards Manual (DSM) and described in SWM Need Fact Sheet 0-1. The proposed solution addresses the need to provide treatment for future development projects in this BMP Strategy Area (BMP SA-2.1), as summarized in the table below. The subsequent table provides a summary of the BMP sizing requirements, as calculated based on DSM criteria.

Future Development Projects Treated by BMP

Project # [1]	Drainage Basin	Planned Development / Redevelopment Project Name	Acres Treated by BMP
2 [2]	2	Runway 3-21 & Taxiway M Rehabilitation	12.0
41	2	Perimeter Road Rehabilitation	2.3
73	2	Central Apron E Reconstruction	0.4
76	2	Assumed Development (To Be Determined)	11.9
77 [2]	2	Assumed Development (To Be Determined)	1.6
83 [2]	2	MP Airtrans Ramp Construction	4.8
108 [2]	2	MP Air Cargo Site Prep Phase 2	2.4
Total Acres of Development Treated			35.4

Notes:
1. Project numbers correspond to future development areas displayed on Figure 1, and included in the Port's list of future development projects (Appendix A).
2. Project crosses into an adjacent BMP Strategy Area. Acreage reflects portion in this BMP Strategy Area.

Water Quality Treatment BMP Sizing Basis

Area to be Treated	Impervious Acres to be Treated	Annual Runoff Volume (ac-ft)	WQ Design Flow Rate (cfs)[1]	WQ Design Volume (ac-ft)[2]
Planned Development/Redevelopment Area Only [1]	35.4	216.0	3.0	1.1
Entire BMP Strategy Area [3]	89.4	84.3	7.6	2.9

Notes:
1. Based on 0.1 in/hr design intensity, per DSM requirements for offline flow-based BMPs.
2. Based on 0.45 inch design depth, per DSM requirements for volume-based BMPs with 24-hr drawdown time.
3. Provided for planning purposes only. BMP sizing and costs based on Planned Development / Redevelopment Area Only.

Solution Description

Solution Type	Summary Description
New or Modified Infrastructure	Construction of subsurface flow (SSF) wetland and stormwater diversion. Modification of existing West Quiescent Basin and West Detention Basin.

Figure 1 is a vicinity map showing the Strategy Area boundary, future projects requiring water quality BMPs, and location of the proposed BMP. Figure 2 shows the approximate footprint of the proposed BMP, which consists of retrofitting and enlarging the existing West Detention Basin into a treatment train consisting of the existing West Quiescent Basin for pre-treatment and spill control draining to an outlet-controlled sub-surface flow (SSF) wetland. Storage above the SSF wetland will be approximately equivalent to the amount of storage in the existing detention facility. Runoff will then be returned to the existing storm sewer via gravity flow to STSMH3017. While a variety of alternative treatment solutions are possible that could meet the Port's treatment requirements, the proposed solution was selected to provide treatment for multiple pollutants while minimizing potential wildlife attractants and interactions with groundwater. Figure 3 illustrates a cross section of the proposed solution. Figure 3 is a typical cross section for a subsurface flow wetland with detention storage. Assuming treatment would only be provided for the planned development/ redevelopment area only, the SSF wetland was preliminary sized using the water quality design volume with an assumed 3-foot gravel depth.

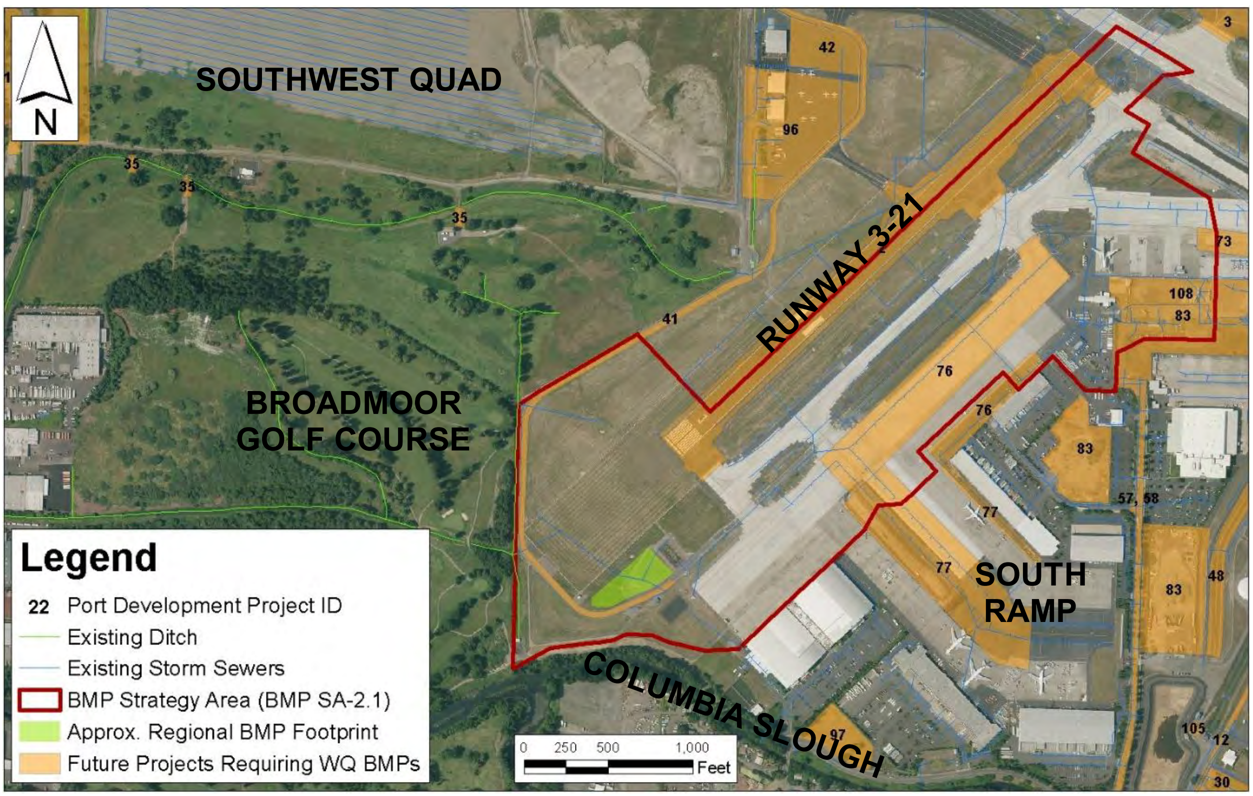


Figure 1: BMP SA-2.1 Vicinity

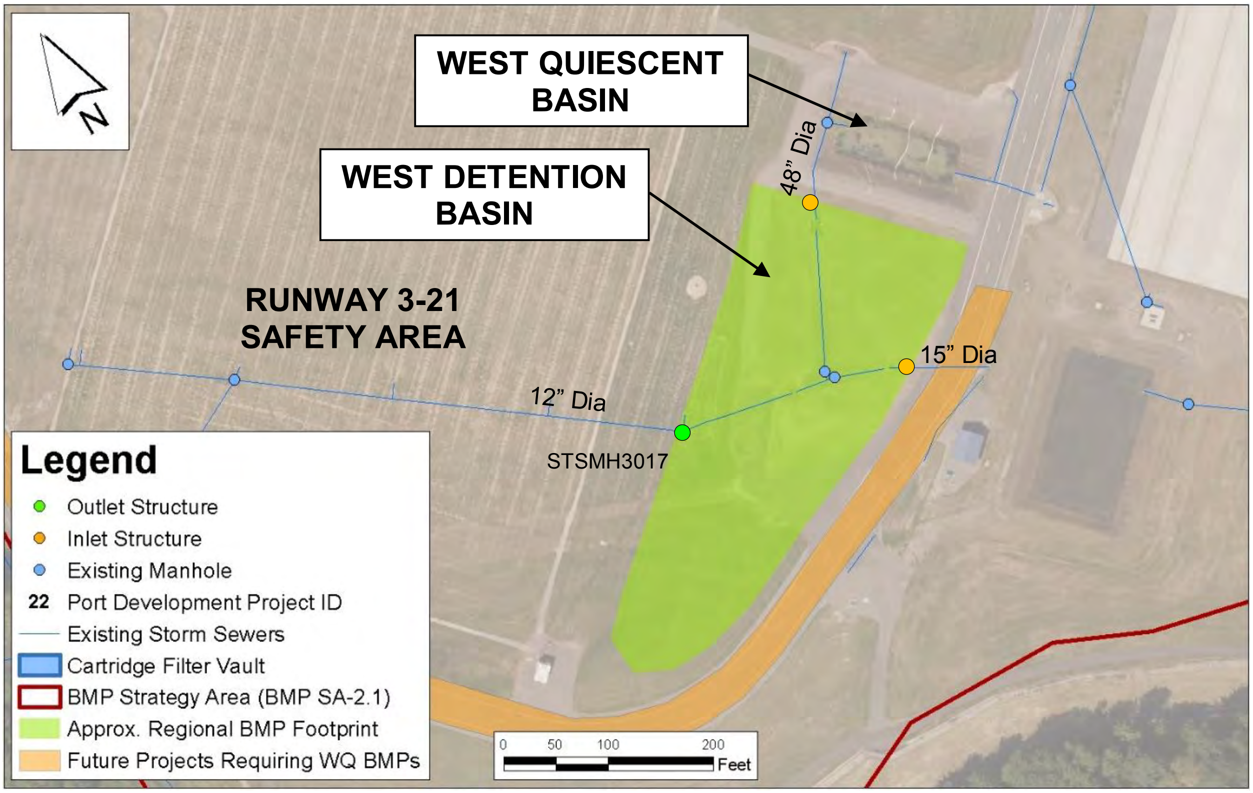


Figure 2: Plan View of Proposed Detention Basin and SSF Wetland for BMP SA-2.1

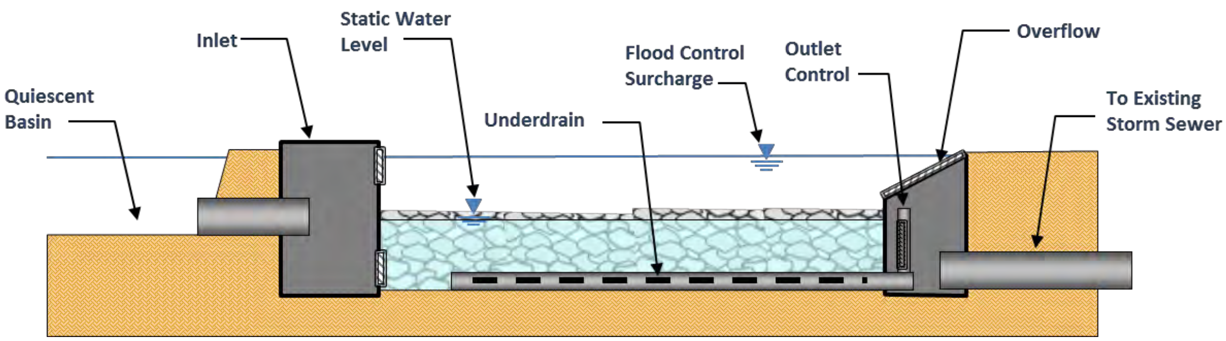


Figure 3: Cross-Section of Proposed SSF Wetland

Implementation Considerations

The following tables provide recommended considerations as the project moves from planning concept to implemented solution. The tables below address three phases of implementation, including planning and design, construction, and post-construction.

Planning and Design Considerations

Item	Description
Field Data Collection	• Underground utility location • Local topographic surface to support design • Local groundwater elevations to support structural design
Additional Technical Analysis	• Geotechnical and hydrogeological studies may be needed to support detailed design. • Detailed analysis of the proposed system using the PDX stormwater model is recommended prior to design to assess hydraulic feasibility and conveyance mechanisms. • An actuated outlet structure with real-time control of drawdown rates may be considered to minimize ponding time and maximize flood control and water quality benefits.
Permitting	No permits needed for installation.
Siting	During detailed design, review the extents and layout and adjust as necessary to optimize land use, avoid utilities and meet setback requirements.
Coordination with Elements of Other Projects	• Post-construction BMPs must be installed to address the MS4 permit requirements following completion of the associated development/redevelopment projects. • Coordinate SWM Solution 2-B with SWM Solution 2-A because the projects are adjacent and may intersect.
Enabling Projects	None identified.
Related Solutions	None identified.
Coordination with Port Departments	• Environmental - MS4 compliance, BMP tracking • Planning and Development - Charter and Business Case Development • Engineering - pipe sizing, utility relocation, design coordination • Maintenance - regular maintenance of SSF wetlands for plant management • Asset Management - addition of new assets • Wildlife Management - coordination on wetland plants, observation of wildlife as SSF wetland develops
Coordination with Tenants	None identified.
Coordination with Outside Agencies	None identified.
Design Disciplines Involved	Civil, Structural and others as needed

Construction Considerations

Item	Description
Construction Components	• Connect to existing storm sewers at two locations. • Construct SSF wetland. • Decommission storm sewer within BMP footprint. • Protect and/or relocate existing utilities as needed to install solution.
Airport Operational Impacts	• Construction access within the Air Operations Area (AOA) is required. Construction is planned near aircraft movement areas, including the Crosswinds Runway (3-21) and the perimeter road. • Truck traffic and heavy equipment operation is anticipated during construction.
Construction Challenges	• An estimated 8,700 CY of excavation spoils would need to be exported and disposed of and 8,700 CY of stone aggregate imported. • Equipment and material staging areas would need to be identified as well as soil and aggregate stockpile areas.

Post-Construction Considerations

Item	Description
Post-Construction Coordination with Airport Operations	None identified.
Considerations for Operation and Maintenance (O&M) of the Solution	• Access for filter maintenance. • Maintain emerging vegetation.

Potential Risks if Solution is Implemented / Risk Mitigation Strategies

Item	Description	Mitigation Strategy
Regulatory Compliance	Effectively tracking development project treatment needs and BMPs to which it is assigned	Develop BMP tracking tool.
Airport or Tenant Operations	None identified.	Not applicable.
Aircraft Safety	Risk of wildlife attraction	Selected BMP will only have temporary ponding during large storm events. Coordinate design features with Port Natural Resources staff.
Future Development Limitations	BMP footprint area will be unavailable for other development.	Coordinate siting with project planners to confirm location minimizes conflicts with future development.

Schedule Analysis

Item	Description
Critical Schedule Drivers	Coordinate the construction with the following project timeframes:[1] • Project #2: Runway 3-21 & Taxiway M Rehabilitation (2021) • Project #41: Perimeter Road Rehabilitation (2017) • Project #73: Central Apron E Reconstruction (2020) • Project #76: –Assumed Development (To Be Determined) (unknown timeframe) • Project #77: –Assumed Development (To Be Determined) (unknown timeframe) • Project #83: MP Airtrans Ramp Construction (2022) • Project #108: MP Air Cargo Site Prep Phase 2 (unknown timeframe) • SWM Solution 2-A: Replace Basin 2 Outfall Pipe and Portion of Basin 2 Trunk Line
Target Construction Timeframe (2016-2020, 2021-2025, 2026-2035)	2016-2020 Timeframe selected to correspond with above development projects. Assumed that BMP will be installed by end of timeframe.
Planning and Design Lead Time (<6 months, 6-12 months, 12-24 months)	12-24 months to allow for monitoring and SSF wetland pilot testing prior to full scale design

Notes:

1. Project numbers and timeframes are from the Port's list of future development projects (Appendix A).

Cost Analysis

Item	Description
Opinion of Probable Capital Cost (2015 Dollars)[1]	$1,400,000
Cost Estimate Class / Contingency (1-Bid received, 2-Construction, 3-Design, 4-Concept Design, 5- Screening/Planning)	5- Screening/Planning
Fixed Asset Modifications Excluded from Cost Estimate	None identified.
Cost Assumptions	• Includes 40% for hard cost contingency. • Includes 30% for soft cost contingency. • Other relevant assumptions provided in “BMP Sizing Basis” and “Construction Considerations” sections in this fact sheet.
O&M Cost Considerations	• Estimated annual O&M labor for SSF wetland 50 mhr/year[2]

Notes:
1. Supporting detailed cost tables are provided in Appendix B.
2. O&M level of effort estimated based on DSM Appendix O values.

BASINS 3-5 STORMWATER MANAGEMENT FACT SHEETS

BASINS 3-5 STORMWATER MANAGEMENT FACT SHEETS

The SWM needs identified in Basins 3-5 are associated with ponding and water quality treatment requirement issues. SWM needs in Basins 3-5 are summarized in Table 13 below, and SWM solutions proposed to address these needs are described in Table 14. Both tables indicate how the SWM solutions align with each SWM need, and vice versa. SWM need and solution fact sheets for Basins 3-5 immediately follow the tables.

The only SWM issues in Basins 3, 4, and 5 are associated with water quality BMPs to meet regulatory requirements for development. Two regional BMP treatment systems are proposed. One solution (3-A) involves only planning recommendations because of the uncertainty of the development. No ponding issues were identified in these basins and no specific asset management issues were evaluated.

Table 13 – Basins 3-5 SWM Needs

SWM Need ID	Issue Type	Need Description	Corresponding SWM Solution ID
0-1	Stormwater Controls	Address Requirement for Post-Construction Stormwater Pollutant and Runoff Control	3-A, 4-A, 5-A

Table 14 – Basins 3-5 SWM Solutions

SWM Solution ID	Solution Type	Solution Description	Corresponding SWM Need ID
3-A	Future Planning Considerations	Water Quality Planning Recommendations for BMP Strategy Area (BMP SA)-3.1	0-1
4-A	New or Modified Infrastructure	Provide Regional Water Quality Treatment for BMP Strategy Area (BMP SA)-4.1	0-1
5-A	New or Modified Infrastructure	Provide Regional Water Quality Treatment for BMP Strategy Area (BMP SA)-5.1	0-1

SWM SOLUTION FACT SHEET 3-A

Stormwater Management Solution Tracking Information

SWM Solution ID	Solution Name	Capital Cost Summary	Anticipated Implementation Timeframe	Author	Revision Date
3-A	Water Quality Planning Recommendations for BMP Strategy Area (BMP SA)-3.1	$77,000	2016-2020	GS&P and Geosyntec	June 2015

Stormwater Management Needs Addressed by Solution

SWM Need ID	Need Name	Need Type		
		Address Ponding and Facilitate Drainage	Address Risk of Stormwater Asset Failure	Provide Required Stormwater Controls
0-1	Post-Construction Stormwater Pollutant and Runoff Control			X

Development projects planned by the Port will trigger stormwater quality treatment requirements of the MS4 permit as outlined in the Port of Portland Stormwater Design Standards Manual (DSM) and described in SWM Need Fact Sheet 0-1. The proposed solution addresses the need to provide treatment for future development projects in this BMP Strategy Area (BMP SA-3.1), as summarized in the table below. The subsequent table provides a summary of the BMP sizing requirements, as calculated based on DSM criteria.

Future Development Projects Treated by BMP

Project # [1]	Drainage Basin	Planned Development / Redevelopment Project Name	Acres Treated by BMP
97	3	South of FedEx	2.0
Total Acres of Development Treated			2.0

Notes:

1. Project numbers correspond to future development areas displayed on Figure 1, and included in the Port's list of future development projects (Appendix A).

Water Quality Treatment BMP Sizing Basis

Area to be Treated	Impervious Acres to be Treated	Annual Runoff Volume (ac-ft)	WQ Design Flow Rate (cfs)[1]	WQ Design Volume (ac-ft)[2]
Planned Development/Redevelopment Area Only	2.0	4.7	0.2	0.04
Entire BMP Strategy Area [3]	13.4	32.0	1.1	0.3

Notes:

1. Based on 0.1 in/hr design intensity, per DSM requirements for offline flow-based BMPs.
2. Based on 0.45 inch design depth, per DSM requirements for volume based BMPs with 24-hr drawdown time.
3. Provided for planning purposes only. BMP sizing and costs based on Planned Development / Redevelopment Area Only.

Solution Description

Solution Type	Summary Description
Future Planning Considerations	Select and construct BMPs, such as bioretention, vegetated swales, and/or LID approaches as part of development project construction activities for project within BMP strategy area. This solution does not include use of a regional treatment facility.

Figure 1 depicts the BMP Strategy Area with the single planned future development project (Project #97). Proposed BMP locations are omitted since the proposed BMPs can be either distributed controls or sub-regional facilities whose locations are dependent on the type of development and the location and distribution of pervious areas within the development. If the planned development includes parking lots and landscaped areas, distributed stormwater controls such as bioretention facilities, infiltration trenches, vegetated swales, and/or other low impact development (LID) design elements can be used to reduce effective impervious areas and treat runoff. Alternatively, depending on site grading and planned storm sewer routing, a single BMP may be used prior to discharging. The location and size of the proposed BMPs can be determined once the extents of the improvements are known.

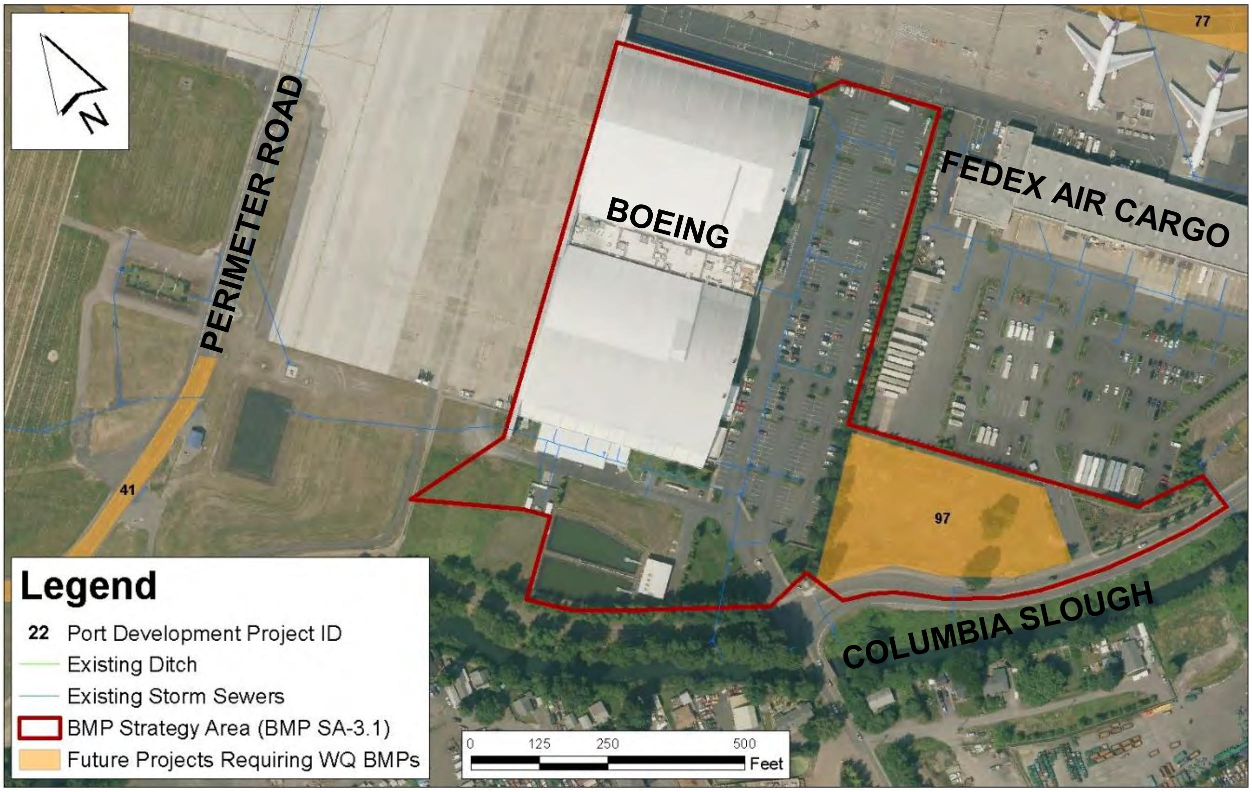


Figure 1: BMP SA-3.1 Vicinity

Implementation Considerations

The following tables provide recommended considerations as the project moves from planning concept to implemented solution. The tables below address implementation considerations for planning and design, construction, and post-construction.

Planning and Design Considerations

Item	Description
Field Data Collection	None identified.
Additional Technical Analysis	Individual BMP sizing needed once the type and location determined. Hydraulic analyses that considers influent flows, head losses, and tailwater conditions for the discharge.
Permitting	None identified.
Siting	During detailed design, review the development project extents and layout, with subsequent adjustment as needed to optimize land use, avoid utilities and meet setback requirements
Coordination with Elements of Other Projects	Post-construction BMPs must be installed to address the MS4 permit requirements following completion of the associated development/redevelopment projects.
Enabling Projects	None identified.
Related Solutions	None identified.
Coordination with Port Departments	• Planning and Development - Charter and Business Case Development • Engineering - pipe sizing, utility relocation, design coordination • Maintenance - change in catch basins and manholes requiring routine maintenance • Asset Management - removal of existing assets, addition of new assets • Wildlife Management - identify significance of potential risks
Coordination with Tenants	Port to determine the timeline for construction of treatment BMPs in coordination with the development projects in the BMP Strategy Area and their respective tenants (FedEx).
Coordination with Outside Agencies	None identified.
Design Disciplines Involved	Civil, Landscape Architect, and others as needed depending on BMPs selected

Construction Considerations

Item	Description
Construction Components	Depends on BMPs selected.
Airport Operational Impacts	None identified.
Construction Challenges	None identified.

Post-Construction Considerations

Item	Description
Post-Construction Coordination with Airport Operations	None identified.
Considerations for Operation and Maintenance (O&M) of the Solution	Depends on BMP selected. Refer to DSM Appendix O for guidance on O&M level of effort for various BMPs.

Potential Risks if Solution is Implemented / Risk Mitigation Strategies

Item	Description	Mitigation Strategy
Regulatory Compliance	Effectively tracking development project treatment needs and BMPs to which it is assigned	Develop BMP tracking tool.
Airport or Tenant Operations	None identified.	Not applicable.
Aircraft Safety	Risk of wildlife attraction	Selected BMP should not have exposed water surface to minimize wildlife attraction. Coordinate design features with Port Natural Resources staff.
Future Development Limitations	BMP footprint area will be unavailable for other development.	Coordinate siting with project planners to confirm location minimizes conflicts with future development.

Schedule Analysis

Item	Description
Critical Schedule Drivers	Coordinate the construction with the following project timeframe:[1] • Project #97: South of FedEx (unknown timeframe)
Target Construction Timeframe 2016-2020, 2021-2025, 2026-2035)	2016-2020 Timeframe selected to be conservative due to unknown timeframe of development project. Assumed that BMP will be installed by end of timeframe.
Planning and Design Lead Time (<6 months, 6-12 months, 12-24 months)	6-12 months from beginning of development project design

Notes:

1. Project numbers and timeframes are from the Port's list of future development projects (Appendix A).

Cost Analysis

Item	Description
Opinion of Probable Capital Cost (2015 Dollars)	$77,000
Cost Estimate Class / Contingency (1-Bid received, 2-Construction, 3-Design, 4-Concept Design, 5- Screening/Planning)	5- Screening/Planning
Fixed Asset Modifications Excluded from Cost Estimate	None identified.
Cost Assumptions	• Includes 30% for hard cost contingency. • Includes 30% for soft cost contingency. • Other relevant assumptions provided in "BMP Sizing Basis" section in this fact sheet. • Assumes bioretention BMPs as representative for cost planning purposes, using unit costs from DSM Appendix N.
O&M Cost Considerations	Reference DSM Appendix O for information on O&M level of effort for BMPs.

SWM SOLUTION FACT SHEET 4-A

Stormwater Management Solution Tracking Information

SWM Solution ID	Solution Name	Capital Cost Summary	Anticipated Implementation Timeframe	Author	Revision Date
4-A	Provide Regional Water Quality Treatment for BMP Strategy Area (BMP SA)-4.1	$1,100,000	2026-2035	GS&P and Geosyntec	June 2015

Stormwater Management Needs Addressed by Solution

SWM Need ID	Need Name	Need Type		
		Address Ponding and Facilitate Drainage	Address Risk of Stormwater Asset Failure	Provide Required Stormwater Controls
0-1	Post-Construction Stormwater Pollutant and Runoff Control			X

Development projects planned by the Port will trigger stormwater quality treatment requirements of the MS4 permit as outlined in the Port of Portland Stormwater Design Standards Manual (DSM) and described in SWM Need Fact Sheet 0-1. The proposed solution addresses the need to provide treatment for future development projects in this BMP Strategy Area (BMP SA-4.1), as summarized in the table below. The subsequent table provides a summary of the BMP sizing requirements, as calculated based on DSM criteria.

Future Development Projects Treated by BMP

Project # [1]	Drainage Basin	Planned Development / Redevelopment Project Name	Acres Treated by BMP
76 [2]	4	Assumed Development (To Be Determined)	1.6
77 [2]	4	Assumed Development (To Be Determined)	10.4
Total Acres of Development Treated			12.0

Notes:

1. Project numbers correspond to future development areas displayed on Figure 1, and included in the Port's list of future development projects (Appendix A).
2. Project crosses into an adjacent BMP Strategy Area. Acreage reflects portion in this BMP Strategy Area.

Water Quality Treatment BMP Sizing Basis

Area to be Treated	Impervious Acres to be Treated	Annual Runoff Volume (ac-ft)	WQ Design Flow Rate (cfs)[1]	WQ Design Volume (ac-ft)[2]
Planned Development/Redevelopment Area Only	12.0	28.7	1.0	0.4
Entire BMP Strategy Area [3]	45.2	107.8	3.8	1.4

Notes:

1. Based on 0.1 in/hr design intensity, per DSM requirements for offline flow-based BMPs.
2. Based on 0.45 inch design depth, per DSM requirements for volume-based BMPs with 24-hr drawdown time.
3. Provided for planning purposes only. BMP sizing and costs based on Planned Development / Redevelopment Area Only.

Solution Description

Solution Type	Summary Description
New or Modified Infrastructure	Installation of cartridge filter vault and oil water separator and decommissioning of the Central Quiescent Basin

Figure 1 depicts the BMP Strategy Area with the planned future development projects and proposed BMP location. Figure 2 shows the existing Central Quiescent Basin (CQB), BMP footprint, cartridge filter vault, and existing storm drains. The proposed project would decommission the CQB and replace it with an oil water separator vault and cartridge filter BMP. Runoff will then be returned to the storm sewer trunk line via gravity flow at a new manhole.

While a variety of alternative treatment solutions are possible at this location that could meet the Port's treatment requirements, the proposed solution was selected to provide treatment within a small footprint for this densely developed area while minimizing impacts to existing operations. The new oil water separator would provide the spill containment functions of the CQB and protect the cartridge filter from contamination. Furthermore, this solution would remove an open water source which can be a hazardous wildlife attraction and shifts the maintenance to a subsurface vault. Figure 3 illustrates a cross-section of the proposed solution. Assuming treatment would only be provided for the planned development/redevelopment area only, the cartridge filters were preliminarily sized using the water quality design flow rate.

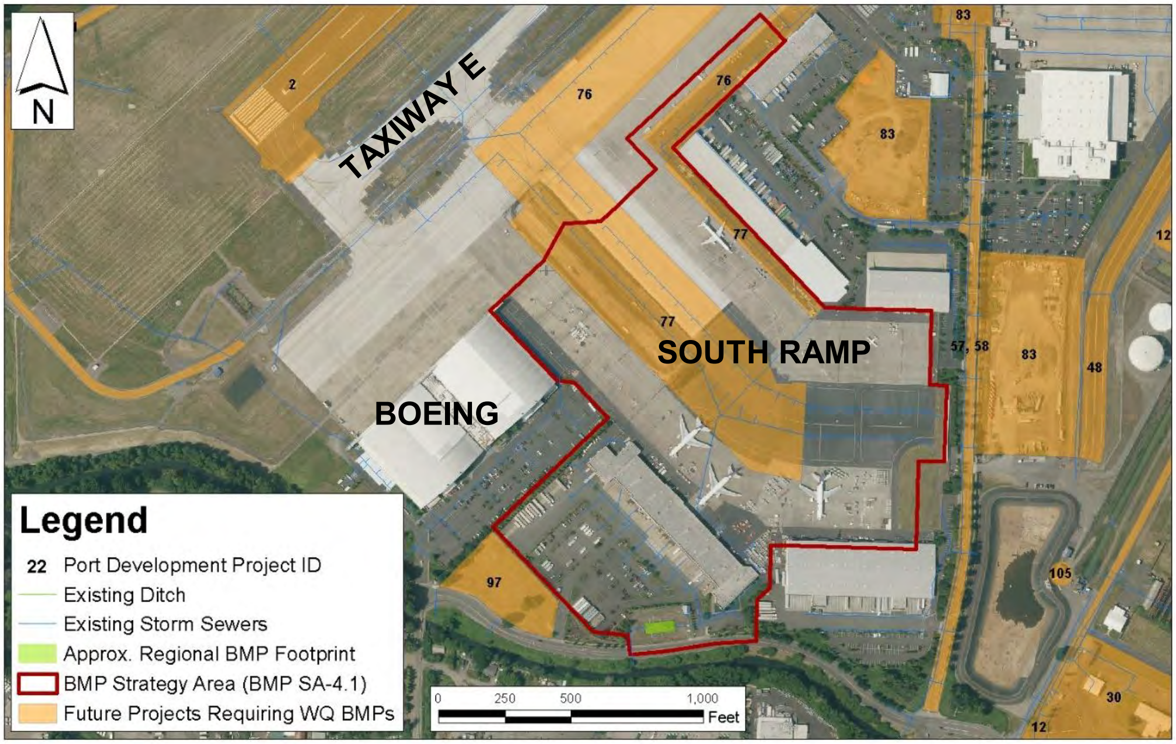


Figure 1: BMP SA-4.1 Vicinity

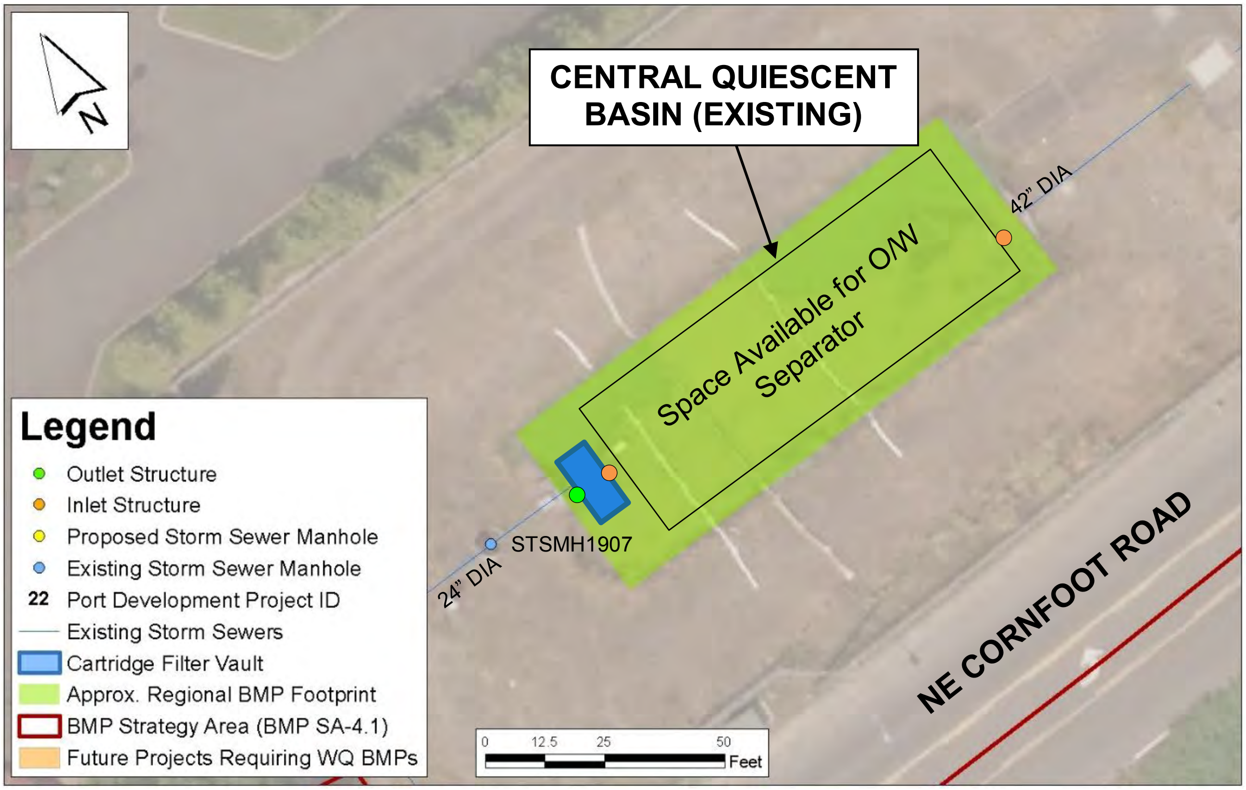


Figure 2: Layout of Proposed Oil Water Separator and Cartridge Filter for BMP SA-4.1

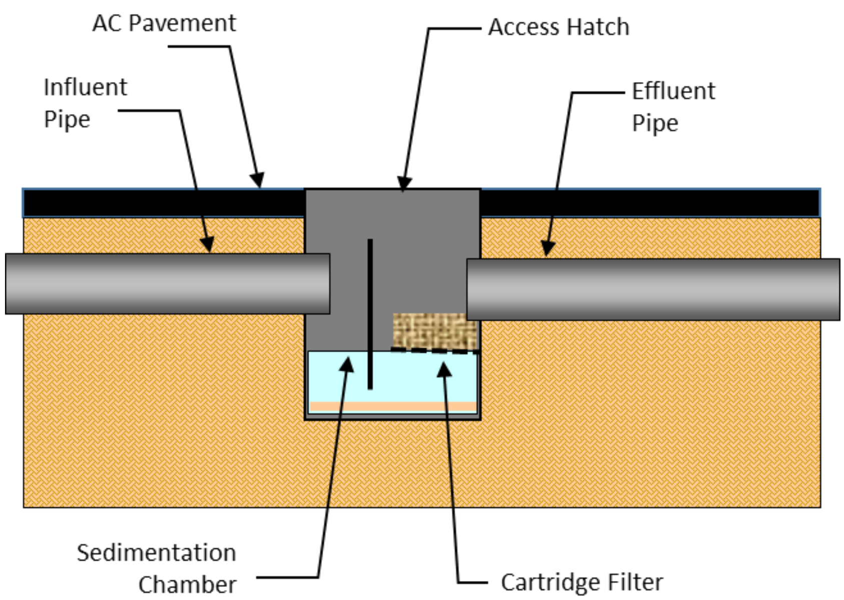


Figure 3: Cross-Section of Cartridge Filter

Implementation Considerations

The following tables provide recommended considerations as the project moves from planning concept to implemented solution. The tables below address three phases of implementation, including planning and design, construction, and post-construction.

Planning and Design Considerations

Item	Description
Field Data Collection	• Underground utility location • Verification of pipe diameters and invert elevations prior to design • Local topographic surface to support design • Local groundwater elevations to support structural design
Additional Technical Analysis	Identify design flow rates entering the CQB to help size the oil water separator
Permitting	No permits needed for installation, but coordinate oil-water separator installation with PDX SPCC Plan.
Siting	During detailed design, review the extents and layout and adjust as necessary to fit within the existing CQB footprint. Access for maintenance.
Coordination with Elements of Other Projects	Post-construction BMPs must be installed to address the MS4 permit requirements following completion of the associated development/redevelopment projects.
Enabling Projects	None identified.
Related Solutions	None identified.
Coordination with Port Departments	• Environmental - MS4 compliance, BMP tracking, spill control sizing • Planning and Development - Charter and Business Case Development • Engineering - oil-water separator sizing, utility relocation, design coordination • Maintenance - oil water separator and cartridge filter maintenance • Asset Management - removal of existing assets, addition of new assets • Wildlife Management - change in management plan for CQB
Coordination with Tenants	Port to determine the timeline for construction of water quality treatment BMPs in coordination with the development projects in the BMP Strategy Area and their respective tenants.
Coordination with Outside Agencies	None identified.
Design Disciplines Involved	Civil, Structural, Environmental, and others as needed

Construction Considerations

Item	Description
Construction Components	• Construct oil water separator (size to be determined). • Construct one 1.0 cfs cartridge filter vault. • Connect to existing storm sewer at one location. • Decommission the Central Quiescent Basin.
Airport Operational Impacts	Access from NE Cornfoot Road will be interrupted during construction.
Construction Challenges	• Depending on the size of the oil water separator, up to 4,000 CY of fill would need to be imported to fill the CQB • Equipment and material staging areas would need to be identified

Post-Construction Considerations

Item	Description
Post-Construction Coordination with Airport Operations	None identified.
Considerations for Operation and Maintenance (O&M) of the Solution	Access to oil water separator and cartridge filters for scheduled maintenance

Potential Risks if Solution is Implemented / Risk Mitigation Strategies

Item	Description	Mitigation Strategy
Regulatory Compliance	Effectively tracking development project treatment needs and BMPs to which it is assigned	Develop BMP tracking tool.
Airport or Tenant Operations	None identified.	Not applicable.
Aircraft Safety	None identified.	Not applicable.
Future Development Limitations	BMP footprint area will be unavailable for other development.	Not applicable. —Footprint currently unavailable.

Schedule Analysis

Item	Description
Critical Schedule Drivers	Coordinate the construction with the following project timeframes:[1] • Project #76: –Assumed Development (To Be Determined) (unknown timeframe) • Project #77: –Assumed Development (To Be Determined) (unknown timeframe)
Target Construction Timeframe (2016-2020, 2021-2025, 2026-2035)	2026-2035 Timeframe selected due to low priority and unknown timeframe of the planned development. The timeframe will depend upon the development schedule for the site.
Planning and Design Lead Time (<6 months, 6-12 months, 12-24 months)	6-12 months

Notes:
1. Project numbers and timeframes are from the Port's list of future development projects (Appendix A).

Cost Analysis

Item	Description
Opinion of Probable Capital Cost (2015 Dollars)[1]	$1,100,000
Cost Estimate Class / Contingency (1-Bid received, 2-Construction, 3-Design, 4-Concept Design, 5- Screening/Planning)	5- Screening/Planning
Fixed Asset Modifications Excluded from Cost Estimate	None identified.
Cost Assumptions	• Includes 40% for hard cost contingency. • Includes 30% for soft cost contingency. • Other relevant assumptions provided in "BMP Sizing Basis" and "Construction Considerations" sections in this fact sheet.
O&M Cost Considerations	Estimated annual O&M labor for Cartridge Filter at 24 mhr/year[2]

Notes:
1. Supporting detailed cost tables are provided in Appendix B.
2. O&M level of effort estimated based on DSM Appendix O values.

SWM SOLUTION FACT SHEET 5-A

Stormwater Management Solution Tracking Information

SWM Solution ID	Solution Name	Capital Cost Summary	Anticipated Implementation Timeframe Summary	Author	Revision Date
5-A	Provide Regional Water Quality Treatment for BMP Strategy Area (BMP SA)-5.1	$1,100,000	2021-2025	GS&P and Geosyntec	June 2015

Stormwater Management Needs Addressed by Solution

SWM Need ID	Need Name	Need Type		
		Address Ponding and Facilitate Drainage	Address Risk of Stormwater Asset Failure	Provide Required Stormwater Controls
0-1	Post-Construction Stormwater Pollutant and Runoff Control			X

Development projects planned by the Port will trigger stormwater quality treatment requirements of the MS4 permit as outlined in the Port of Portland Stormwater Design Standards Manual (DSM) and described in SWM Need Fact Sheet 0-1. The proposed solution addresses the need to provide treatment for future development projects in this BMP Strategy Area (BMP SA-5.1), as summarized in the table below. The subsequent table provides a summary of the BMP sizing requirements, as calculated based on DSM criteria.

Future Development Projects Treated by BMP

Project # [1]	Drainage Basin	Planned Development / Redevelopment Project Name	Acres Treated by BMP
57 [2]	5	Transport Way Rehabilitation	3.2
58 [2]	5	Rehabilitation of Airtrans Way	
83 [2]	5	MP Airtrans Ramp Construction	10.3
Total Acres of Development Treated			13.5

Notes:
1. Project numbers correspond to future development areas shown on Figure 1, and included in the Port's list of future development projects (Appendix A).
2. Project crosses into an adjacent BMP Strategy Area. Acreage reflects portion in this BMP Strategy Area.

Water Quality Treatment BMP Sizing Basis

Area to be Treated	Impervious Acres to be Treated	Annual Runoff Volume (ac-ft)	WQ Design Flow Rate (cfs)[1]	WQ Design Volume (ac-ft)[2]
Planned Development/Redevelopment Area Only	13.5	32.3	1.1	0.4
Entire BMP Strategy Area [3]	40.1	95.8	3.4	1.3

Notes:
1. Based on 0.1 in/hr design intensity, per DSM requirements for offline flow-based BMPs.
2. Based on 0.45 inch design depth, per DSM requirements for volume-based BMPs with 24-hr drawdown time.
3. Provided for planning purposes only. BMP sizing and costs based on Planned Development / Redevelopment Area Only.

Solution Description

Solution Type	Summary Description
New or Modified Infrastructure	Construction of diversion structure, lift station, and bioretention basin

Figure 1 depicts the BMP Strategy Area with the planned future development projects and proposed BMP location. Figure 2 shows the BMP footprint, existing storm sewer, lift station, and return manhole. The proposed project will divert runoff from the 54-inch HDPE trunk line (STSLN6456) at STSMH1341 to a lift station. A force main from the lift station will route runoff to the forebay of a bioretention basin, which will provide the final treatment. Runoff will then be returned to the storm sewer trunk line via gravity flow at a new manhole. While a variety of alternative treatment solutions are possible at this location that could meet the Port's treatment requirements, the proposed solution was selected to provide reliable and sustainable treatment for multiple pollutants while utilizing available open space and eliminating the need for cartridge filters.

Figure 3 illustrates a cross section of the proposed solution. Assuming treatment would only be provided for the planned development/redevelopment area only, the lift station was preliminarily sized using the water quality design flow rate. The bioretention basin was preliminary sized using the water quality design volume with an assumed 2-foot media depth.

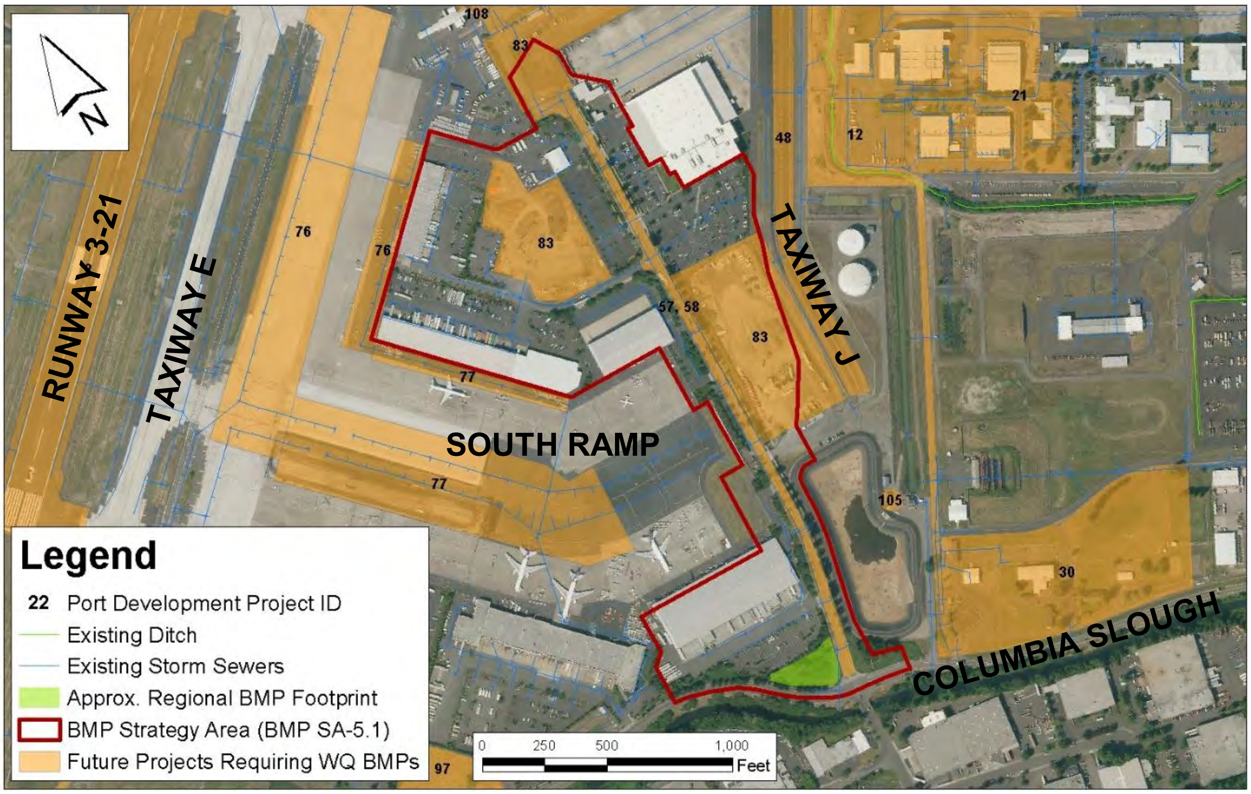


Figure 1: BMP SA-5.1 Vicinity

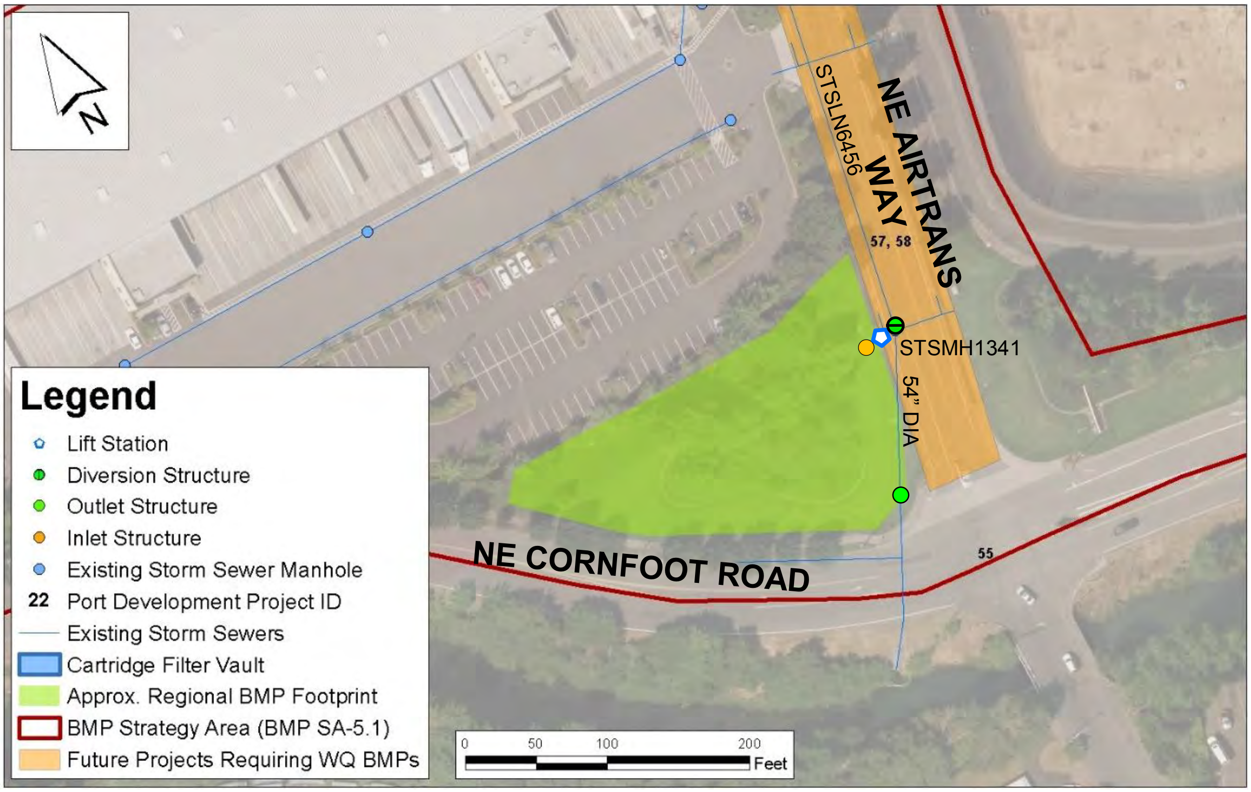


Figure 2: Layout of Proposed Lift Station and Bioretention System for BMP SA-5.1

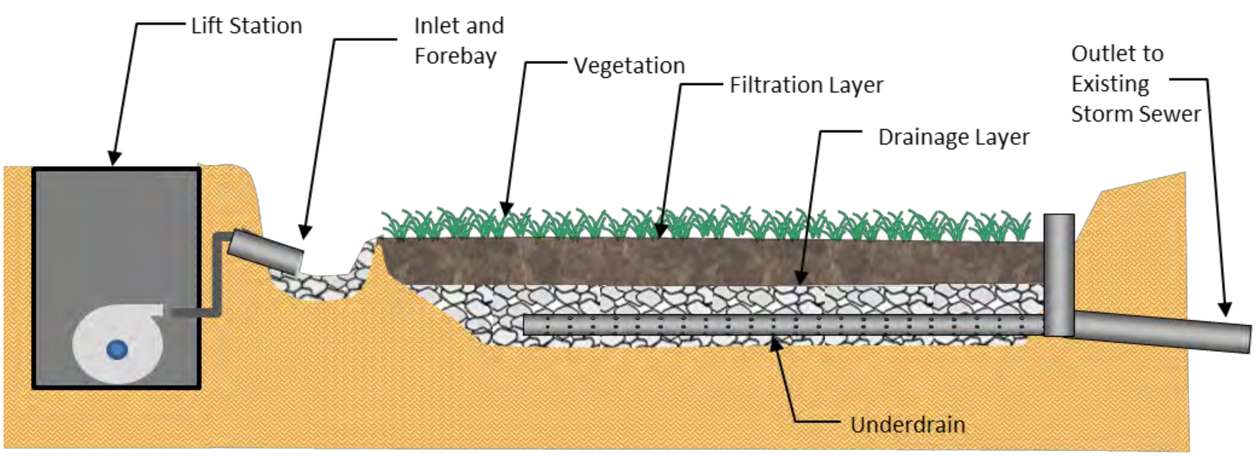


Figure 3: Cross-Section of Bioretention System with Lift Station

Implementation Considerations

The following tables provide recommended considerations as the project moves from planning concept to implemented solution. The tables below address three phases of implementation, including planning and design, construction, and post-construction.

Planning and Design Considerations

Item	Description
Field Data Collection	• Underground utility location • Local topographic surface to support design • Local groundwater elevations to support structural design
Additional Technical Analysis	• Geotechnical and hydrogeological studies may be needed to support detailed design. • Detailed analysis of the proposed system using the PDX stormwater model is recommended prior to design to assess hydraulic feasibility and conveyance mechanisms.
Permitting	No permits needed for installation.
Siting	During detailed design, review the extents and layout and adjust as necessary to optimize land use, avoid utilities and meet setback requirements
Coordination with Elements of Other Projects	• Post-construction BMPs must be installed to address the MS4 permit requirements following completion of the associated development/redevelopment projects. • Coordinate with the Rehabilitation of Airtrans Way for construction efficiency, including pavement demolition and repair.
Enabling Projects	None identified.
Related Solutions	None identified.
Coordination with Port Departments	• Environmental - MS4 compliance, BMP tracking • Planning and Development - Charter and Business Case Development • Engineering - pump sizing, utility relocation, design coordination • Maintenance - pump, forebay solids, bioretention basin plants • Asset Management - removal of existing assets, addition of new assets • Wildlife Management - Bioretention cell plants, observing wildlife
Coordination with Tenants	Port to determine the timeline for construction of solution in coordination with the development projects in the BMP Strategy Area and their respective tenants.
Coordination with Outside Agencies	None identified.
Design Disciplines Involved	Civil, Structural, Mechanical, Electrical, and others as needed to relocate utilities

Construction Considerations

Item	Description
Construction Components	• Construct one diversion manhole in roadway. • Construct one 1.1 cfs lift station. • Construct 0.7 acres of bioretention. • Construct one return manhole. • Connect to existing storm sewers at two locations. • Demolish and repair pavement on roadway surface.
Airport Operational Impacts	None identified.
Construction Challenges	• Construction required in roadway and right of way. • An estimated 2,600 CY of excavation spoils would need to be exported and disposed of and 1,300 CY of bioretention media imported. • Equipment and material staging areas would need to be identified as well as soil and aggregate stockpile areas.

Post-Construction Considerations

Item	Description
Post-Construction Coordination with Airport Operations	None identified.
Considerations for Operation and Maintenance (O&M) of the Solution	• Access to lift station for scheduled maintenance • Access to bioretention basin for scheduled maintenance (sediment removal in forebay and vegetation maintenance throughout)

Potential Risks if Solution is Implemented / Risk Mitigation Strategies

Item	Description	Mitigation Strategy
Regulatory Compliance	Effectively tracking development project treatment needs and BMPs to which it is assigned	Develop BMP tracking tool.
Airport or Tenant Operations	None identified.	Not applicable.
Aircraft Safety	Risk of wildlife attraction	Selected BMP will have temporarily exposed water surface during storm events. Coordinate design features with Port Natural Resources staff.
Future Development Limitations	BMP footprint area will be unavailable for other development.	Coordinate siting with project planners to confirm location and minimize conflicts with future development.

Schedule Analysis

Item	Description
Critical Schedule Drivers	Coordinate the construction with the following project timeframes:[1] • Project #57: Transport Way Rehabilitation (2016) • Project #58: ATC Pavement Rehabilitation Phase 2 (2016) • Project #83: MP Airtrans Ramp Construction (2022)
Target Construction Timeframe (2016-2020, 2021-2025, 2026-2035)	2021-2025 Timeframe selected to align with Project #83 because it is the large majority of the development area. Assumes BMP installed by end of timeframe.
Planning and Design Lead Time (<6 months, 6-12 months, 12-24 months)	6-12 months

Notes:
1. Project numbers and timeframes are from the Port's list of future development projects (Appendix A).

Cost Analysis

Item	Description
Opinion of Probable Capital Cost (2015 Dollars)[1]	$1,100,000
Cost Estimate Class / Contingency (1-Bid received, 2-Construction, 3-Design, 4-Concept Design, 5- Screening/Planning)	5- Screening/Planning
Fixed Asset Modifications Excluded from Cost Estimate	None identified.
Cost Assumptions	• Includes 40% for hard cost contingency. • Includes 30% for soft cost contingency. • Other relevant assumptions provided in "BMP Sizing Basis" and "Construction Considerations" sections in this fact sheet.
O&M Cost Considerations	• Pump replacement at 5-10 years • Bioretention media replacement at 20 years • Annual O&M labor for bioretention 25 mhr/year [2]

Notes:
1. Supporting detailed cost tables are provided in Appendix B.
2. O&M level of effort estimated based on DSM Appendix O values.

BASIN 6 STORMWATER MANAGEMENT FACT SHEETS

BASIN 6 STORMWATER MANAGEMENT FACT SHEETS

The SWM needs identified in Basin 6 are associated with ponding and water quality treatment requirement issues. SWM needs in Basin 6 are summarized in Table 15 below, and SWM solutions proposed to address these needs are described in Table 16. Both tables indicate how the SWM solutions align with each SWM need, and vice versa. Basin 6 SWM need and solution fact sheets immediately follow the tables.

The only SWM issues in Basin 6 are associated with water quality BMPs to meet regulatory requirements for development. One regional BMP treatment system is proposed (Solution 6-D). Solution 6-D is a modification of the East Detention Basin to provide improved water quality treatment and without reducing existing basin volume. Three SWM solutions involve only planning recommendations with no specific capital project proposed because of the uncertainty of the development. No ponding issues were identified Basin 6 and no specific asset management issues were evaluated.

Table 15 – Basin 6 SWM Needs

SWM Need ID	Issue Type	Need Description	Corresponding SWM Solution ID
0-1	Stormwater Controls	Address Requirement for Post-Construction Stormwater Pollutant and Runoff Control	6-A, 6-B, 6-C, 6-D

Table 16 – Basin 6 SWM Solutions

SWM Solution ID	Solution Type	Solution Description	Corresponding SWM Need ID
6-A	Future Planning Considerations	Water Quality Planning Recommendations for BMP Strategy Area (BMP SA)-6.1	0-1
6-B	Future Planning Considerations	Water Quality Planning Recommendations for BMP Strategy Area (BMP SA)-6.2	0-1
6-C	Future Planning Considerations	Water Quality Planning Recommendations for BMP Strategy Area (BMP SA)-6.3	0-1
6-D	New or Modified Infrastructure	Provide Regional Water Quality Treatment for BMP Strategy Area (BMP SA)-6.4	0-1

SWM SOLUTION FACT SHEET 6-A

Stormwater Management Solution Tracking Information

SWM Solution ID	Solution Name	Capital Cost Summary	Anticipated Implementation Timeframe	Author	Revision Date
6-A	Water Quality Planning Recommendations for BMP Strategy Area (BMP SA)-6.1	$290,000	2026-2035	GS&P and Geosyntec	June 2015

Stormwater Management Needs Addressed by Solution

SWM Need ID	Need Name	Need Type		
		Address Ponding and Facilitate Drainage	Address Risk of Stormwater Asset Failure	Provide Required Stormwater Controls
0-1	Post-Construction Stormwater Pollutant and Runoff Control			X

Development projects planned by the Port will trigger stormwater quality treatment requirements of the MS4 permit as outlined in the Port of Portland Stormwater Design Standards Manual (DSM) and described in SWM Need Fact Sheet 0-1. The proposed solution addresses the need to provide treatment for future development projects in this BMP Strategy Area (BMP SA-6.1), as summarized in the table below. The subsequent table provides a summary of the BMP sizing requirements, as calculated based on DSM criteria.

Future Development Projects Treated by BMP

Project # [1]	Drainage Basin	Planned Development / Redevelopment Project Name	Acres Treated by BMP
12	6	ORANG Parcel C Modifications	1.0
30 [2]	6	ORANG Parcel D2 2030	6.5
105	6	Assumed Development (To Be Determined)	0.1
Total Acres of Development Treated			7.6

Notes:
1. Project numbers correspond to future development areas displayed on Figure 1, and included in the Port's list of future development projects (Appendix A).
2. Project crosses into an adjacent BMP Strategy Area. Acreage reflects portion in this BMP Strategy Area.

Water Quality Treatment BMP Sizing Basis

Area to be Treated	Impervious Acres to be Treated	Annual Runoff Volume (ac-ft)	WQ Design Flow Rate (cfs)[1]	WQ Design Volume (ac-ft)[2]
Planned Development/Redevelopment Area Only	7.6	18.2	0.6	0.2
Entire BMP Strategy Area [3]	18.2	43.8	1.5	0.4

Notes:
1. Based on 0.1 in/hr design intensity, per DSM requirements for offline flow-based BMPs.
2. Based on 0.45 inch design depth, per DSM requirements for volume based BMPs with 24-hr drawdown time.
3. Provided for planning purposes only. BMP sizing and costs based on Planned Development / Redevelopment Area Only.

Solution Description

Solution Type	Summary Description
Future Planning Considerations	Select and construct BMPs, such as planter boxes, bioretention, vegetated swales, and/or LID approaches as part of development project construction activities within the BMP strategy area. This solution does not include use of a regional treatment facility.

Figure 1 depicts the BMP Strategy Area with the planned future development projects. Proposed BMP locations are omitted since the proposed BMPs can be either distributed controls or sub-regional facilities whose locations are dependent on the type of development and the location and distribution of pervious areas within the development. A regional BMP is not practical for this BMP Strategy Area because the future development projects are dispersed and the treatment of upland areas of Drainage Basin 6 will be treated by other BMPs. For building-based projects with roofs, parking lots, and landscaped areas, distributed stormwater controls such as planter box filters, bioretention facilities, infiltration trenches, vegetated swales, and/or other low impact development (LID) design elements can be used to reduce effective impervious areas and treat runoff. The location and size of the proposed BMPs can be determined once the extents of the improvements are known.

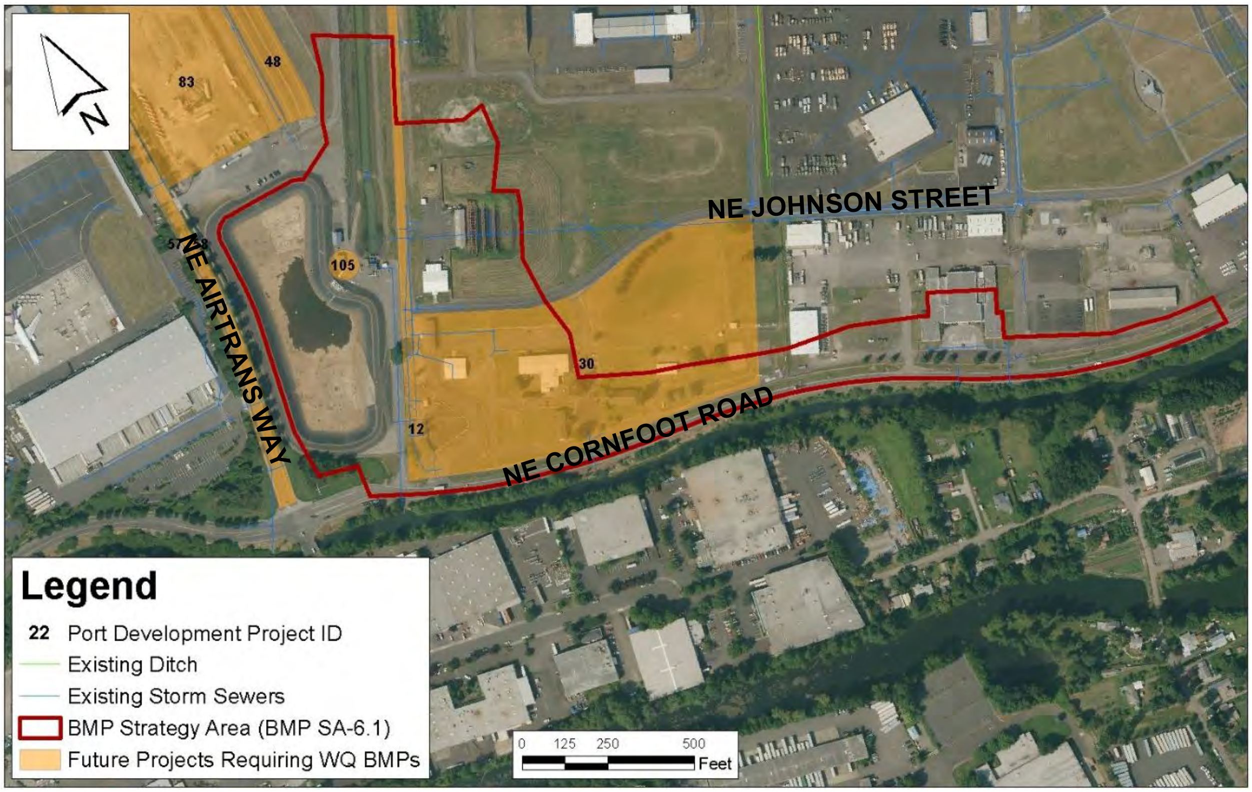


Figure 1: BMP SA-6.1 Vicinity

Implementation Considerations

The following tables provide recommended considerations as the project moves from planning concept to implemented solution. The tables below address implementation considerations for planning and design, construction, and post-construction.

Planning and Design Considerations

Item	Description
Field Data Collection	None identified.
Additional Technical Analysis	Individual BMP sizing needed once the type and location determined. Hydraulic analyses that considers influent flows, head losses, and tailwater conditions for the discharge.
Permitting	None identified.
Siting	During detailed design, review the development project extents and layout, with subsequent adjustment as needed to optimize land use, avoid utilities and meet setback requirements
Coordination with Elements of Other Projects	Post-construction BMPs must be installed to address the MS4 permit requirements following completion of the associated development/redevelopment projects.
Enabling Projects	None identified.
Related Solutions	None identified.
Coordination with Tenants	Port to determine the timeline for construction of water quality treatment BMPs in coordination with the development projects in the BMP Strategy Area and their respective tenants.
Coordination with Port Departments	• Planning and Development - Charter and Business Case Development • Engineering - pipe sizing, utility relocation, design coordination • Maintenance - change in catch basins and manholes requiring routine maintenance • Asset Management - removal of existing assets, addition of new assets • Wildlife Management - identify significance of potential risks
Coordination with Outside Agencies	None identified.
Design Disciplines Involved	Civil and others as needed depending on BMPs selected

Construction Considerations

Item	Description
Construction Components	Depends on BMPs selected.
Airport Operational Impacts	None identified.
Construction Challenges	Routing new gravity conveyance pipelines among project areas, BMPs, and existing stormwater conveyance may be challenging given conflicts with existing infrastructure and hydraulic needs.

Post-Construction Considerations

Item	Description
Post-Construction Coordination with Airport Operations	None identified.
Considerations for Operation and Maintenance (O&M) of the Solution	Depends on BMP selected. Refer to DSM Appendix O for guidance on O&M level of effort for various BMPs.

Potential Risks if Solution is Implemented / Risk Mitigation Strategies

Item	Description	Mitigation Strategy
Regulatory Compliance	Effectively tracking development project treatment needs and BMPs to which it is assigned.	Develop BMP tracking tool.
Airport or Tenant Operations	None identified.	Not applicable.
Aircraft Safety	Risk of wildlife attraction	Selected BMPs should not have exposed water surfaces to minimize wildlife attraction. Coordinate design features with Port Natural Resources staff.
Future Development Limitations	BMP footprint area will be unavailable for other development.	Coordinate siting with project planners to confirm location minimizes conflicts with future development.

Schedule Analysis

Item	Description
Critical Schedule Drivers	Coordinate the construction with the following project timeframes:[1] • Project #12: ORANG Parcel C Modifications (2015) • Project #30: ORANG Parcel D2 (2030) • Project #105: Assumed Development (To Be Determined) (unknown timeframe)
Target Construction Timeframe (2016-2020, 2021-2025, 2026-2035)	2026-2035 Timeframe selected because large majority of development area planned for 2030. Assumed that BMP will be installed by end of timeframe.
Planning and Design Lead Time (<6 months, 6-12 months, 12-24 months)	6-12 months from beginning of development project design

Notes:

1. Project numbers and timeframes are from the Port's list of future development projects (Appendix A).

Cost Analysis

Item	Description
Opinion of Probable Capital Cost (2015 Dollars)	$290,000
Cost Estimate Class / Contingency (1-Bid received, 2-Construction, 3-Design, 4-Concept Design, 5- Screening/Planning)	5- Screening/Planning
Fixed Asset Modifications Excluded from Cost Estimate	None identified.
Cost Assumptions	• Includes 30% for hard cost contingency. • Includes 30% for soft cost contingency. • Other relevant assumptions provided in “BMP Sizing Basis” section in this fact sheet. • Assumes bioretention BMPs as representative for cost planning purposes, using unit costs from DSM Appendix N.
O&M Cost Considerations	Reference DSM Appendix O for information on O&M level of effort.

SWM SOLUTION FACT SHEET 6-B

Stormwater Management Solution Tracking Information

SWM Solution ID	Solution Name	Capital Cost Summary	Anticipated Implementation Timeframe	Author	Revision Date
6-B	Water Quality Planning Recommendations for BMP Strategy Area (BMP SA)-6.2	$180,000	2026-2035	GS&P and Geosyntec	June 2015

Stormwater Management Needs Addressed by Solution

SWM Need ID	Need Name	Need Type		
		Address Ponding and Facilitate Drainage	Address Risk of Stormwater Asset Failure	Provide Required Stormwater Controls
0-1	Post-Construction Stormwater Pollutant and Runoff Control			X

Development projects planned by the Port will trigger stormwater quality treatment requirements of the MS4 permit as outlined in the Port of Portland Stormwater Design Standards Manual (DSM) and described in SWM Need Fact Sheet 0-1. The proposed solution addresses the need to provide treatment for future development projects in this BMP Strategy Area (BMP SA-6.2), as summarized in the table below. The subsequent table provides a summary of the BMP sizing requirements, as calculated based on DSM criteria.

Future Development Projects Treated by BMP

Project # [1]	Drainage Basin	Planned Development / Redevelopment Project Name	Acres Treated by BMP
30 [2]	6	ORANG Parcel D2 - 2030	4.6
Total Acres of Development Treated			4.6

Notes:
1. Project numbers correspond to future development areas displayed on Figure 1, and included in the Port's list of future development projects (Appendix A).
2. Project crosses into an adjacent BMP Strategy Area. Acreage reflects portion in this BMP Strategy Area.

Water Quality Treatment BMP Sizing Basis

Area to be Treated	Impervious Acres to be Treated	Annual Runoff Volume (ac-ft)	WQ Design Flow Rate (cfs)[1]	WQ Design Volume (ac-ft)[2]
Planned Development/Redevelopment Area Only	4.6	11.0	0.4	0.1
Entire BMP Strategy Area [3]	36.2	87.7	3.1	0.8

Notes:
1. Based on 0.1 in/hr design intensity, per DSM requirements for offline flow-based BMPs.
2. Based on 0.45 inch design depth, per DSM requirements for volume based BMPs with 24-hr drawdown time.
3. Provided for planning purposes only. BMP sizing and costs based on Planned Development / Redevelopment Area Only.

Solution Description

Solution Type	Summary Description
Future Planning Considerations	Select and construct BMPs, such as planter boxes, bioretention, vegetated swales, and/or LID approaches as part of construction activities for Project #30. This solution does not include use of a regional treatment facility.

Figure 1 depicts the BMP Strategy Area with the planned future development projects. Proposed BMP locations are omitted since the proposed BMPs can be either distributed controls or sub-regional facilities whose locations are dependent on the type of development and the location and distribution of pervious areas within the development. For building-based projects with roofs, parking lots, and landscaped areas, distributed stormwater controls such as planter box filters, bioretention facilities, infiltration trenches, vegetated swales, and/or other low impact development (LID) design elements can be used to reduce effective impervious areas and treat runoff. Alternatively, sub-regional facilities can be used to provide combined treatment for several projects. The location and size of the proposed BMPs can be determined once the extents of the improvements are known.

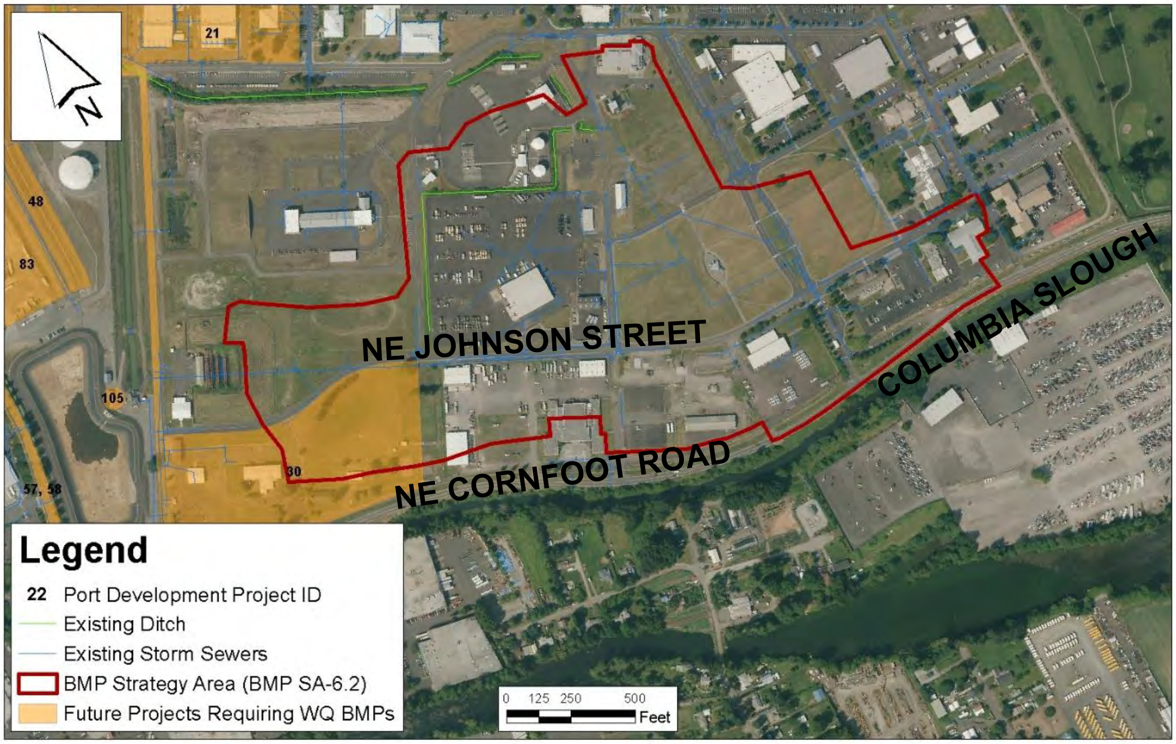


Figure 1: BMP SA-6.2 Vicinity

Implementation Considerations

The following tables provide recommended considerations as the project moves from planning concept to implemented solution. The tables below address implementation considerations for planning and design, construction, and post-construction.

Planning and Design Considerations

Item	Description
Field Data Collection	None identified.
Additional Technical Analysis	Individual BMP sizing needed once the type and location determined. Hydraulic analyses that considers influent flows, head losses, and tailwater conditions for the discharge.
Permitting	None identified.
Siting	During detailed design, review the development project extents and layout, with subsequent adjustment as needed to optimize land use, avoid utilities and meet setback requirements
Coordination with Elements of Other Projects	Post-construction BMPs must be installed to address the MS4 permit requirements following completion of the associated development/redevelopment projects.
Enabling Projects	None identified.
Related Solutions	None identified.
Coordination with Port Departments	• Planning and Development - Charter and Business Case Development • Engineering - pipe sizing, utility relocation, design coordination • Maintenance - change in catch basins and manholes requiring routine maintenance • Asset Management - removal of existing assets, addition of new assets • Wildlife Management - identify significance of potential risks
Coordination with Tenants	Port to determine the timeline for construction of water quality treatment BMPs in coordination with the development projects in the BMP Strategy Area and their respective tenants.
Coordination with Outside Agencies	None identified.
Design Disciplines Involved	Civil, Landscape Architect, and others as needed depending on BMPs selected

Construction Considerations

Item	Description
Construction Components	Depends on BMPs selected.
Airport Operational Impacts	None identified.
Construction Challenges	Routing new gravity conveyance pipelines among project areas, BMPs, and existing stormwater conveyance may be challenging given conflicts with existing infrastructure and hydraulic needs.

Post-Construction Considerations

Item	Description
Post-Construction Coordination with Airport Operations	None identified.
Considerations for Operation and Maintenance (O&M) of the Solution	Depends on BMP selected. Refer to DSM Appendix O for guidance on O&M level of effort for various BMPs.

Potential Risks if Solution is Implemented / Risk Mitigation Strategies

Item	Description	Mitigation Strategy
Regulatory Compliance	Effectively tracking development project treatment needs and BMPs to which it is assigned	Develop BMP tracking tool.
Airport or Tenant Operations	None identified.	Not applicable.
Aircraft Safety	Risk of wildlife attraction	Selected BMP should not have exposed water surface to minimize wildlife attraction. Coordinate design features with Port Natural Resources staff.
Future Development Limitations	BMP footprint area will be unavailable for other development.	Coordinate siting with project planners to confirm location minimizes conflicts with future development.

Schedule Analysis

Item	Description
Critical Schedule Drivers	Coordinate the construction with the following project timeframe:[1] • Project #30: ORANG Parcel D2 (2030)
Target Construction Timeframe (2016-2020, 2021-2025, 2026-2035)	2026-2035 Timeframe selected to correspond with above development project. Assumed that BMP will be installed following construction.
Planning and Design Lead Time (<6 months, 6-12 months, 12-24 months)	6-12 months from beginning of development project design

Notes:
1. Project numbers and timeframes are from the Port's list of future development projects (Appendix A).

Cost Analysis

Item	Description
Opinion of Probable Capital Cost (2015 Dollars)	$180,000
Cost Estimate Class / Contingency (1-Bid received, 2-Construction, 3-Design, 4-Concept Design, 5- Screening/Planning)	5- Screening/Planning
Fixed Asset Modifications Excluded from Cost Estimate	None identified.
Cost Assumptions	• Includes 30% for hard cost contingency. • Includes 30% for soft cost contingency. • Other relevant assumptions provided in "BMP Sizing Basis" section in this fact sheet. • Assumes bioretention BMPs as representative for cost planning purposes, using unit costs from DSM Appendix N.
O&M Cost Considerations	Reference DSM Appendix O for information on O&M level of effort for BMPs.

SWM SOLUTION FACT SHEET 6-C

Stormwater Management Solution Tracking Information

SWM Solution ID	Solution Name	Capital Cost Summary	Anticipated Implementation Timeframe	Author	Revision Date
6-C	Water Quality Planning Recommendations for BMP Strategy Area (BMP SA)-6.3	$1,200,000	2016-2020	GS&P and Geosyntec	June 2015

Stormwater Management Needs Addressed by Solution

SWM Need ID	Need Name	Need Type		
		Address Ponding and Facilitate Drainage	Address Risk of Stormwater Asset Failure	Provide Required Stormwater Controls
0-1	Post-Construction Stormwater Pollutant and Runoff Control			X

Development projects planned by the Port will trigger stormwater quality treatment requirements of the MS4 permit as outlined in the Port of Portland Stormwater Design Standards Manual (DSM) and described in SWM Need Fact Sheet 0-1. The proposed solution addresses the need to provide treatment for future development projects in this BMP Strategy Area (BMP SA-6.3), as summarized in the table below. The subsequent table provides a summary of the BMP sizing requirements, as calculated based on DSM criteria.

Future Development Projects Treated by BMP

Project # [1]	Drainage Basin	Planned Development / Redevelopment Project Name	Acres Treated by BMP
12 [2]	6	ORANG Parcel C Modifications	24.2
21	6	ORANG Parcel D1 2030	7.0
Total Acres of Development Treated			31.2

Notes:
1. Project numbers correspond to future development areas displayed on Figure 1, and included in the Port's list of future development projects (Appendix A).
2. Project crosses into an adjacent BMP Strategy Area. Acreage reflects portion in this BMP Strategy Area.

Water Quality Treatment BMP Sizing Basis

Area to be Treated	Impervious Acres to be Treated	Annual Runoff Volume (ac-ft)	WQ Design Flow Rate (cfs)[1]	WQ Design Volume (ac-ft)[2]
Planned Development/Redevelopment Area Only	31.2	74.1	2.6	1.0
Entire BMP Strategy Area [3]	104.6	251.8	8.9	3.3

Notes:
1. Based on 0.1 in/hr design intensity, per DSM requirements for offline flow-based BMPs.
2. Based on 0.45 inch design depth, per DSM requirements for volume based BMPs with 24-hr drawdown time.
3. Provided for planning purposes only. BMP sizing and costs based on Planned Development / Redevelopment Area Only.

Solution Description

Solution Type	Summary Description
Future Planning Considerations	Select and construct BMPs, such as planter boxes, bioretention, vegetated swales, and/or LID approaches as part of construction activities for development projects within BMP Strategy Area.

Figure 1 depicts the BMP Strategy Area with the two planned future development projects (Projects #12 and #21). Proposed BMP locations are omitted since the proposed BMPs can be either distributed controls or sub-regional facilities whose locations are dependent on the type and amount of development that occurs for these projects. For building-based projects with roofs, parking lots, and landscaped areas, distributed stormwater controls such as planter box filters, bioretention facilities, infiltration trenches, vegetated swales, and/or other low impact development (LID) design elements can be used to reduce effective impervious areas and treat runoff. Alternatively, sub-regional facilities can be used to provide combined treatment for both development projects. The location and size of the proposed BMPs can be determined once the extents of the improvements are known. It may be possible to tie the storm sewer from these projects into a water quality retrofitted East Detention Basin for treatment (refer to SWM Solution 6-D).

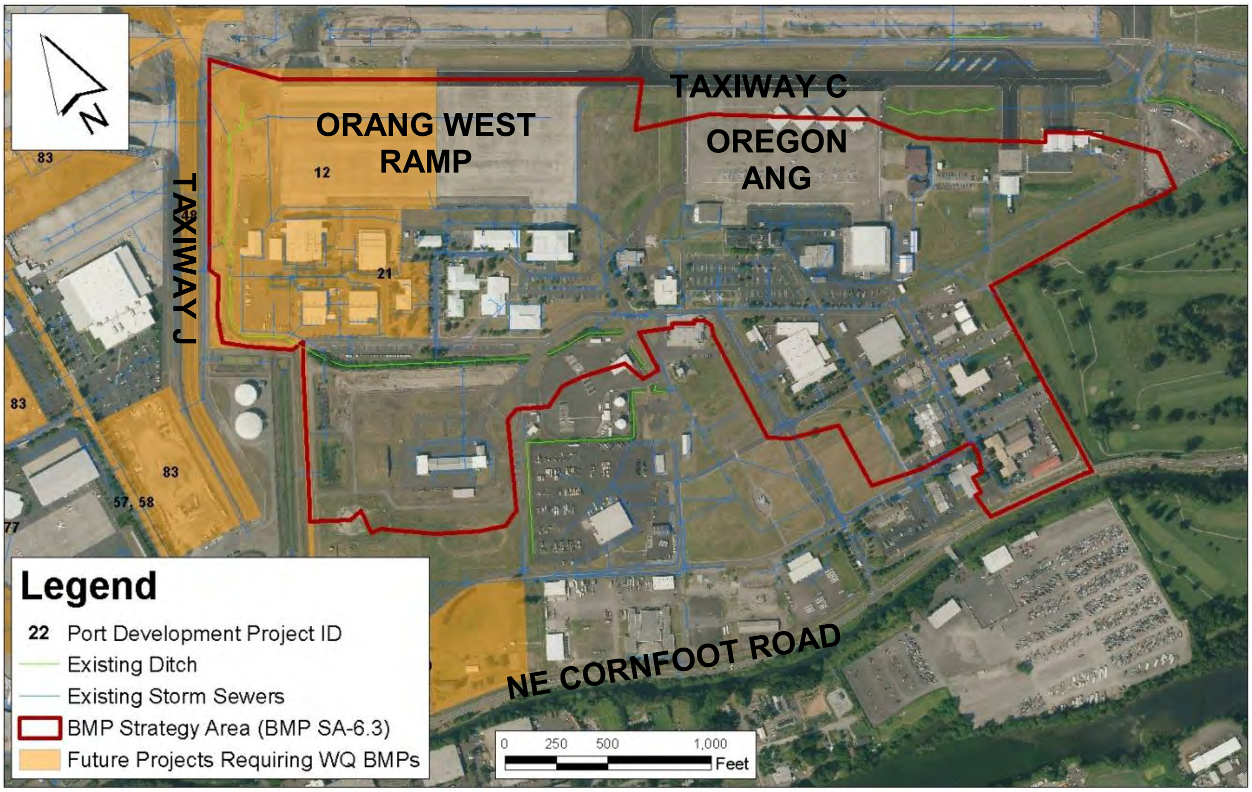


Figure 1: BMP SA-6.3 Vicinity

Implementation Considerations

The following tables provide recommended considerations as the project moves from planning concept to implemented solution. The tables below address implementation considerations for planning and design, construction, and post-construction.

Planning and Design Considerations

Item	Description
Field Data Collection	None identified.
Additional Technical Analysis	Individual BMP sizing needed once the type and location determined. Hydraulic analyses that consider influent flows, head losses, and tailwater conditions for the discharge. If evaluating whether projects could tie into the East Detention Basin, analysis of the proposed system to assess hydraulic impacts and treatment capacity recommended.
Permitting	None identified.
Siting	During detailed design, review the development project extents and layout, with subsequent adjustment as needed to optimize land use, avoid utilities and meet setback requirements
Coordination with Elements of Other Projects	• Post-construction BMPs must be installed to address the MS4 permit requirements following completion of the associated development/redevelopment projects. • Coordinate with SWM Solution 6-D (Provide Regional Water Quality Treatment for BMP SA-6.4) to evaluate the possibility of routing development project area to modified East Detention Basin.
Enabling Projects	None identified.
Related Solutions	None identified.
Coordination with Port Departments	• Planning and Development - Charter and Business Case Development • Engineering - pipe sizing, utility relocation, design coordination • Maintenance - change in catch basins and manholes requiring routine maintenance • Asset Management - removal of existing assets, addition of new assets • Wildlife Management - identify significance of potential risks
Coordination with Tenants	Port to determine the timeline for construction of water quality treatment BMPs in coordination with the development projects in the BMP Strategy Area and their respective tenants.
Coordination with Outside Agencies	None identified.
Design Disciplines	Civil, Landscape Architect, and others as needed depending on BMPs

Involved	selected

Construction Considerations

Item	Description
Construction Components	Depends on BMPs selected.
Airport Operational Impacts	None identified.
Construction Challenges	Routing new gravity conveyance pipelines among project areas, BMPs, and existing stormwater conveyance may be challenging given conflicts with existing infrastructure and hydraulic needs.

Post-Construction Considerations

Item	Description
Post-Construction Coordination with Airport Operations	None identified.
Considerations for Operation and Maintenance (O&M) of the Solution	Depends on BMP selected. Refer to DSM Appendix O for guidance on O&M level of effort for various BMPs.

Potential Risks if Solution is Implemented / Risk Mitigation Strategies

Item	Description	Mitigation Strategy
Regulatory Compliance	Effectively tracking development project treatment needs and BMPs to which it is assigned	Develop BMP tracking tool.
Airport or Tenant Operations	None identified.	Not applicable.
Aircraft Safety	Risk of wildlife attraction	Selected BMP should not have exposed water surface to minimize wildlife attraction. Coordinate design features with Port Natural Resources staff.
Future Development Limitations	BMP footprint area will be unavailable for other development.	Coordinate siting with project planners to confirm location minimizes conflicts with future development.

Schedule Analysis

Item	Description
Critical Schedule Drivers	Coordinate the construction with the following project timeframes:[1] • Project #12: ORANG Parcel C Modifications (2015) • Project #21: ORANG Parcel D1 (2030) • SWM Solution 6-D: Provide Regional Water Quality Treatment for BMP Strategy Area (BMP SA)-6.4
Target Construction Timeframe (2016-2020, 2021-2025, 2026-2035)	2016-2020 Timeframe selected because large majority of development area planned for 2015. Assumed that BMP will be installed by end of timeframe.
Planning and Design Lead Time (<6 months, 6-12 months, 12-24 months)	6-12 months from beginning of development project design

Notes:
1. Project numbers and timeframes are from the Port's list of future development projects (Appendix A).

Cost Analysis

Item	Description
Opinion of Probable Capital Cost (2015 Dollars)	$1,200,000
Cost Estimate Class / Contingency (1-Bid received, 2-Construction, 3-Design, 4-Concept Design, 5- Screening/Planning)	5- Screening/Planning
Fixed Asset Modifications Excluded from Cost Estimate	None identified.
Cost Assumptions	• Includes 30% for hard cost contingency. • Includes 30% for soft cost contingency. • Other relevant assumptions provided in "BMP Sizing Basis" section in this fact sheet. • Assumes bioretention BMPs as representative for cost planning purposes, using unit costs from DSM Appendix N.
O&M Cost Considerations	Reference DSM Appendix O for information on O&M level of effort for BMPs.

SWM SOLUTION FACT SHEET 6-D

Stormwater Management Solution Tracking Information

SWM Solution ID	Solution Name	Capital Cost Summary	Anticipated Implementation Timeframe	Author	Revision Date
6-D	Provide Regional Water Quality Treatment for BMP Strategy Area (BMP SA)-6.4	$1,300,000	2016-2020	GS&P and Geosyntec	June 2015

Stormwater Management Needs Addressed by Solution

SWM Need ID	Need Name	Need Type		
		Address Ponding and Facilitate Drainage	Address Risk of Stormwater Asset Failure	Provide Required Stormwater Controls
0-1	Post-Construction Stormwater Pollutant and Runoff Control			X

Development projects planned by the Port will trigger stormwater quality treatment requirements of the MS4 permit as outlined in the Port of Portland Stormwater Design Standards Manual (DSM) and described in SWM Need Fact Sheet 0-1. The proposed solution addresses the need to provide treatment for future development projects in this BMP Strategy Area (BMP SA-6.4), as summarized in the table below. The subsequent table provides a summary of the BMP sizing requirements, as calculated based on DSM criteria.

Future Development Projects Treated by BMP

Project # [1]	Drainage Basin	Planned Development / Redevelopment Project Name	Acres Treated by BMP
3	6	Taxiway E North Rehabilitation	3.7
4	6	Taxiway T Southwest Rehabilitation	10.2
12	6	ORANG Parcel C Modifications	1.8
15	6	RAC QTA Expansion	2.5
36	6	Taxiway B Center & Exits Rehabilitation	12.8
37	6	Taxiway T SE Taxiway B East & CCA Apron 2	13.0
48	6	Taxiway J Rehabilitation	6.5
73	6	Central Apron E Reconstruction	3.5
83	6	MP Airtrans Ramp Construction	5.1
108	6	MP Air Cargo Site Prep Phase 2	1.6
Total Acres of Development Treated			61

Notes:

1. Project numbers correspond to future development areas displayed on Figure 1, and included in the Port's list of future development projects (Appendix A).

Water Quality Treatment BMP Sizing Basis

Area to be Treated	Impervious Acres to be Treated	Annual Runoff Volume (ac-ft)	WQ Design Flow Rate (cfs)[1]	WQ Design Volume (ac-ft)[2]
Planned Development/Redevelopment Area Only	61	144.9	5.1	1.9
Entire BMP Strategy Area[3]	185.9	445.1	15.7	5.9

Notes:

1. Based on 0.1 in/hr design intensity, per DSM requirements for offline flow-based BMPs.
2. Based on 0.45 inch design depth, per DSM requirements for volume-based BMPs with 24-hr drawdown time.
3. Provided for planning purposes only. BMP sizing and costs based on Planned Development / Redevelopment Area Only.

Solution Description

Solution Type	Summary Description
New or Modified Infrastructure	Modification of East Quiescent Basin (EQB) outlet structure and construction of terrace filters, berm filter, and real-time control outlet structure within the East Detention Basin (EDB) to improve treatment performance.

Figure 1 depicts the BMP Strategy Area with the planned future development projects and proposed BMP location. Figure 2 shows the BMP footprint and existing storm sewer network. The proposed BMP consists of retrofitting the existing basins to provide water quality treatment and will include an elevated outlet in the EQB that drains into the EDB. The EDB will be retrofitted with terrace filters and a permeable berm filter with an actively controlled real-time outlet. Real-time outlet control is proposed to maximize the available storage in the pond and improve capture efficiency and treatment performance without impacting the existing flood control or deicing system functions. A standalone controller is assumed for this solution, but the Port may want to program this function into the existing SCADA controls. While a variety of alternative treatment solutions are possible at this location that could meet the Port's treatment requirements, the proposed solution was selected to provide reliable treatment for multiple pollutants using the existing infrastructure.

Figure 3 illustrates a cross section of the proposed solution. Note that the filter berm and real-time control outlet structure are proposed for placement immediately upstream of where the Oregon Air National Guard discharges to the EDB. This location was selected to accommodate 1200-COLS monitoring of treated Port stormwater prior to commingling with ORANG stormwater.

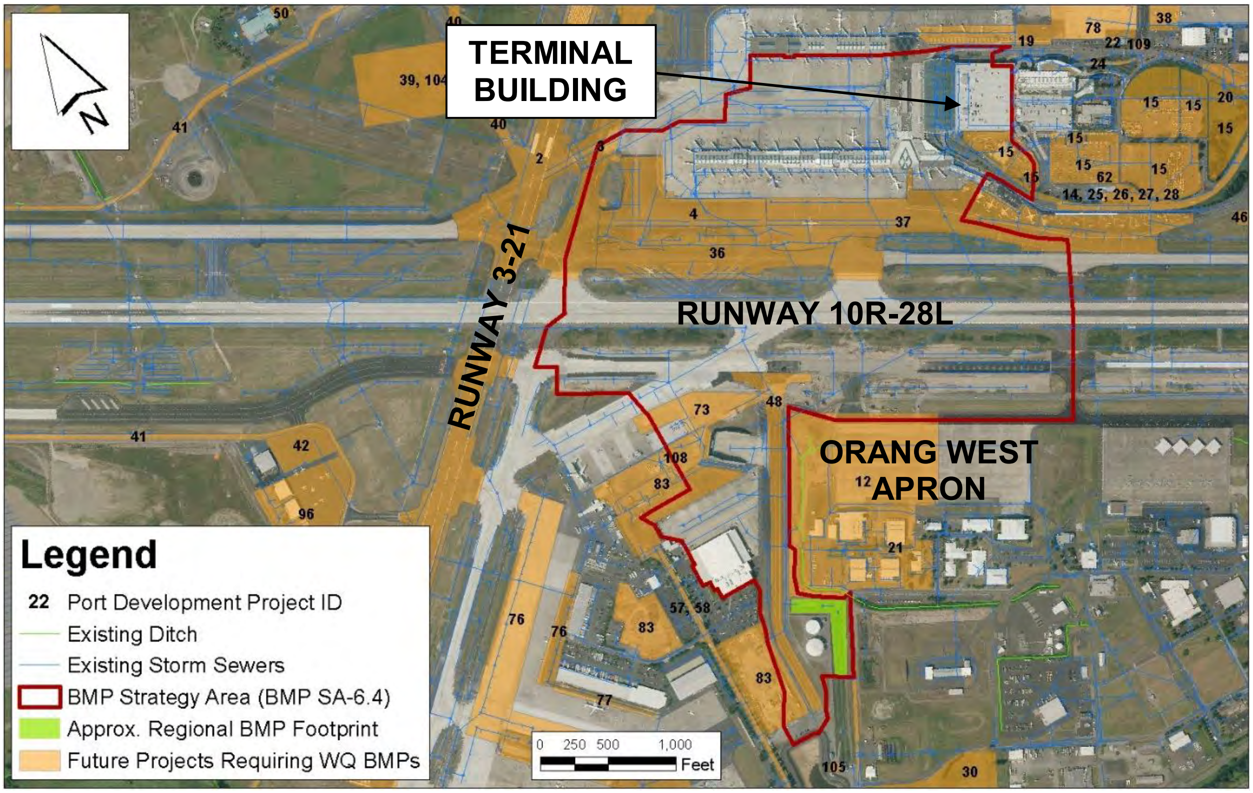


Figure 1: BMP SA-6.4 Vicinity

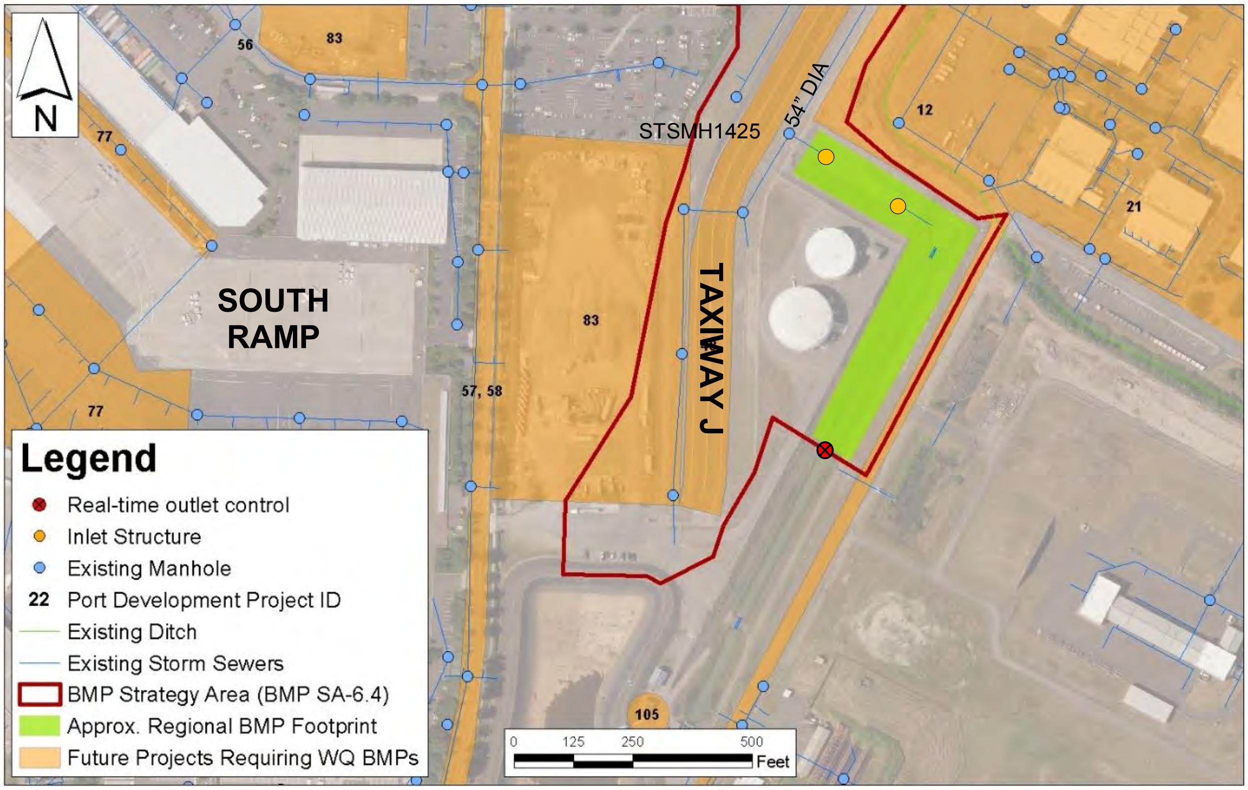


Figure 2: Layout of Proposed Water Quality Retrofits to EQB and EDB for BMP SA-6.4

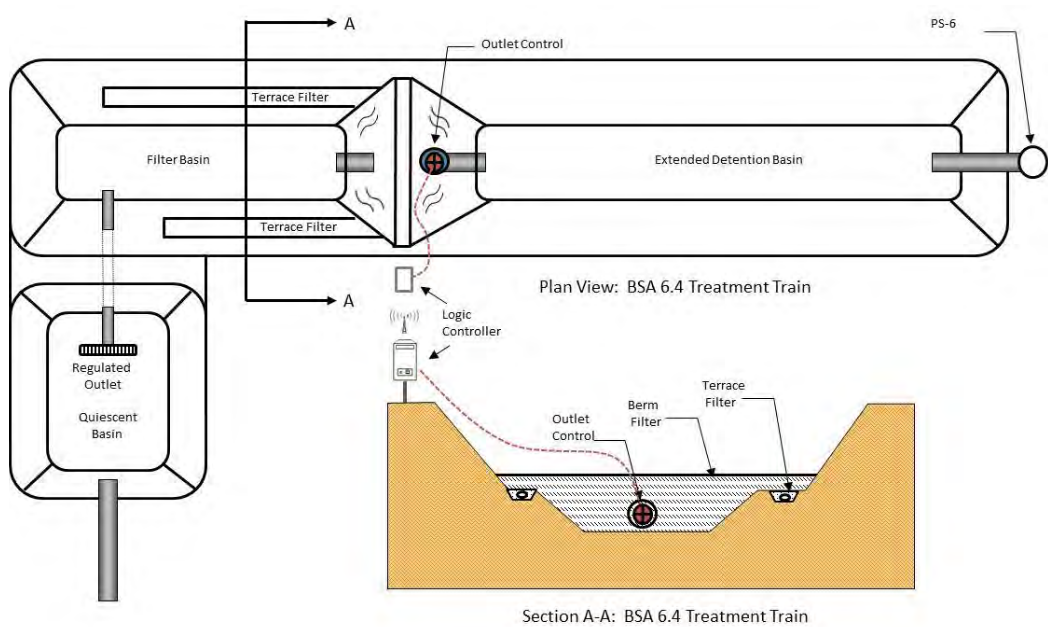


Figure 3: Plan and Section View of Proposed Water Quality Retrofits to EQB and EDB

Implementation Considerations

The following tables provide recommended considerations as the project moves from planning concept to implemented solution. The tables below address three phases of implementation, including planning and design, construction, and post-construction.

Planning and Design Considerations

Item	Description
Field Data Collection	• Topographical survey of basins and existing pipe inverts • Potential water quality sampling to establish existing performance
Additional Technical Analysis	• Site survey to assess existing detention basin characteristics • Geotechnical and hydrogeological studies may be needed to support detailed design. • Detailed analysis of the proposed system using the PDX stormwater hydraulic model is recommended prior to design to assess hydraulic feasibility and conveyance mechanisms. • Consideration of options for integrating controls into Port Deicing SCADA system
Permitting	None identified.
Siting	Additional footprint may be necessary if proposed modification impacts flood control function
Coordination with Elements of Other Projects	• Post-construction BMPs must be installed to address the MS4 permit requirements following completion of the associated development/redevelopment projects. • It may be possible to treat Future Development Projects #12 and #21 with this system (refer to SWM Solution 6-C); however, additional analyses are necessary to evaluate the annual volume of runoff that can be treated.
Enabling Projects	None identified.
Related Solutions	None identified.
Coordination with Port Departments	• Environmental - MS4 compliance, changes to sampling, BMP tracking • Planning and Development - Charter and Business Case Development • Engineering - control system, design coordination • Maintenance - sediment removal, communications • Asset Management - modification of existing assets • Wildlife Management - identify changes to current plans
Coordination with Tenants	None identified.
Coordination with Outside Agencies	None identified.

Item	Description
Design Disciplines Involved	Civil, Structural, Mechanical, Electrical, Instrumentation, and others as needed

Construction Considerations

Item	Description
Construction Components	• Connect to existing storm sewer • Construct new inlet to pond • Re-grade exiting storm water ponds • Replace geomembrane liner • Construct new filter berm • Construct new terrace filter • Control system
Airport Operational Impacts	None identified.
Construction Challenges	• Diversion of runoff around existing ponds will be required during construction • Dewatering of existing wet pond will be required during construction

Post-Construction Considerations

Item	Description
Post-Construction Coordination with Airport Operations	The operation of the real-time control outlet would need to be coordinated with flood control and deicing operations. The general operation would be to fully open the outlet when the water level in the pond exceeds (or is forecasted to exceed) a flood control threshold or when deicing system diversion is occurring. Determine if controls standalone or part of existing SCADA.
Considerations for Operation and Maintenance (O&M) of the Solution	• Proposed BMP may require more frequent sediment removal in the EQB. • New O&M tasks will be created to support maintenance of the terrace and berm filters and the real-time outlet.

Potential Risks if Solution is Implemented / Risk Mitigation Strategies

Item	Description	Mitigation Strategy
Regulatory Compliance	Effectively tracking development project treatment needs and BMPs to which it is assigned	Develop BMP tracking tool.
Airport or Tenant Operations	None identified.	Not applicable.
Aircraft Safety	Risk of wildlife attraction	Continue existing wildlife management activities at this location.
Future Development Limitations	BMP footprint area will be unavailable for other development.	Coordinate siting with project planners to confirm location and minimize conflicts with future development.

Schedule Analysis

Item	Description
Critical Schedule Drivers	Coordinate the design and construction with the following project timeframes:[1] • Project #3: Taxiway E North Rehabilitation (2015) • Project #4: Taxiway T Southwest Rehabilitation (2014) • Project #12: ORANG Parcel C Modifications (2015) • Project #15: RAC QTA Expansion (2016) • Project #36: Taxiway B Center & Exits Rehabilitation (2018) • Project #37: Taxiway T SE Taxiway B East & CCA Apron 2 (2021) • Project #48: Taxiway J Rehabilitation (2024) • Project #73: Central Apron E Reconstruction (2020) • Project #83: MP Airtrans Ramp Construction (2022) • Project #108: MP Air Cargo Site Prep Phase 2 (unknown timeframe) • SWM Solution 6-C: Water Quality Planning Recommendations for (BMP SA)-6.3
Target Construction Timeframe (2016-2020, 2021-2025, 2026-2035)	2016-2020 Timeframe selected to align with development projects. Assumed modifications complete at end of timeframe.
Planning and Design Lead Time (<6 months, 6-12 months, 12-24 months)	6-12 months. Would include developing models to evaluate the performance of the terrace and berm filters and operation of the real-time outlet control prior to detailed design.

Notes:
1. Project numbers and timeframes are from the Port's list of future development projects (Appendix A).

Cost Analysis

Item	Description
Opinion of Probable Capital Cost (2015 Dollars)[1]	$1,300,000
Cost Estimate Class / Contingency (1-Bid received, 2-Construction, 3-Design, 4-Concept Design, 5- Screening/Planning)	5- Screening/Planning
Fixed Asset Modifications Excluded from Cost Estimate	None identified.
Cost Assumptions	• Includes 100% for hard cost contingency. • Includes 30% for soft cost contingency. • Other relevant assumptions provided in “BMP Sizing Basis” and “Construction Considerations” sections in this fact sheet.
O&M Cost Considerations	Need conceptual design before O&M cost consideration can be developed.

Notes:

1. Supporting detailed cost tables are provided in Appendix B.

BASIN 7 STORMWATER MANAGEMENT FACT SHEETS

BASIN 7 STORMWATER MANAGEMENT FACT SHEETS

SWM needs identified in Basin 7 were associated with ponding, asset management, and water quality treatment requirement issues. SWM needs in Basin 7 are summarized in Table 17 below, and SWM solutions proposed to address these needs are described in Table 18. Both tables indicate how the SWM Solutions align with each SWM need, and vice versa. Basin 7 SWM need and solution fact sheets immediately follow the tables.

Many of the SWM needs and solutions for Basin 7 are driven by, or related to, the insufficient capacity in the existing Basin 7 trunk line. SWM Solution 7-A involves pumping approximately 90 acres of Basin 7 to the Columbia River, thereby removing approximately 15% of the water volume from the existing trunk and alleviating the capacity shortage. Several of the other Basin 7 solutions are dependent upon, or affected by, the installation of Solution 7-A. The solutions addressing ponding needs (7-B, 7-C) would require additional consideration if 7-A is not implemented because of changes to basin hydraulics. The asset failure need addressed by Solution 7-H (Improve Basin 7 Trunk Line to Address Risk of Asset Failure) would be affected if 7-A is not implemented because the cure in place lining used in 7-H would decrease the diameter of the trunk line. The three regional BMP solutions (7-C, 7-D, and 7-E) would be affected because basis for the development area calculation would change.

The overall development plans and some of the specific SWM solutions for Basin 7 were evaluated for potential effects on the deicing system and compliance with the deicing NPDES permit. In particular, Solution 7-A (pumping 90 acres of the basin to the Columbia River) would send a small amount of BOD from general aviation deicing operations to the Columbia River. Although a detailed analysis of the river's assimilative capacity at the potential discharge point has not been completed, it is believed that the quantity of BOD discharged from the proposed pump station collection area will be well below the allowable river BOD loading. As such, no provision for additional deicer management storage or treatment has been included in the proposed solutions. Provisions have been made for monitoring of the stormwater from Basin 7 to be discharged to the river. Removal of the Solution 7-A collection area from existing deicing system will have a small effective on freeing up dilute system storage capacity.

A preliminary analysis of regional spill control measures that may be implemented in Basin 7 has been conducted which may lead to implementation of spill control mechanisms at three locations in the basin. These spill control mechanisms would likely be integrated into BMP facilities. The most challenging spill control site is the recommended pump station site described in SWM Solution 7-A. Space constraints at that location may limit the size of storm that can pass through a spill control unit while maintaining separation of water and fuel. At this time, however, costs for those spill control mechanisms has not be integrated into the BMP facility costs.

Table 17 – Basin 7 SWM Needs

SWM Need ID	Issue Type	Need Description	Corresponding SWM Solution ID
0-1	Stormwater Controls	Address Requirement for Post-Construction Stormwater Pollutant and Runoff Control	7-D, 7-E, 7-F, 7-G
7-1	Ponding	Address Ponding within General Aviation (GA) Ramp, North Cargo Facility and NE Airport Way	7-A
7-2	Ponding	Address Ponding in the Employee Lot, NE Airport Way and Future Rental Car Quick Turn-Around (QTA)	7-A
7-3	Asset Management	Address Risk of Asset Failure for Basin 7 Trunk Line	7-H
7-4	Ponding	Address Ponding at Post Office	7-A, 7-B
7-5	Asset Management	Address Risk of Asset Failure for Pipe Across Southeast Ramp	7-B
7-6	Ponding	Address Ponding North of Concourse D	7-C
7-7	Asset Management	Address Risk of Asset Failure for Lateral North of North Ramp	7-C

Table 18 – Basin 7 SWM Solutions

SWM Solution ID	Solution Type	Solution Description	Corresponding SWM Need ID
7-A	New or Modified Infrastructure	Provide Pump Station to Address Basin 7 Capacity Limitations	7-1, 7-2, 7-4
7-B	New or Modified Infrastructure	Replace and Extend Pipe Across Southeast Ramp to Post Office	7-4, 7-5
7-C	New or Modified Infrastructure	Replace Lateral North of North Ramp	7-6, 7-7
7-D	New or Modified Infrastructure	Provide Regional Water Quality Treatment for BMP Strategy Area (BMP SA)-7.1	0-1
7-E	New or Modified Infrastructure	Provide Regional Water Quality Treatment for BMP Strategy Area (BMP SA)-7.2	0-1
7-F	New or Modified Infrastructure	Provide Regional Water Quality Treatment for BMP Strategy Area (BMP SA)-7.3	0-1
7-G	Future Planning Considerations	Water Quality Planning Recommendations for BMP Strategy Area (BMP SA)-7.4	0-1
7-H	New or Modified Infrastructure	Improve Basin 7 Trunk Line to Address Risk of Asset Failure	7-3

SWM NEED FACT SHEET 7-1

Stormwater Management Need Tracking Information

SWM Need ID	Need Name	Issue Type	Author	Revision Date
7-1	Address Ponding within General Aviation (GA) Ramp, North Cargo Facility and NE Airport Way	Ponding	GS&P	June 2015

Stormwater Management Solutions Identified to Address Need

SWM Solution ID	Solution Name	Solution Type		
		New or Modified Infrastructure	Operational Change	Future Planning Considerations
7-A	Provide Pump Station to Address Basin 7 Capacity Limitations	X		

Issue Characterization

Issue Type	Issue Description
Ponding	The Port has indicated the GA Ramp area as a flood prone area. Stormwater hydraulic modeling of the existing Basin 7 drainage system verifies observations as well as reveals a risk of excessive ponding along the North Cargo Facility and NE Airport Way during the 10-year and 100-year, 24-hour storm events under future (2035) development conditions, as shown in Figure 1. Additionally, the ponding poses a risk of building flooding at the existing Hangars K and L as well as the North Cargo Facility. The ponding extents overlap with multiple future development project extents, which poses a risk to future structures and operations at the site.

Factors Potentially Contributing to Issue

Factor	Characterization Basis
Insufficient Drainage System Capacity	Assessments using the PDX stormwater hydraulic model indicate that ponding during the 10-year and 100-year storm events is created by insufficient drainage capacity in the Basin 7 trunk line. Additionally, the stormwater hydraulic modeling assessments indicated that the existing Basin 7 drainage system is no longer sufficient to convey all stormwater runoff from the existing or future developments in Basin 7 during the 10-year and 100-year storm events. Therefore, a means of adding hydraulic capacity to prevent backup of stormwater is needed.
Columbia Slough Water Levels	Tailwater from the Columbia Slough extends into the drainage system and may further reduce available drainage capacity.

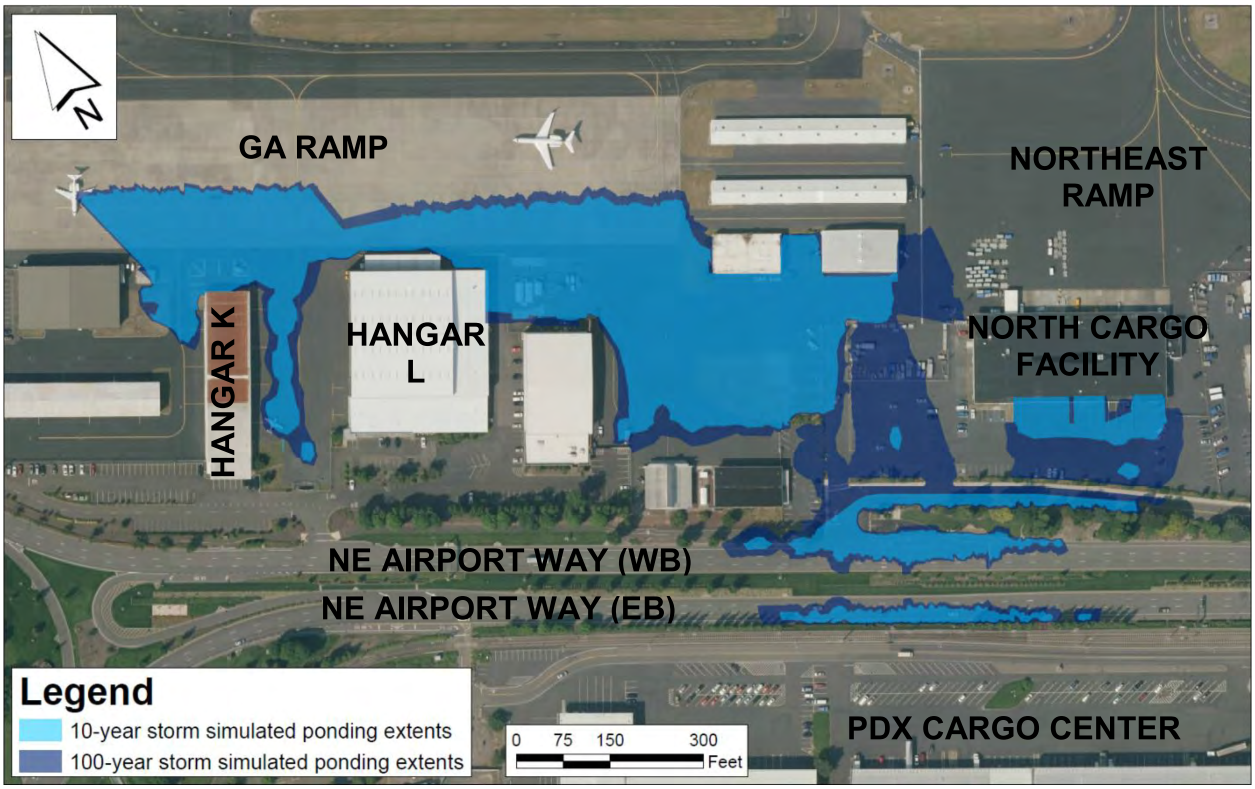


Figure 1: Plan View of Need

Recommendations to Further Characterize Issue and Define Need

The following are actions recommended for further characterizing the issue before designing and implementing the identified solution(s).

Action	Description
Additional Technical Analysis	The identified ponding extents were determined based upon: • the existing grade, including the low lying pavement in the North Cargo Facility loading dock; • existing drainage infrastructure sizes and locations; and • hydrologic conditions associated with assumed future development, as shown in Figure 4-1. As site development plans and future drainage infrastructure are better defined, the stormwater hydraulic model should be updated to better define the extent of ponding and to assist in fine-tuning the proposed solutions.

Regulatory Drivers for Stormwater Management Need

Driver	Description
FAA Hazardous Wildlife Attractant Criteria (FAA AC 150/5200-33)	Ponding at this location within the central area of the airfield increases the risk of attracting wildlife across the approach or departure airspace or into the Air Operations Area (AOA) of all three of the runways. According to FAA AC 150/5200-33, this poses a wildlife strike risk to aircraft.
FAA Airport Drainage Design Criteria (FAA AC 150/5320-5)	AC 150/5320-5 requires that airport drainage systems “provide for safe … operation of the facility” and “convey design flows… without surcharging inlets or otherwise causing surface flooding,” in particular for runways, taxiways and aircraft aprons during the 5-year storm event. The extent of ponding on the GA Ramp for the 10-year storm makes it highly likely that ponding is also present for the 5-year storm event, which is not allowable per FAA AC 150/5320-5.
FAA Airport Drainage Design Criteria (FAA AC 150/5320-5)	Pavement ponding is likely to occur along NE Airport Way (westbound and eastbound) and Frontage Road during both the 10-year and 100-year storm events. Both of these roadways serve as access routes for airport operational vehicles. According to FAA AC 150/5320-5, “the objective of storm drainage design is to provide for safe passage of vehicles or operation of the facility during the design storm event.” Therefore, the need to address ponding along NE Airport Way and Frontage Road is driven by a regulatory need to provide for safe vehicle passage.

Consequence of Not Mitigating Stormwater Management Need

Item	Description
Operations	Ponding along the GA Ramp and North Cargo Facility poses a risk of causing damage to existing equipment and structures during the 10-year and 100-year storm events. Ponding also limits access to buildings and operational areas during both storm events. Ponding along NE Airport Way limits access to the Terminal Building for inbound and outbound traffic during the 10 and 100-year storm events.
Wildlife Hazard Management	Standing water on and near the airfield poses an increased risk of hazardous wildlife attraction and for wildlife strikes.
Planning and Development	The ponding along the GA Ramp overlaps with multiple future development project extents, including:[1] • Project #85: GA West Redevelopment Phase 1 • Project #90: GA Apron Central Rehabilitation • Project #91: DD-GA West Redevelopment Phase 2 (Atlantic Aviation) If the need is not met, new pavement or buildings associated with the future development are at risk of flooding during the 10 and 100-year storm events.

Notes:
1. Project numbers were pulled from the Port's list of future development projects (Appendix A).

Criteria to be Addressed by Stormwater Management Solutions

Item	Description
Flooding of Existing/Future Pavement	Eliminate ponding onto the GA Ramp, North Cargo Center Facility loading dock and parking lot, future GA development, and NE Airport Way during the 10-year storm.
Flooding of Existing/Future Buildings	Eliminate risk of flooding existing and future buildings during the 100-year storm.
Ponding in Unpaved Areas Identified as Critical for Ponding Reduction	Reduce the 10-year storm peak ponding elevation to the lowest known ground elevation.
Asset Management Criteria	Not applicable.
Water Quality Treatment Criteria	Not applicable.

SWM NEED FACT SHEET 7-2

Stormwater Management Need Tracking Information

SWM Need ID	Need Name	Issue Type	Author	Revision Date
7-2	Address Ponding in the Employee Lot, NE Airport Way and Future Rental Car Quick Turn-Around (QTA)	Ponding	GS&P	June 2015

Stormwater Management Solutions Identified to Address Need

SWM Solution ID	Solution Name	Solution Type		
		New or Modified Infrastructure	Operational Change	Future Planning Considerations
7-A	Provide Pump Station to Address Basin 7 Capacity Limitations	X		

Issue Characterization

Issue Type	Issue Description
Ponding	The Port has indicated that NE Airport Way eastbound and the employee parking lot just east of the Terminal Building are flood prone areas. Stormwater hydraulic modeling of the existing Basin 7 drainage system under future (2035) conditions indicates a risk of ponding during the 10-year and 100-year, 24-hour storm events within the existing employee parking lot east of the Terminal Building that will be the site of the RAC QTA future development. The ponding also extends onto NE Airport Way eastbound, just east of the Terminal. See Figure 1 for the estimated ponding extents during both the 10-year and 100-year, 24-hour storm events under future (2035) development conditions. The ponding creates risks for operations and hazardous wildlife attraction that the Port wants to mitigate; the ponding extents also overlap with the RAC QTA project extents, which poses a risk to future structures and operations at the site.

Factors Potentially Contributing to Issue

Factor	Characterization Basis
Insufficient drainage system capacity	Assessments using the PDX stormwater hydraulic model indicate that ponding during the 10-year and 100-year storm events is caused by insufficient drainage capacity in the Basin 7 South trunk line. Limited capacity in this trunk line is partially due to an elevation difference between the South trunk line and the 72-inch Basin 7 main trunk line at the point where flows from both trunk lines merge. Due to a significantly lower elevation, discharges from the South trunk line cannot flow by gravity into the main trunk line, causing long-term standing water, which effectively reduces the South trunk line's capacity. Directing flows away from the Basin 7 South trunk line is needed for both current conditions and conditions following the 2015 QTA development.
Columbia Slough water levels	Tailwater from the Columbia Slough extends into the drainage system and may further reduce available drainage capacity.

Recommendations to Further Characterize Issue and Define Need

The following are actions recommended for further characterizing the issue before designing and implementing the identified solution(s).

Action	Description
Additional Technical Analysis	The identified ponding extents were determined based upon: • the existing grade • existing drainage infrastructure sizes and locations; and • hydrologic conditions associated with assumed future development, as shown in Figure 4-1. As site development plans and future drainage infrastructure are better defined (e.g., QTA), the stormwater hydraulic model should be updated to better define the extent of ponding and to assist in fine-tuning the proposed solutions.

Figure 1: Plan View of Need

Regulatory Drivers for Stormwater Management Need

Driver	Description
FAA Hazardous Wildlife Attractant Criteria (FAA AC 150/5200-33)	Due to its proximity to PDX and location within the FAA 10,000 foot separation area, ponding at this location may attract wildlife into the runways' approach or departure airspace or into the Air Operations Area (AOA). According to FAA AC 150/5200-33, this poses a wildlife strike risk to aircraft.
FAA Airport Drainage Design Criteria (FAA AC 150/5320-5)	Pavement ponding is likely to occur along NE Airport Way eastbound and in the employee parking lot east of the Terminal Building during both the 10-year and 100-year storm events. Both of these ponding locations may serve as access routes for airport operational vehicles. According to FAA AC 150/5320-5, "the objective of storm drainage design is to provide for safe passage of vehicles or operation of the facility during the design storm event." Therefore, the need to address ponding along NE Airport Way and in the employee parking lot is driven by a regulatory need to provide for safe vehicle passage.

Consequence of Not Mitigating Stormwater Management Need

Item	Description
Operations	Failure to address ponding in the employee parking lot and on NE Airport Way eastbound may compromise the safety of airport operational vehicles (and other vehicles) passing through these areas during storm events. Operations at current rental car facilities near the Terminal Building may also be impacted, with potential for damage to vehicles. Additionally, ponding may require that alternative vehicle traffic routes be established for outbound traffic from the Terminal Building.
Wildlife Hazard Management	Standing water in close proximity to the airport poses an increased risk of hazardous wildlife attraction and for wildlife strikes.
Planning and Development	The ponding overlaps with the future development extents of the RAC QTA project (#15).[1] If the need is not met, pavement or buildings (if applicable) associated with the future development are at risk of flooding during the 10 and 100-year storm events.

Notes:

1. Project numbers were pulled from the Port's list of future development projects (Appendix A).

Criteria to be Addressed by Stormwater Management Solutions

Item	Description
Flooding of Existing/Future Pavement	Eliminate ponding onto the existing employee parking lot, NE Airport Way eastbound, and the future RAC QTA development during the 10-year storm.
Flooding of Existing/Future Buildings	Not applicable.
Ponding in Unpaved Areas Identified as Critical for Ponding Reduction	Not applicable.
Asset Management Criteria	Not applicable.
Water Quality Treatment Criteria	Not applicable.

SWM NEED FACT SHEET 7-3

Stormwater Management Need Tracking Information

SWM Need ID	Need Name	Issue Type	Author	Revision Date
7-3	Address Risk of Asset Failure for Basin 7 Trunk Line	Asset Management	GS&P	June 2015

Stormwater Management Solutions Identified to Address Need

SWM Solution ID	Solution Name	Solution Type		
		New or Modified Infrastructure	Operational Change	Future Planning Considerations
7-H	Improve Basin 7 Trunk Line to Address Risk of Asset Failure	X		

Issue Characterization

Issue Type	Issue Description
Asset Management	The large storm sewer trunk line that extends nearly the full north-south length of PDX Drainage Basin 7 carries a majority of the Basin 7 stormwater runoff to either pump station E (deicing system) or the Columbia Slough. The upstream portion of the trunk line was constructed between 1955 and 1979 using bituminous-lined corrugated metal pipe (CMP), a material for which useful life estimates vary. Based on an assumed useful life of 30 years that is typical for unlined CMP[1] (though the bituminous lining can extend useful life by 6 months to 25 years), the useful life for CMP pipes along the Basin 7 trunk line is estimated to be between 120% and 200% expended as of 2015. Even in the case that the pipe lining is sufficient to extend the useful life by 25 years (best case scenario), the pipes have still expended between 65% and 110% of their useful lives as of 2015. Pipes along the Basin 7 storm sewer trunk line that are estimated to have a high useful life expended are shown in purple and red in Figure 1. The high percentage of useful life expended for these pipes creates a high risk of failure.

Notes:

1. The basis of this assumption is described in Appendix B of the *Port Stormwater Asset Management Assessment Report*, GS&P Team, July 2014.

Factors Potentially Contributing to Issue

Factor	Characterization Basis
Pipe Age & Material (Useful Life Expended)	Useful life expended is a simplified indicator for likelihood of failure and relies only on industry standards for expected pipe lifespan (based on pipe material) and a pipe's current age. CMP is typically assumed to have an expected lifespan of 30 years if unlined. The addition of a bituminous coating like tar is expected to extend life; however, the estimates of lifespan increases vary significantly, ranging from 6 months to 25 years. If it is assumed that the tar linings add 25 years to the lifespan of a CMP pipe, the upper portions of the Basin 7 trunk line have expended 65 – 110% of their useful life. The actual lifespan of a specific tar-lined CMP pipe can be affected by a variety of environmental and construction factors, including (but not limited to): • corrosion of the galvanized coating, leading to compromised structural integrity • pulling apart of pipe seams as the pipe loses structural integrity • pipe-to-pipe joint design • pipe-to-structure joint design • construction quality • surface land use, including loads applied to the surface by buildings and vehicles • surrounding soil characteristics • groundwater presence and flow outside of the pipe • root growth • geotechnical stability • soil corrosivity • chemical degradation, especially in the presence of standing water containing biodegradable contaminants such as deicing chemicals[1]
Pipe Defects	A video-inspection of the Basin 7 trunk line was conducted in September 2014. The inspection revealed that pipes in the upper portion of the trunk line are lined with tar, a characteristic that was previously undocumented. Accumulation of significant sediment deposits was also observed. No significant structural defects were noted in the interior of the pipes. The exterior of the pipes could not be inspected.

Notes:

1. The Basin 7 trunk line carries a substantial portion of the deicing chemicals applied at PDX and also has standing water due to the pipeline configuration and tailwater effects from the Columbia Slough. The soils on the outside of the pipe may also be affected by infiltration of deicing chemicals that can lead to corrosive soils from anaerobic degradation. This combination of conditions has been observed to accelerate pipe and joint degradation at other airports.

Recommendations to Further Characterize Issue and Define Need

The following actions are recommended to further characterize the issue before designing and implementing the identified solution(s).

Action	Description
Coding of Inspection Defects	Results of the Basin 7 trunk line video-inspection from September 2014 should be consolidated with defects coded to an industry standard to facilitate future comparisons.

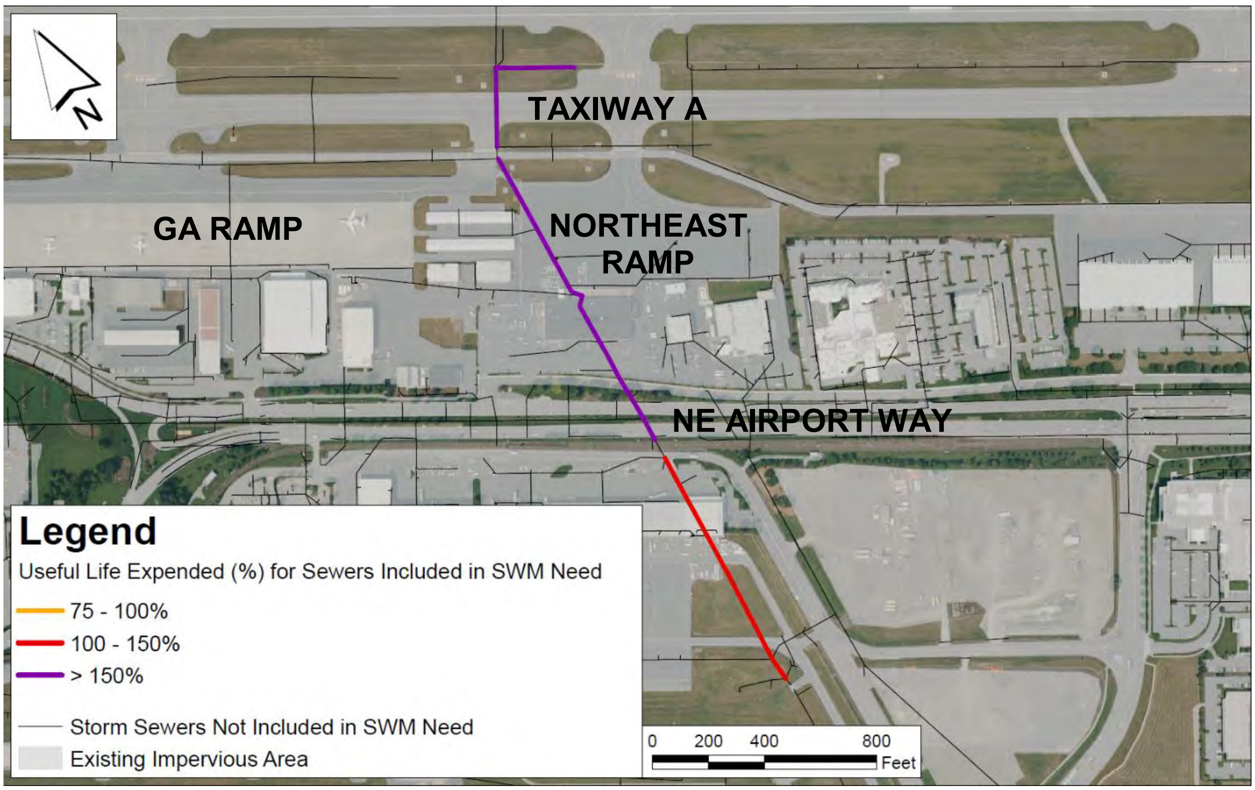


Figure 1: Plan View of Need

Regulatory Drivers for Stormwater Management Need

Driver	Description
FAA Hazardous Wildlife Attractant Criteria (FAA AC 150/5200-33)	Failure of the Basin 7 trunk line will create extensive ponding along the eastern half of the North Runway (10L-28R), along Taxiway A, and on the North, Northeast, Southeast, and GA Ramps during large storm events. Ponding at these locations has the potential to pose a hazardous wildlife attractant risk. According to FAA AC 150/5200-33, this poses a wildlife strike risk to aircraft.
FAA Airport Design and Drainage Design Criteria (FAA ACs 150/5300-13, 150/5320-5)	Failure of the Basin 7 trunk line will create extensive ponding within the runway safety area (RSA) for Runway 10L-28R. According to FAA AC 150/5300-13, the RSA must be “drained by grading or storm sewers to prevent water accumulation.” Failure of the trunk line would also increase the risk for ponding onto the airfield’s paved surfaces, such as Runway 10L-28R, Taxiways A, K, V and W, the North Ramp, the Northeast Ramp, the Southeast Ramp, and the GA Ramp. FAA AC 150/5320-5 requires that airport drainage systems “provide for safe…operation of the facility” and “convey design flows…without surcharging inlets or otherwise causing surface flooding,” in particular for runways, taxiways and aircraft aprons during the 5-year FAA drainage design storm. Additionally, the center 50% of runways and taxiways must remain free from ponding during the 10-year storm. Pipe failure has the potential to violate these criteria during smaller, more frequent storm events.

Consequence of Not Mitigating Stormwater Management Need

Item	Description
Operations	In the event of a pipe failure along the Basin 7 trunk line, drainage from the following operational areas may be severely limited until the failed pipe(s) can be replaced: • Eastern end of Runway 10L-28R • Taxiways A, V and W • Portions of Taxiway K • North Ramp • Northeast Ramp • Southeast Ramp • GA Ramp • NE Airport Way (immediately east of the Terminal Building) • PDX Cargo Center • The perimeter road • Portions of development east of the Terminal Building Additionally, pipe failure may cause structural damage to any overlying developments, especially when the underlying pipe is large in size, as is the case with the 60-inch upstream portion of the Basin 7 trunk line. The following major developments may be at risk of structural damage if the Basin 7 trunk line should fail: • Taxiway A • Northeast Ramp • The perimeter road • PDX Cargo Center North • PDX Cargo Center East • NE Airport Way • MAX Light Rail
Wildlife Hazard Management	In the event of a pipe failure along the Basin 7 trunk line, the drainage system serving approximately 450 acres of land north and east of the PDX Terminal Building may be compromised. Since much of this area is part of the PDX airfield, a pipe failure would increase the risk for prolonged ponding on the airfield, particularly in infield areas along Runway 10L-28R. Prolonged ponding on the airfield may pose an increased risk for hazardous wildlife attraction and potential for wildlife strikes.

Criteria to be Addressed by Stormwater Management Solutions

Item	Description
Flooding of Existing/Future Pavement	Not applicable.
Flooding of Existing/Future Buildings	Not applicable.
Ponding in Unpaved Areas Identified as Critical for Ponding Reduction	Not applicable.
Asset Management Criteria	Reduce the likelihood of failure for active storm sewer pipes, focusing on pipes that have expended ≥75% of their estimated useful life and may have a potentially high consequence of failure.
Water Quality Treatment Criteria	Not applicable.

SWM NEED FACT SHEET 7-4

Stormwater Management Need Tracking Information

SWM Need ID	Need Name	Issue Type	Author	Revision Date
7-4	Address Ponding at Post Office	Ponding	GS&P	June 2015

Stormwater Management Solutions Identified to Address Need

SWM Solution ID	Solution Name	Solution Type		
		New or Modified Infrastructure	Operational Change	Future Planning Considerations
7-A[1]	Provide Pump Station to Address Basin 7 Capacity Limitations	X		
7-B[1]	Replace and Extend Pipe across Southeast Ramp to Post Office	X		

Notes:
1. Both SWM Solution 7-A and SWM Solution 7-B are needed to address SWM Need 7-4.

Issue Characterization

Issue Type	Issue Description
Ponding	The Port has indicated the PDX Post Office area as a flood prone area. Stormwater hydraulic modeling of the existing Basin 7 drainage system reveals a risk of ponding at the Post Office site during the 10-year and 100-year, 24-hour storm events under future (2035) development conditions, as shown in Figure 1. The ponding creates risks for operations and hazardous wildlife attraction that the Port wants to mitigate.

Factors Potentially Contributing to Issue

Factor	Characterization Basis
Insufficient Drainage System Capacity	The Post Office drainage system includes a flow diversion, where the north parking lot area drains to the storm sewers along NE Airport Way and the loading dock drains to the Basin 7 South trunk line. Assessments using the PDX stormwater hydraulic model indicate that ponding in the parking lot north of the Post Office during the 10-year and 100-year storm events is associated with insufficient drainage capacity in the storm sewers along NE Airport Way. Ponding in the Post Office loading dock area during the 10-year and 100-year storm events is attributed to insufficient capacity in the Basin 7 South trunk line.
Columbia Slough Water Levels	Tailwater from the Columbia Slough extends into the drainage system and reduces available drainage capacity.

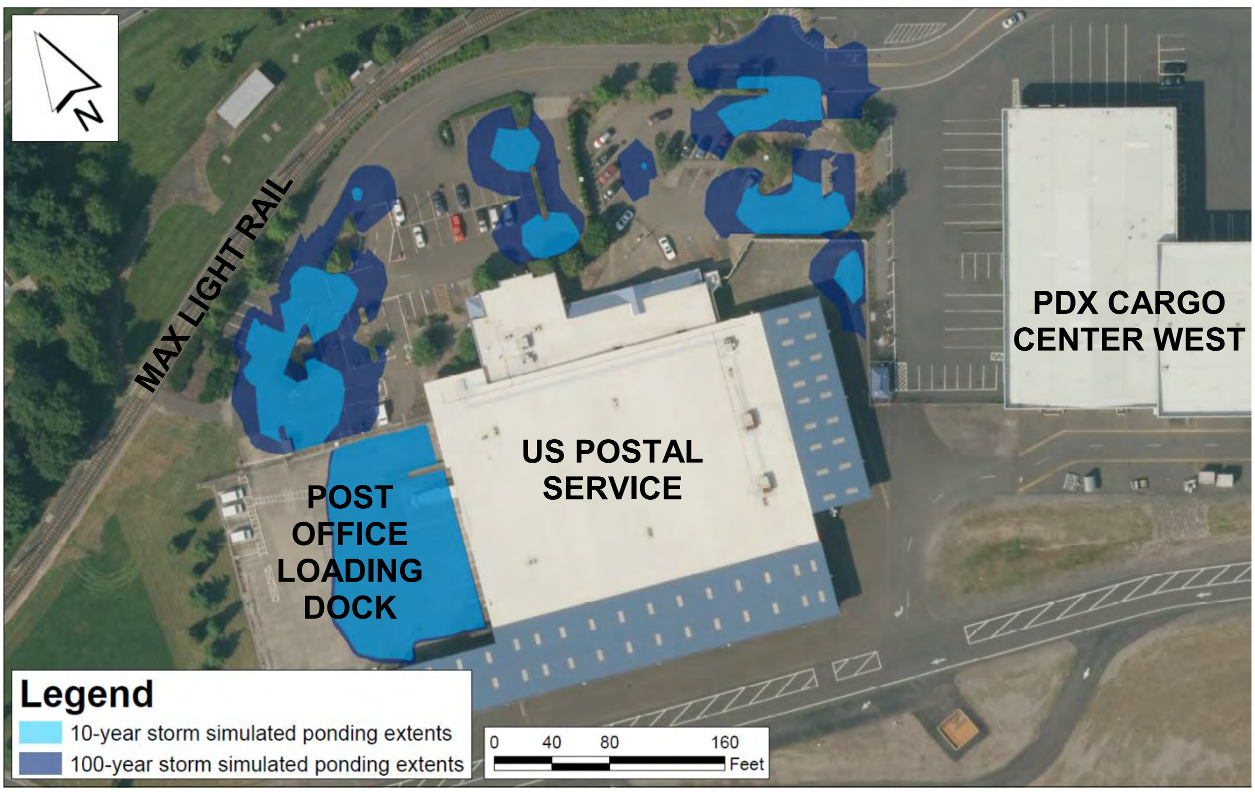


Figure 1: Plan View of Need

Recommendations to Further Characterize Issue and Define Need

No additional data are required to characterize this issue and define the need.

Regulatory Drivers for Stormwater Management Need

Driver	Description
FAA Hazardous Wildlife Attractant Criteria (FAA AC 150/5200-33)	Due to its proximity to PDX and location within the FAA 10,000 foot separation area, ponding at this location poses a risk for attracting wildlife into the runways' approach or departure airspace or into the Air Operations Area (AOA). According to FAA AC 150/5200-33, this poses a wildlife strike risk to aircraft.

Consequence of Not Mitigating Stormwater Management Need

Item	Description
Operations	Ponding near the Post Office limits access to buildings and operational areas at the site during the 10-year and 100-year storm events. Ponding in the loading dock area can impede Post Office operations, cause damage to buildings and equipment, and pose a safety threat.
Wildlife Hazard Management	Standing water in close proximity to the airport poses an increased risk of hazardous wildlife attraction and for wildlife strikes.

Criteria to be Addressed by Stormwater Management Solutions

Item	Description
Flooding of Existing/Future Pavement	Eliminate ponding onto pavement near the Post Office, including the Post Office loading dock, during the 10-year storm.
Flooding of Existing/Future Buildings	Eliminate risk of flooding the lower levels of the Post Office during the 100-year storm.
Ponding in Unpaved Areas Identified as Critical for Ponding Reduction	Reduce the 10-year storm peak ponding elevation to the lowest known ground elevation.
Asset Management Criteria	Not applicable.
Water Quality Treatment Criteria	Not applicable.

SWM NEED FACT SHEET 7-5

Stormwater Management Need Tracking Information

SWM Need ID	Need Name	Issue Type	Author	Revision Date
7-5	Address Risk of Asset Failure for Pipe Across Southeast Ramp	Asset Management	GS&P	June 2015

Stormwater Management Solutions Identified to Address Need

SWM Solution ID	Solution Name	Solution Type		
		New or Modified Infrastructure	Operational Change	Future Planning Considerations
7-B	Replace and Extend Pipe Across Southeast Ramp to Post Office	X		

Issue Characterization

Issue Type	Issue Description
Asset Management	The storm sewer lateral serving the Southeast Ramp in PDX Drainage Basin 7 is composed of corrugated metal pipes (CMP pipes) and concrete pipes installed in 1979, with the majority of the pipes being CMP. At this location, it is not known if the CMP pipes are bituminous-lined, a condition that can extend a CMP pipe's useful life by an estimated 6 months to 25 years. If it is assumed that the CMP pipes are unlined, the CMP and concrete pipes serving the Southeast Ramp are estimated to have useful lives of 30 and 75 years, respectively.[1] Based on these assumptions, the CMP pipes have expended approximately 120% of their estimated useful lives as of the year 2015, as shown in Figure 1. Meanwhile, the concrete pipes installed at this location are expected to have at least 25 years of remaining useful life and are not considered part of this SWM need. The high percentage of useful life expended for CMP pipes serving the Southeast Ramp creates a high risk of failure for these pipes.

Notes:

1. The basis of this assumption is described in Appendix B of the *Port Stormwater Asset Management Assessment Report*, GS&P Team, July 2014.

Factors Potentially Contributing to Issue

Factor	Characterization Basis
Pipe Age & Material (Useful Life Expended)	Useful life expended is a simplified indicator for likelihood of failure and relies only on industry standards for expected pipe lifespan (based on pipe material) and a pipe's current age. CMP pipes are typically assumed to have a lifespan of 30 years if unlined. The addition of a bituminous coating like tar is expected to extend life; however, the estimates of lifespan increases vary significantly, ranging from 6 months to 25 years. Current records do not indicate if the CMP pipes serving the Southeast Ramp are lined, and no condition assessment has been conducted to assess the lining or condition. Even if lined, the CMP pipes serving the Southeast Ramp are likely to have expended at least 65% of their useful life. The actual lifespan of a specific CMP pipe can be affected by a variety of environmental and construction factors, including (but not limited to): • corrosion of the galvanized coating, leading to compromised structural integrity • pulling apart of pipe seams as the pipe loses structural integrity • pipe-to-pipe joint design • pipe-to-structure joint design • construction quality • surface land use, including loads applied to the surface by buildings and vehicles • surrounding soil characteristics • groundwater presence and flow outside of the pipe • root growth • geotechnical stability • soil corrosivity • chemical degradation, especially in the presence of standing water containing biodegradable contaminants such as deicing chemicals[1]
Pipe Defects	Inspections to assess the condition of these pipes have not been performed, and pipe defects have not been identified.

Notes:

1. The piping in the Southeast Ramp may be exposed to deicing chemicals which likely accelerate pipe corrosion as the chemicals degrade.

Recommendations to Further Characterize Issue and Define Need

The following actions are recommended to further characterize the issue before designing and implementing the identified solution(s).

Action	Description
Inspections / Condition Assessment	A field inspection of the storm sewer lateral serving the Southeast Ramp (shown in red in Figure 1) is recommended to determine the actual infrastructure condition. Defects should be coded with an industry-standard method.

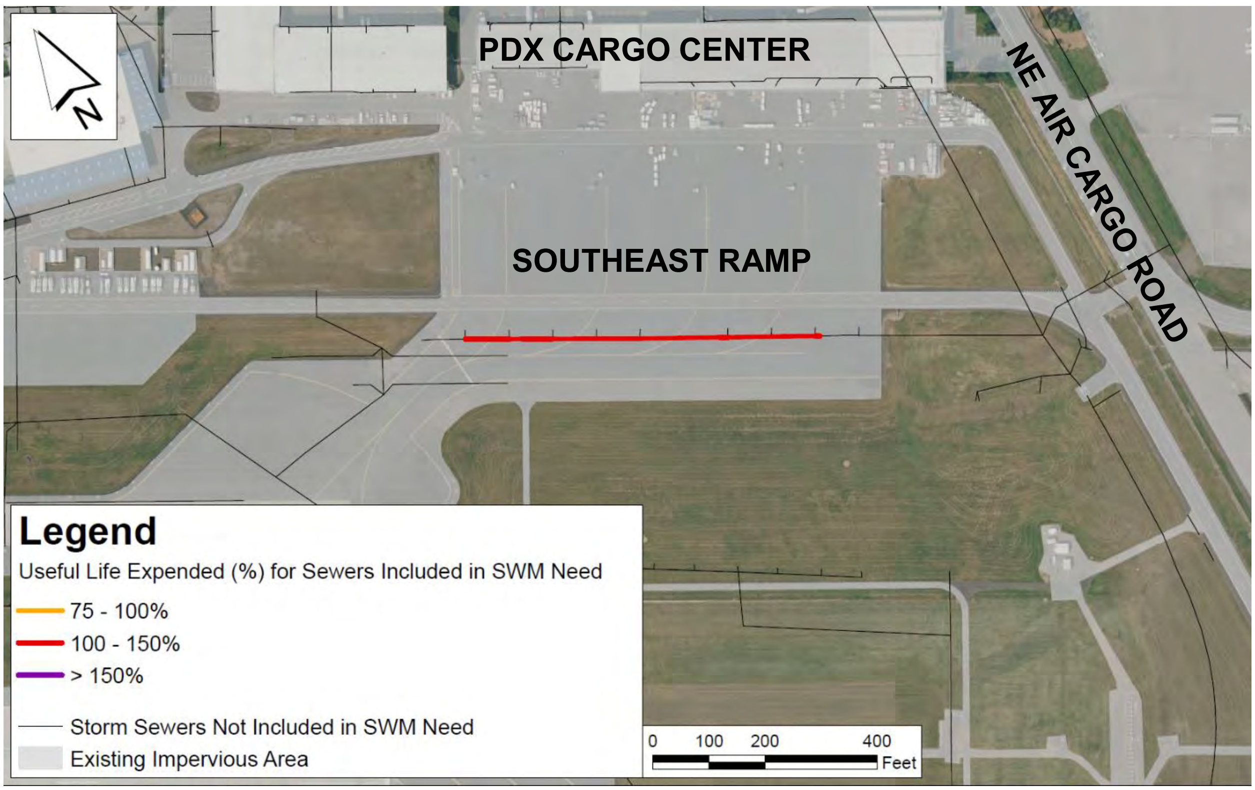


Figure 1: Plan View of Need

Regulatory Drivers for Stormwater Management Need

Driver	Description
FAA Hazardous Wildlife Attractant Criteria (FAA AC 150/5200-33)	Failure of the storm sewer lateral serving the Southeast Ramp will lead to extensive ponding on the Southeast Ramp during large storm events. Ponding at this location has the potential to pose a hazardous wildlife attractant risk. According to FAA AC 150/5200-33, this poses a wildlife strike risk to aircraft.
FAA Airport Design and Drainage Design Criteria (FAA ACs 150/5300-13, 150/5320-5)	Failure of the storm sewer lateral serving the Southeast Ramp will lead to extensive ponding on airfield pavement, particularly on the Southeast Ramp. AC 150/5320-5 requires that airport drainage systems "provide for safe … operation of the facility" and "convey design flows… without surcharging inlets or otherwise causing surface flooding," in particular for runways, taxiways and aircraft aprons during the 5-year FAA drainage design storm. Pipe failure along the storm sewer lateral serving the Southeast Ramp has the potential to violate these criteria during smaller, more frequent storm events.

Consequence of Not Mitigating Stormwater Management Need

Item	Description
Operations	In the event of a pipe failure along the storm sewer lateral serving the Southeast Ramp, drainage from the Southeast Ramp may be severely limited until the failed pipe(s) can be replaced. Additionally, the pipes serving the Southeast Ramp lie directly below the ramp and may cause structural damage to the overlying pavement in the event of a pipe failure.
Wildlife Hazard Management	In the event of a pipe failure along the lateral serving the Southeast Ramp, the drainage system serving approximately 16 acres of the airfield may be compromised. Such a failure would increase the risk for prolonged ponding on the airfield, particularly on pavement at the Southeast Ramp, which is in close proximity to the eastern end of Runway 10R-28L. Prolonged ponding on the airfield may pose an increased risk for hazardous wildlife attraction and potential for wildlife strikes.

Criteria to be Addressed by Stormwater Management Solutions

Item	Description
Flooding of Existing / Future Pavement	Not applicable.
Flooding of Existing / Future Buildings	Not applicable.
Ponding in Unpaved Areas Identified as Critical for Ponding Reduction	Not applicable.
Asset Management Criteria	Reduce the likelihood of failure for active storm sewer pipes, focusing on pipes that have expended ≥75% of their estimated useful life and may have a potentially high consequence of failure.
Water Quality Treatment Criteria	Not applicable.

SWM NEED FACT SHEET 7-6

Stormwater Management Need Tracking Information

SWM Need ID	Need Name	Issue Type	Author	Revision Date
7-6	Address Ponding North of Concourse D	Ponding	GS&P	June 2015

Stormwater Management Solutions Identified to Address Need

SWM Solution ID	Solution Name	Solution Type		
		New or Modified Infrastructure	Operational Change	Future Planning Considerations
7-C	Replace Lateral North of North Ramp	X		

Issue Characterization

Issue Type	Issue Description
Ponding	Stormwater hydraulic modeling of the existing Basin 7 drainage system indicates a risk of ponding during the 10-year and 100-year, 24-hour storm events that extends beyond the centerline of Taxiway K under future (2035) development conditions, as shown in Figure 1. The ponding creates risks for operations and hazardous wildlife attraction that the Port wants to mitigate.

Factors Potentially Contributing to Issue

Factor	Characterization Basis
Insufficient Drainage System Capacity	Assessments using the PDX stormwater hydraulic model indicate that ponding at this location during the 10-year and 100-year storm events is created by insufficient flow and storage capacity in the Basin 7 north lateral storm sewers, which run along the North Ramp and discharge to the Basin 7 main trunk line.
Columbia Slough Water Levels	Tailwater from the Columbia Slough extends into the drainage system and may further reduce available drainage capacity.

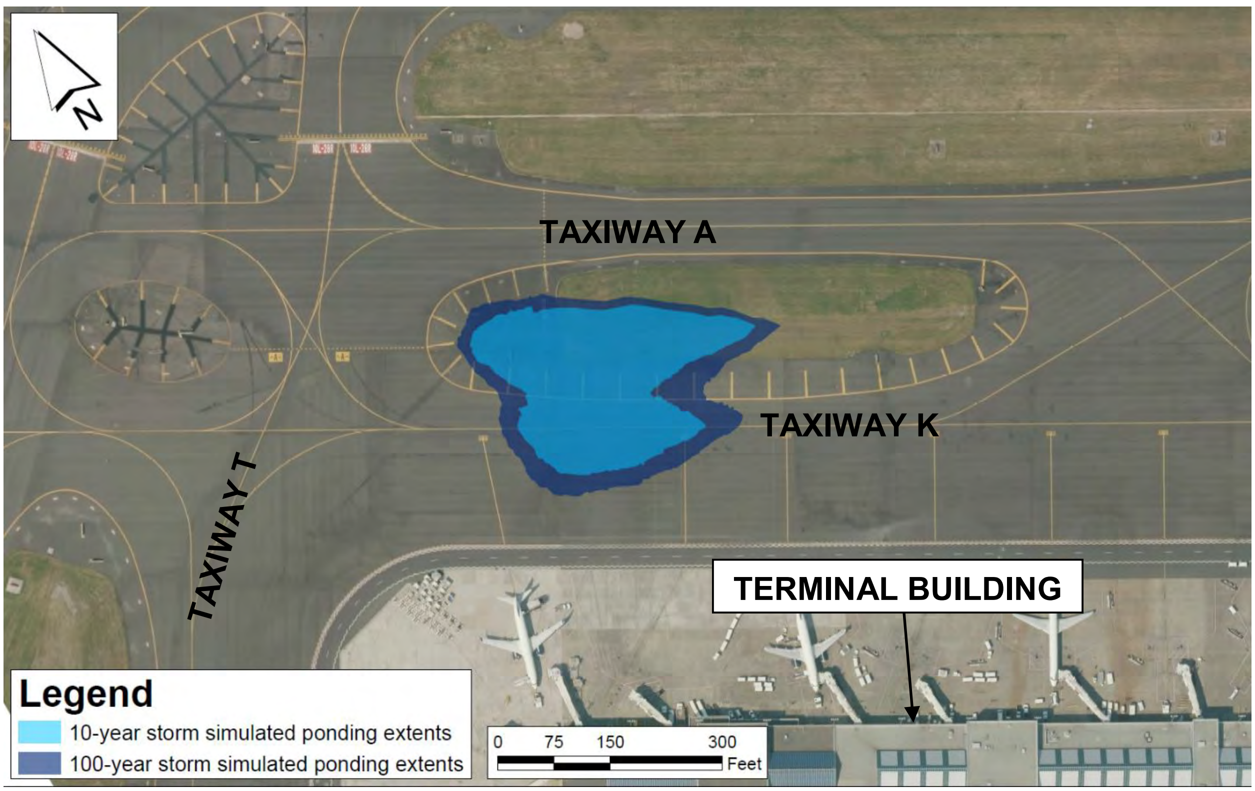


Figure 1: Plan View of Need

Recommendations to Further Characterize Issue and Define Need

The following are actions recommended for further characterizing the issue before designing and implementing the identified solution(s).

Action	Description
Field Observations During Storm Events	Field observations are recommended in this area to confirm the occurrence of problematic ponding, prior to implementing SWM Solution 7-C. This may be accomplished by monitoring the area for drainage issues during or following large storm events, or consultation with staff or tenants that may be familiar with drainage in this area.

Regulatory Drivers for Stormwater Management Need

Driver	Description
FAA Hazardous Wildlife Attractant Criteria (FAA AC 150/5200-33)	Ponding at this location within the central area of the airfield increases the risk of attracting wildlife across the approach or departure airspace or into the air operations area (AOA) of all three of the runways. According to FAA AC 150/5200-33, this poses a wildlife strike risk to aircraft.
FAA Airport Drainage Design Criteria (FAA AC 150/5320-5)	Ponding extends over the Taxiway K centerline for the 10-year, 24-hour storm event and potentially for more frequent events, which can impede operations. According to the FAA AC 150/5320-5, the center 50% of taxiways must remain free from ponding. Additionally, the airport drainage system must "provide for safe passage of vehicles or operation of the facility."

Consequence of Not Mitigating Stormwater Management Need

Item	Description
Operations	Ponding along Taxiway K could prevent safe passage of aircraft traffic around the terminal and hinder airport operations during the 10-year storm event.
Wildlife Hazard Management	Standing water on the airfield poses an increased risk of hazardous wildlife attraction and for wildlife strikes.

Criteria to be Addressed by Stormwater Management Solutions

Item	Description
Flooding of Existing/Future Pavement	Eliminate ponding onto Taxiway K during the 10-year storm.
Flooding of Existing/Future Buildings	Not applicable.
Ponding in Unpaved Areas Identified as Critical for Ponding Reduction	Reduce the 10-year storm peak ponding elevation to the lowest known ground elevation.
Asset Management Criteria	Not applicable.
Water Quality Treatment Criteria	Not applicable.

SWM NEED FACT SHEET 7-7

Stormwater Management Need Tracking Information

SWM Need ID	Need Name	Issue Type	Author	Revision Date
7-7	Address Risk of Asset Failure for Lateral North of North Ramp	Asset Management	GS&P	June 2015

Stormwater Management Solutions Identified to Address Need

SWM Solution ID	Solution Name	Solution Type		
		New or Modified Infrastructure	Operational Change	Future Planning Considerations
7-C	Replace Lateral North of North Ramp	X		

Issue Characterization

Issue Type	Issue Description
Asset Management	The storm sewer lateral serving the North Ramp in PDX Drainage Basin 7 is composed of corrugated metal pipes (CMP pipes) and high-density polyethylene (HDPE) pipes. At this location, it is not known if the CMP pipes are bituminous-lined, a condition that can extend a CMP pipe's useful life by 6 months to 25 years. If it is assumed that the CMP pipes are unlined, the CMP and HDPE pipes serving the North Ramp are estimated to have useful lives of 30 and 75 years, respectively.[1] With a 1955 installation year, the majority of the CMP pipes serving the North Ramp have expended approximately 200% of their estimated useful lives as of the year 2015. If the pipes are lined, the useful life expended is still likely greater than 100% for CMP pipes installed in 1955. Shorter segments of CMP along the North Ramp lateral were installed in 1958 and 1992, which (if unlined) have expended 190% and 77% of their estimated useful lives, respectively, as of 2015. Meanwhile, the HDPE pipes serving the North Ramp are expected to have at least 50 years of remaining useful life and are not considered part of this SWM need. The high percentage of useful life expended for CMP pipes serving the North Ramp creates a high risk of failure for these pipes. See Figure 1 for the locations of all CMP pipes in the North Ramp lateral that have expended greater than or equal to 75% of their useful lives (assuming that the pipes are unlined).

Notes:

1. The basis of this assumption is described in Appendix B of the *Port Stormwater Asset Management Assessment Report*, GS&P Team, July 2014.

Factors Potentially Contributing to Issue

Factor	Characterization Basis
Pipe Age & Material (Useful Life Expended)	Useful life expended is a simplified indicator for likelihood of failure and relies only on industry standards for expected pipe lifespan (based on pipe material) and a pipe's current age. CMP is typically assumed to have an expected life of 30 years if unlined. The addition of a bituminous coating like tar is expected to extend life; however, the estimates of lifespan increases vary significantly, ranging from 6 months to 25 years. Current records do not indicate if the CMP pipes serving the North Ramp are lined, and no condition assessment has been conducted to assess the lining or condition. Even if lined, most of the CMP pipes in the North Ramp likely have expended at least 100% of their expected useful life. The actual lifespan of a specific CMP pipe can be affected by a variety of environmental and construction factors, including (but not limited to): • corrosion of the galvanized coating, leading to compromised structural integrity • pulling apart of pipe seams as the pipe loses structural integrity • pipe-to-pipe joint design • pipe-to-structure joint design • construction quality • surface land use, including loads applied to the surface by buildings and vehicles • surrounding soil characteristics • groundwater presence and flow outside of the pipe • root growth • geotechnical stability • soil corrosivity • chemical degradation, especially in the presence of standing water containing biodegradable contaminants such as deicing chemicals[1]
Pipe Defects	Inspections to assess the condition of these pipes have not been performed, and pipe defects have not been identified.

Notes:

1. The pipes serving the North Ramp may be exposed to deicing chemicals which likely accelerate pipe corrosion as the deicing chemicals degrade.

Recommendations to Further Characterize Issue and Define Need

The following actions are recommended to further characterize the issue before designing and implementing the identified solution(s).

Action	Description
Inspections / Condition Assessment	A field inspection of the storm sewer lateral north of the North Ramp (shown in purple and orange in Figure 1) is recommended to determine the actual infrastructure condition. Defects should be coded with an industry-standard method.

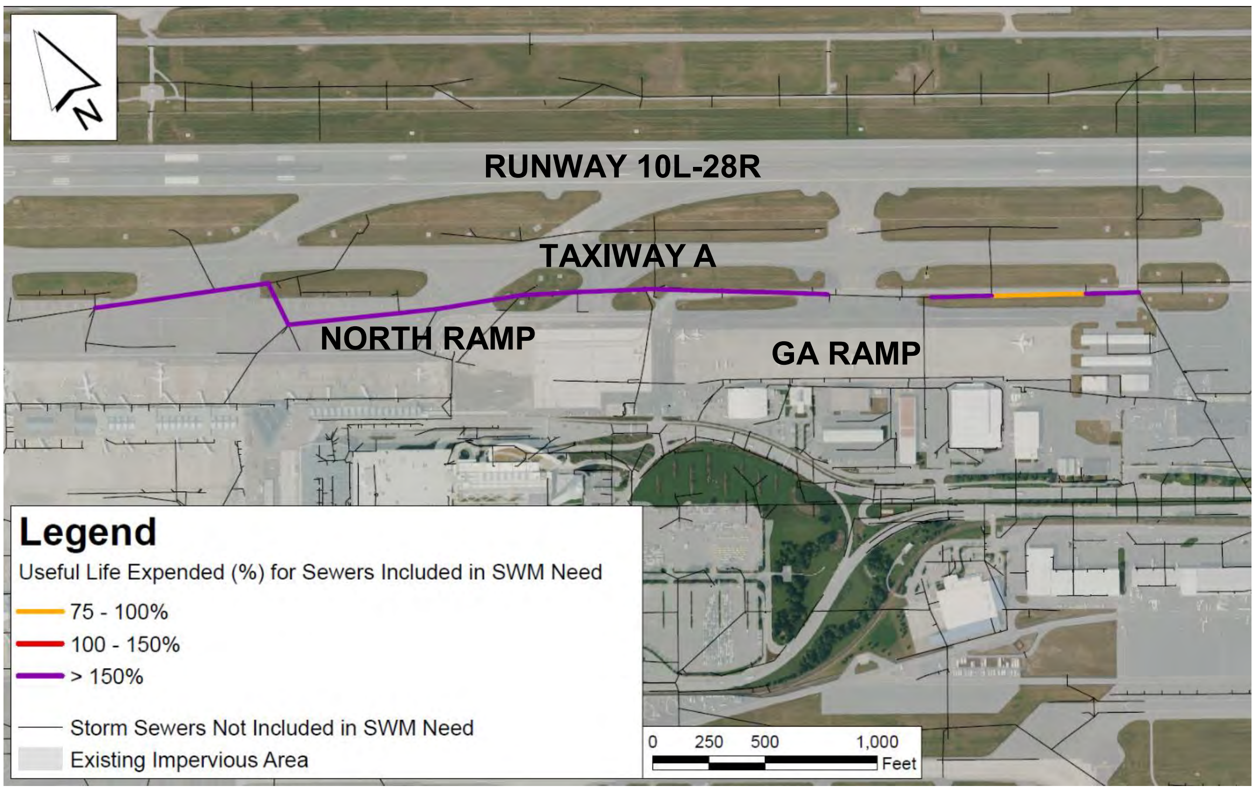


Figure 1: Plan View of Need

Regulatory Drivers for Stormwater Management Need

Driver	Description
FAA Hazardous Wildlife Attractant Criteria (FAA AC 150/5200-33)	Failure of the storm sewer lateral north of the North Ramp will lead to extensive ponding along the central portion of the North Runway (10L-28R) and the western portion of Taxiway A, as well as near the North Ramp and GA Ramp during large storm events. Ponding at these locations has the potential to pose a hazardous wildlife attractant risk. According to FAA AC 150/5200-33, this poses a wildlife strike risk to aircraft.
FAA Airport Design and Drainage Design Criteria (FAA ACs 150/5300-13, 150/5320-5)	Failure of the storm sewer lateral north of the North Ramp will create extensive ponding within the runway safety area (RSA) for Runway 10L-28R. According to FAA AC 150/5300-13, the RSA must be "drained by grading or storm sewers to prevent water accumulation." Failure of the lateral would also increase the risk for ponding onto the airfield's paved surfaces, such as Runway 10L-28R, the North Ramp, the GA Ramp, and Taxiways A, K, V and W. AC 150/5320-5 requires that airport drainage systems "provide for safe … operation of the facility" and "convey design flows… without surcharging inlets or otherwise causing surface flooding," in particular for runways, taxiways and aircraft aprons during the 5-year FAA drainage design storm. Additionally, the center 50% of runways and taxiways must remain free from ponding during the 10-year storm. Pipe failure along the lateral north of the North Ramp has the potential to violate these criteria during smaller, more frequent storm events.

Consequence of Not Mitigating Stormwater Management Need

Item	Description
Operations	In the event of a pipe failure along the lateral north of the North Ramp, drainage from the following operational areas may be severely limited until the failed pipe(s) can be replaced: • Central portion of Runway 10L-28R • Western half of Taxiway A • Portions of Taxiway K • Taxiways V and W • North Ramp • GA Ramp • Portions of the perimeter road Additionally, the lateral north of the North Ramp crosses directly under Taxiways V and W as well as various paved access ways between Taxiway A and the North and GA Ramps. Since the foundations of various taxiways and other paved surfaces are built on top of the lateral north of the North Ramp, pipe failure along this lateral may have negative structural impacts on the overlying pavement.
Wildlife Hazard Management	In the event of a pipe failure along the lateral north of the North Ramp, the drainage system serving approximately 130 acres of the airfield may be compromised, increasing the risk for prolonged ponding on the airfield, particularly in infield areas along Runway 10L-28R and Taxiway A. Prolonged ponding on the airfield may pose an increased risk for hazardous wildlife attraction and potential for wildlife strikes.

Criteria to be Addressed by Stormwater Management Solutions

Item	Description
Flooding of Existing/Future Pavement	Not applicable.
Flooding of Existing/Future Buildings	Not applicable.
Ponding in Unpaved Areas Identified as Critical for Ponding Reduction	Not applicable.
Asset Management Criteria	Reduce the likelihood of failure for active storm sewer pipes, focusing on pipes that have expended ≥75% of their estimated useful life and may have a potentially high consequence of failure.
Water Quality Treatment Criteria	Not applicable.

SWM SOLUTION FACT SHEET 7-A

Stormwater Management Solution Tracking Information

SWM Solution ID	Solution Name	Capital Cost Summary	Anticipated Implementation Timeframe	Author	Revision Date
7-A	Provide Pump Station to Address Basin 7 Capacity Limitations	$15,500,000	2016-2020	GS&P	June 2015

Stormwater Management Needs Addressed by Solution

SWM Need ID	Need Name	Need Type		
		Address Ponding and Facilitate Drainage	Address Risk of Stormwater Asset Failure	Provide Required Stormwater Controls
7-1	Address Ponding within General Aviation (GA) Ramp, North Cargo Facility and NE Airport Way	X		
7-2	Address Ponding in the Employee Lot, NE Airport Way and Future Rental Car Quick Turn-Around (QTA)	X		
7-4	Address Ponding at Post Office	X		

Solution Description

Solution Type	Summary Description
New or Modified Infrastructure	Construct a new drainage system for approximately 90.5 acres in Drainage Basin 7 and route the runoff to the Columbia River via a new force main / outfall fed by a new pump station located near the General Aviation (GA) West Redevelopment Phase 2 (Atlantic Aviation) project.

SWM Solution 7-A involves re-routing approximately 15% of the Drainage Basin 7 drainage area from the Columbia Slough to the Columbia River ("River"). The re-routing requires gravity conveyance piping, a pump station with associated structures, a force main to the River, and a new outfall structure in the River. As shown in Figure 1, the proposed infrastructure upgrades associated with SWM Solution 7-A are located on the General Aviation (GA) Ramp in Basin 7, inside the Air Operations Area (AOA). Pipe corridors associated with the proposed construction extends north to the Columbia River across the North Runway (10L-28R) and associated taxiways and NE Marine Drive, and south of the GA Ramp and outside the AOA along NE Airport Way.

The goal of SWM Solution 7-A is to construct a new drainage system and outfall for a portion of Basin 7, to alleviate the drainage capacity issues in the existing Basin 7 trunk line that are driving excessive ponding in the vicinity of the GA Ramp, the new Atlantic Aviation operational site, the new rental car Quick Turn Around (QTA) area, and areas along NE Airport Way. The proposed diversion of stormwater to the Columbia River would reduce the volume and peak flow rates of stormwater draining through the existing Basin 7 trunk line, which provides potential hydraulic benefits to the entire drainage basin draining to the trunk line, in addition to addressing the ponding areas associated with SWM Need 7-1.

As shown on Figure 1, the collection area for the new pump station includes 90.5 acres around the GA Ramp, the QTA area east of the terminal, and a portion of NE Airport Way. This area was selected based on an iterative analysis of drainage acreage and specific collection area that would most efficiently alleviate the excessive ponding on key operational areas in this part of the airport for large storm events if it were removed from the area draining to the existing Basin 7 storm sewer trunk line.

Multiple local storm sewer upgrades (as shown on Figure 2) are needed to add drainage capacity and to direct flows into the new pump station. One of these pipe modifications includes the tie-in of the storm sewer drainage between the eastbound and westbound sides of NE Airport Way, which the Port has indicated will be the collector sewer for flows from the proposed QTA project. Additional proposed storm sewer tie-ins permanently divert flows from areas around the GA ramp toward the pump station. The assumed storm sewer tie-in points (which are based on existing drainage infrastructure locations at the GA ramp) are subject to change with the planned development by Atlantic Aviation north of the pump station site. New drainage infrastructure associated with the GA West Redevelopment Phase 2 (Atlantic Aviation) project should be tied into the pump station to address the potential for ponding interfering with development and operations in this area. The proposed solution is based upon planned future development as provided by the Port in August 2014. The solution may need to be refined as development plans evolve.

The pump station site (location shown on Figure 2) is tentatively assumed to be located at the current location of Building #8007, which is planned to be demolished. This location is ideal because it is centrally located with respect to storm sewers that need to be tied in to the pump station, and it also would have easy access from NE Airport Way for pump station operations and maintenance. Should this assumed location change, there may be cost implications associated with changes to quantities of cost items, including quantities of gravity pipes and structures diverting stormwater to the pump station, quantitative construction impacts such as area of pavement disturbed, and length of discharge force main.

A conceptual layout for the pump station site is provided in Figure 3. The pump station is currently proposed to have a capacity of 37 cfs (16,600 gpm). Along with the pump station structure, the site will house a diversion vault to collect upstream flows, a valve vault and flow meter vault, a water quality treatment BMP in accordance with DSM requirements (See SWM Solution Fact

Sheet 7-F), and a potentially a spill control structure. Additionally, an emergency generator is recommended to keep the pump station operational in the event of a power shortage or other emergency. The site should also include a building to house a Total Organic Carbon (TOC) monitor, Programmable Logic Controller (PLC), stormwater sampling equipment, and power panels to support permit-required monitoring of discharges. The monitoring system would be connected to the existing deicing system control system. A schematic illustrating a potential sequence and layout of components within the pump station site is provided as Figure 3.

In addition to the emergency generator, it is recommended that there be a connection between the gravity trunk line and the pump station to allow for emergency gravity overflow in the case of pump station service interruptions or equipment failure. This connection should consist of a gravity storm sewer and a slide gate to close off the connection and prevent backflows from the trunk line into the pump station during normal operations. The location of the emergency connection to the trunk line is dependent upon the alignment ultimately selected for trunk line improvements associated with SWM Solution 7-H.

A 24-inch force main will convey flows from the pump station north across the GA Ramp, North Runway (Runway 10L-28R), Taxiway A, North Perimeter Road, NE Marine Drive, and finally through the river levee into the Columbia River. The force main will end within the river with a diffuser-based outfall structure. The specific outfall location will need to be further evaluated from the standpoint of the Columbia River navigation channel and outfall permitting considerations.

Two other approaches were initially considered for improving drainage in Basin 7, but were eventually ruled out in favor of pumping to the river. The first alternative involved expanding the gravity drainage capacity to the Columbia Slough, by replacing upstream portions of the existing 60-inch diameter trunk line with a larger 5-foot by 8-foot rectangular pipe and supplementing downstream portions of the trunk line with an additional parallel 78-inch trunk line. This option had the benefit of also addressing the asset management risk for the existing Basin 7 trunk line, as described in SWM Need Fact Sheet 7-3 and SWM Solution Fact Sheet 7-H. This alternative was ultimately ruled out because of the significant constructability challenges, including a large disturbance area due to the potential trench width and depth, crossing of all lanes of NE Airport Way and the MAX Light Rail, re-routing of the trunk line in a narrow corridor east of PDX Cargo Center, and significant utility conflicts.

The second alternative involved a similar pump station, but with a force main that conveys flows to the south through the airfield and to the storm sewer trunk line upstream of deicing pump station E (PS-E). This alternative offers the benefit of not constructing a new outfall to the River as well as the potential for trenchless pipe installation, reducing potential construction conflicts with roadways, MAX Light Rail, airfield facilities, and utilities. However, this alternative was discarded because it involved conveying stormwater to PS-E at a rate exceeding the maximum pump capacity of PS-E (15,400 gpm), which creates a risk for non-compliance with the deicing NPDES permit.

In particular, when the proposed force main flows (up to 16,600 gpm) are added to the variable gravity flows from the remainder of Basin 7 in the trunk line, it creates a situation where there is a bypass of PS-E every time the proposed pump station is running. This significantly increases the likelihood of discharging TOC load to the Columbia Slough that otherwise would need to be collected for deicing permit compliance. Although this condition could be managed with the addition of storage, options for underground or above ground storage at PS-E are extremely limited. Because of these complications, as well as the benefits associated with flow diversion to the River, it was determined that discharge to the River was less complex, less costly, and less risky than a new force main to PS-E.

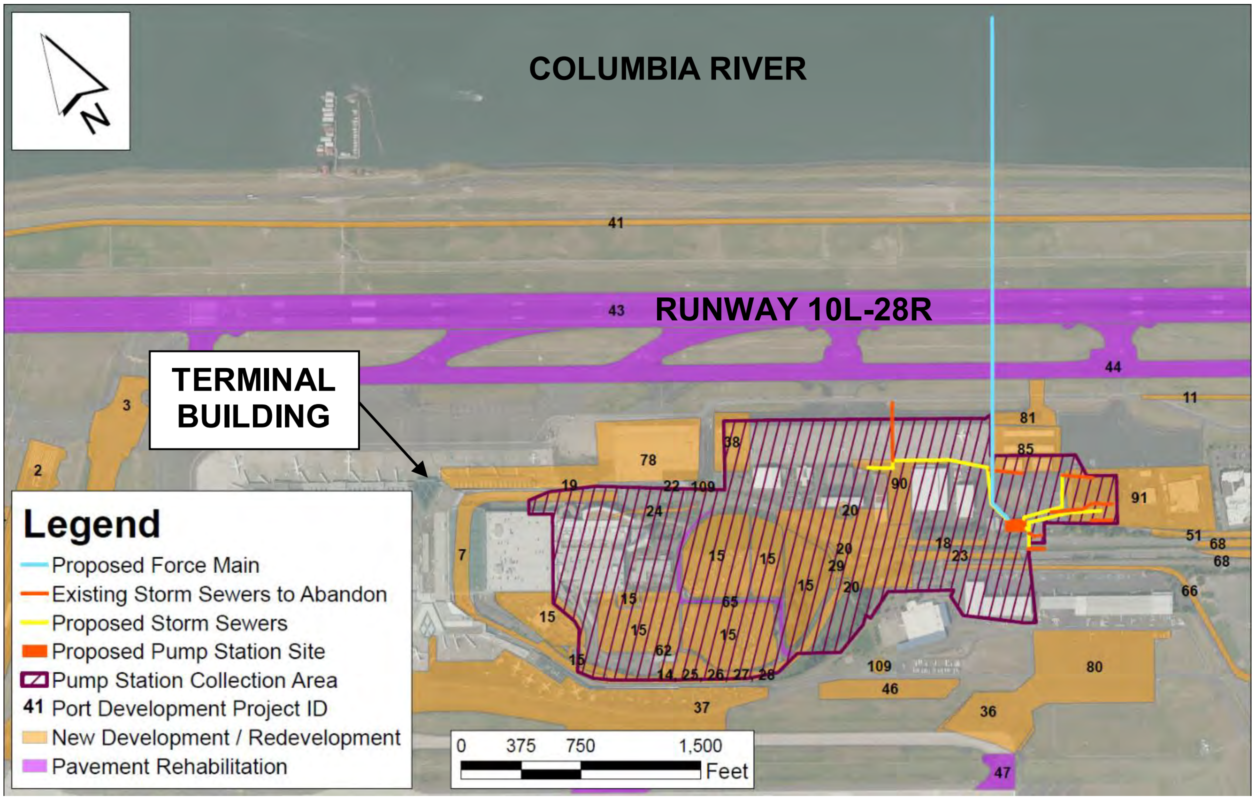


Figure 1: Plan View of Solution – Collection Area and Force Main

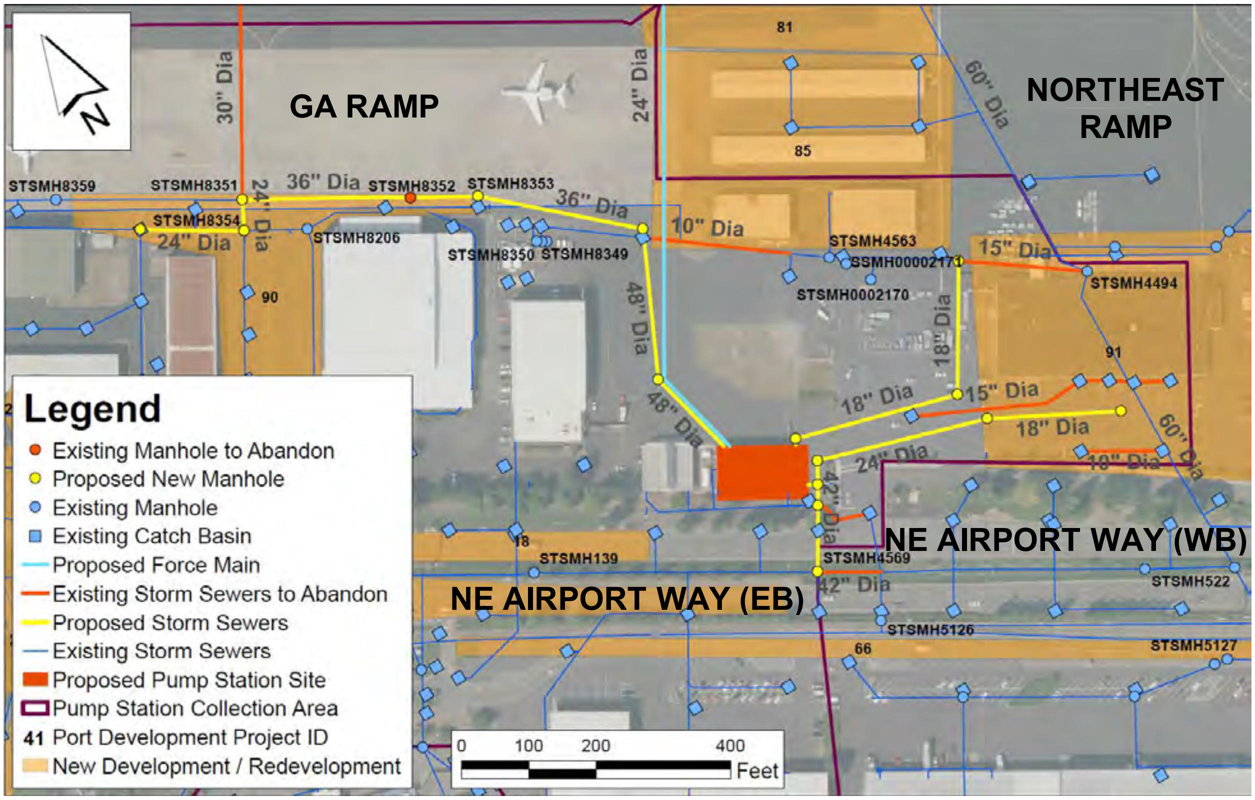


Figure 2: Plan View of Solution – Pump Station Site and Storm Sewer Tie-Ins

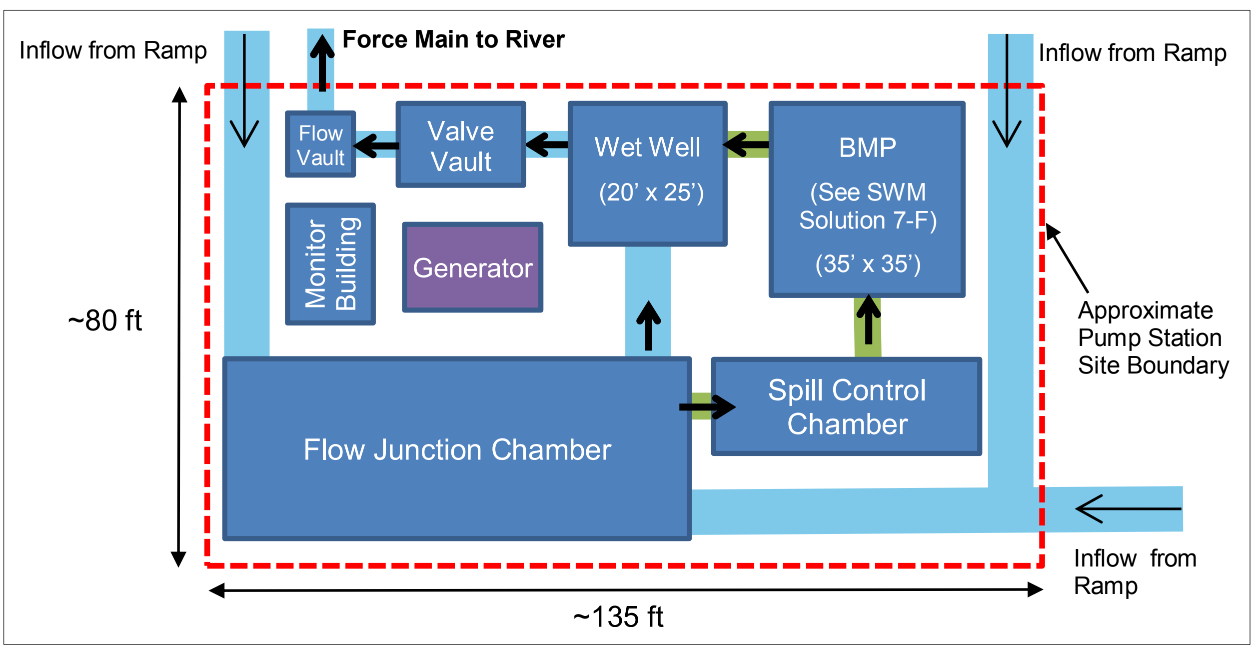


Figure 3: Conceptual Layout of Pump Station Site

Implementation Considerations

The following tables provide recommended considerations as the project moves from planning concept to implemented solution. The tables below address three phases of implementation, including planning and design, construction, and post-construction.

Planning and Design Considerations

Item	Description
Field Data Collection	• Underground utility location • Geotechnical and hydrogeological studies may be needed to support detailed design. • Condition inspection of any existing structures where new pipe connections will be made • Bathymetric analysis of Columbia River at proposed outfall location, as well as conveyance alignment and pump station site.
Additional Technical Analysis	• Stormwater hydraulic modeling analysis to incorporate recent surface and drainage system data from GA West Redevelopment Phase 2 (Atlantic Aviation), QTA, GA West Redevelopment Phase 1, and other local development projects • Provide guidance for development project to support design in coordination with this solution • Verification of pump station collection area • Evaluation of potential permitting and mitigation requirements for a new outfall structure in Columbia River • Conceptual design of the pump station site, considering specific limitations in the site acreage for placement and construction of the pump station site components as well as specific means for routing the gravity pipes to the pump station structures • Conceptual design of the force main and outfall structures taking into account field data collection identified above • Evaluation of the impacts of meeting NMFS criteria for water quantity and quality controls • Water quality analysis of potential discharges to stream to support deicing permit modification • Evaluation of levee crossing criteria and method
Permitting	• Clean Water Act Section 401/404 permitting • Modification to deicing permit • National Marine Fisheries Service (NMFS) consultation • Permitting associated with crossing the Columbia River levee • Potential need for National Environmental Policy Act (NEPA) approval (with FAA or USACE as potential lead agency) • City of Portland Environmental Zones

Item	Description
Siting	• Define limits of the proposed pump station site at Building #8007, and verify the availability of the site. • Assess detailed siting for various structural components of the SWM Solution, as well as siting / alignment of the force main to minimize impacts to airport facilities and operations. • Assess detailed siting of outfall based on completed field surveys and water quality study. • The proposed location of the pump station is centrally located for the collection area. Relocating the pump station may decrease the cost-effectiveness of the solution due to longer quantities of gravity pipe, impacts to leased areas and existing infrastructure, and potential change in collection area. • The solution layout (as shown in Figure 1) should also be adjusted as necessary to optimize land use, minimize excavation, avoid utilities, and meet setback requirements.

Coordination with Elements of Other Projects	• Coordinate storm sewer upgrades, catch basins, and ramp work with adjacent development projects, including:
	  o Project #81: GA Taxi Lane Rehabilitation
	  o Project #85: GA West Redevelopment Phase 1
	  o Project #90: GA Apron Central Rehabilitation
	  o Project #91: DD-GA West Redevelopment Phase 2 (Atlantic Aviation)
	• Coordinate the placement of proposed pipes under NE Airport Way, Westbound with anticipated nearby construction along the roadway (Link A). Such coordination may reduce the net duration of impacts to traffic and pavement.
	• Coordinate the tie-in of drainage from NE Airport Way into the pump station with the tie-in of the RAC QTA Expansion project drainage into NE Airport Way storm sewers.
	• Coordinate the deicing NPDES permit modification required for this solution with the permit modification required for SWM Solution 1-F.
	• Coordinate with SWM Solutions 7-C and 7-H due to the potential for overlap between these solutions.
	• Coordinate design and construction of SWM Solution 7-A with SWM Solution 7-F. The two solutions should be considered one project for the purpose of implementation.

Enabling Projects	Demolition of Building #8007
Related Solutions	The effectiveness of SWM Solution 7-A to address ponding associated with SWM Need 7-4 relies on the implementation of SWM Solution 7-B.

Item	Description
Coordination with Port Departments	• Environmental - NPDES permit, Section 401/404 permit, NEPA, deicing system changes • Planning and Development - Charter and Business Case Development • Engineering - coordination with existing projects, additional hydraulic evaluations, utility relocation, power supply, controls and communications, design coordination • Operations - temporary closure of taxiway and Runway 10L-28R • Maintenance – new pump station and associated facilities to be maintained, change in catch basins and manholes requiring routine maintenance • Asset Management - removal of existing assets, addition of new assets, effect on Basin 7 trunk line asset repair/replacement
Coordination with Tenants	• Coordinate solution location with other planned development projects and tenant facilities, including Atlantic Aviation and QTA tenants. • Coordinate the potential need for runway, taxiway and ramp closures with airlines. • Coordinate the potential closure of the perimeter road with tenants using the impacted portion of the road.
Coordination with Outside Agencies	Coordinate with FAA regarding potential runway and taxiway closures as well as potential crossings of FAA communication and electrical utilities.
Design Disciplines Involved	Civil, Structural, Mechanical / Process, Plumbing, Architectural, Electrical, Instrumentation, and Communications

Construction Considerations

Item	Description
Construction Components	• Replace and upgrade existing storm sewers and catch basins as indicated on Figure 2. • Add new gravity conveyance piping to route stormwater to pump station. • Disconnect existing storm sewers from trunk line and north lateral (under GA Ramp), abandon select pipes and fill with controlled density fill, and repair trunk line to maintain existing function. • Construct new pump station, diversion vault, valve vault, flow meter vault, water quality BMP, spill control facility, emergency generator, emergency connection to the gravity trunk line, and associated structures. • Demolish Building #8007. • Use trenchless technique such as horizontal directional drill to install force main across Taxiway A, Runway 10L-28R, North Perimeter Road, NE Marine Drive and River levee, Columbia River. • Remove and replace the existing AOA security fence south of the GA Ramp as needed to install solution. • Install new diffuser-based outfall structure in the river. • Demolish and reconstruct, or use trenchless technique, to install solution across westbound lanes of NE Airport Way. • Provide primary power to pump station area. • Provide access to SCADA communication network for the deicing system. • Protect and/or relocate existing utilities as needed to install solution.
Airport Operational Impacts	• The Port may wish to temporarily close Runway 10L-28R during directional drilling of force main under the runway. • It is assumed that an open cut approach will be used to install pipe under and across the GA Ramp, which has the potential to temporarily impact access to facilities on the GA Ramp. Alternate vehicle routes may need to be established.
Construction Challenges	• Limited space at construction site, including contractor laydown area. • A trenchless crossing of the north airfield will need to identify appropriate entry and exit points that minimize impacts to airport operations and facilities. • Construction of outfall diffuser (similar to deicing outfall) • There is a significant potential for utility conflicts under NE Airport Way. Utility location is recommended to determine if trenchless or open cut approaches are potentially feasible. • Coordination with the Transportation Security Administration (TSA) will be required when crossing the AOA security fence.

Post-Construction Considerations

Item	Description
Post-Construction Coordination with Airport Operations	• Maintenance for new pump station and associated structures. • TOC monitoring and controls for new pump station. It is not expected that the new discharge to the river will require storage or treatment for deicers because of the low quantity of deicing in this drainage area (primarily GA aircraft). • Operation of the new pump station is intended to be continuous, with the pump operating as necessary based on the runoff volume to the pump station. An emergency generator is included in the solution to minimize the potential for downtime and the risk of impacts to airport operations. Additionally it is recommended that an emergency connection to the gravity trunk line is also included.
Considerations for Operation and Maintenance (O&M) of the Solution	O&M for this solution will be consistent with O&M requirements for existing deicing pump stations, emergency generators, spill control facilities, etc.

Potential Risks if Solution is Implemented / Risk Mitigation Strategies

Item	Description	Mitigation Strategy
Regulatory Compliance	Some BOD from the collection area will be discharged to the Columbia River. Additionally, reasonable potential analysis required by Oregon DEQ and needed to support NMFS consultation may result in limits or benchmarks for non-BOD parameters.	The NPDES permit will need to be modified to define a daily BOD allowance to meet river dissolved oxygen criteria. However, the allowance is likely to be significantly greater than the actual daily BOD discharges. As such, it is not expected that storage or BOD treatment will be necessary. Similar analysis for the existing deicing outfall to Columbia River did not result in controls to meet water quality criteria. Similar evaluation will be needed for the new outfall.
Airport or Tenant Operations	Potential flooding risk if the pump station is unable to operate continuously due to a temporary power shortage.	An emergency generator should be installed at the pump station. Additionally an emergency connection to the gravity trunk line is recommended.
Aircraft Safety	None identified.	Not applicable.
Future Development Limitations	The area proposed for the pump station and associated structures will be unavailable for other development.	Coordinate siting with project planners to confirm location minimizes conflicts with future development.

Schedule Analysis

Item	Description
Critical Schedule Drivers	Alignment of SWM Solution 7-A construction with the construction schedules for the following PDX development projects may reduce costs and operational impacts:[1] • Project #15: RAC QTA Expansion (2016) • Project #18: New Lane at NE Airport Way, Westbound (Link A) (2022) • Project #81: GA Taxi Lane Rehabilitation (2020) • Project #85: GA West Redevelopment Phase 1 (2015) • Project #90: GA Apron Central Rehabilitation (2020) • Project #91: DD-GA West Redevelopment Phase 2 (Atlantic Aviation) (2016) • SWM Solution 1-F: Operate PS-N Continuously • SWM Solution 7-C: Replace Lateral North of North Ramp • SWM Solution 7-F: Provide Regional Water Quality Treatment for BMP Strategy Area (BMP SA)-7.3 • SWM Solution 7-H: Improve Basin 7 Trunk Line to Address Risk of Asset Failure Specific benefits of coordinating with each project listed above are described in the Implementation Considerations section, under Planning and Design Considerations.

Target Construction Timeframe
(2016-2020, 2021-2025, 2026-2035)
	2016-2020
	This timeframe was selected for multiple reasons:
	• The primary driver for this timeframe is coordination of the work with ongoing development projects (listed above).
	• SWM Solution 7-A is the core component of the proposed drainage work in Basin 7. Other planned solutions that depend on the implementation of Solution 7-A include:
	  ○ SWM Solution drainage projects (7-B, 7-C)
	  ○ SWM Solution water quality BMP projects (7-D, 7-E, 7-F, 7-G)
	  ○ Spill control projects for the north and south portions of Basin 7
	• Implementing SWM Solution 7-A is fundamental to the selection of methods for repairing or replacing the Basin 7 trunk line that is at or nearing the end of its useful life (SWM Solution 7-H). SWM Solution 7-A can significantly reduce the costs of addressing this aging asset.

Planning and Design Lead Time (<6 months, 6-12 months, 12-24 months)	12-24 months

Notes:
1. Project numbers and timeframes are from the Port's list of future development projects (Appendix A).

Cost Analysis

Item	Description
Opinion of Probable Capital Cost (2015 Dollars)[1,2]	$15,500,000
Cost Estimate Class / Contingency (1-Bid received, 2-Construction, 3-Design, 4- Concept Design, 5-Screening/Planning)	5- Screening/Planning
Fixed Asset Modifications Excluded from Cost Estimate	• Utility relocation costs not included. • Building #8007 demolition costs not included. • Costs associated with permitting for the levee modification are not considered in this cost estimate. • Spill control • Water quality BMPs (See SWM Solution Fact Sheet 7-F)
Cost Assumptions	• Pump station sited at Building #8007 (changing site will change costs because of challenges is routing gravity flows to pump station) • Open cut of force main on ramp • Directional drill force main from south of Runway 10L-28R through outfall diffuser structure • Quantities associated with directional drill are subject to change based on drill depth and final outfall location • Trenchless crossing of NE Airport Way • Costs for detailed stormwater drainage systems serving individual development project sites are not included. • Costs do not reflect potential modifications required to incorporate the new Atlantic Aviation drainage and development • Includes 50% for hard cost contingency due to complexity and unknowns of pump station site • Includes 50% for soft cost contingency because of permitting costs
O&M Cost Considerations	• Power costs for pump station and associated structures • Monitoring and monitoring costs for additional TOC meter • Maintenance of spill control facility • See SWM Solution Fact Sheet 7-F for costs for Water Quality Treatment BMP • No change from current O&M for upgraded storm sewers.

Notes:

1. Supporting detailed cost tables are provided in Appendix B.
2. Costs are based on current conceptual layout. Quantities included in costs may vary due to potential impacts from the GA West Redevelopment Phase 2 (Atlantic Aviation) project site to the north, including relocated catch basin and tie-in points, realigned pipe corridors to avoid buildings, and re-siting of pump station.

SWM SOLUTION FACT SHEET 7-B

Stormwater Management Solution Tracking Information

SWM Solution ID	Solution Name	Capital Cost Summary	Anticipated Implementation Timeframe	Author	Revision Date
7-B	Replace and Extend Pipe Across Southeast Ramp to Post Office	$1,500,000	2016-2020	GS&P	June 2015

Stormwater Management Needs Addressed by Solution

SWM Need ID	Need Name	Need Type		
		Address Ponding and Facilitate Drainage	Address Risk of Stormwater Asset Failure	Provide Required Stormwater Controls
7-4	Address Ponding at Post Office	X		
7-5	Address Risk of Asset Failure for Pipe Across Southeast Ramp		X	

Solution Description

Solution Type	Summary Description
New or Modified Infrastructure	Replace the pipe across the Southeast Ramp to address risk of asset failure. Increase the pipe size and extend northwest to divert flows from the Post Office to the new pipe to reduce the risk of ponding at the Post Office.

As shown in Figure 1, the proposed infrastructure upgrades associated with Solution 7-B are located on the Southeast Ramp south of the PDX Cargo Center, inside the PDX Air Operations Area (AOA). The solution also extends west to the U.S. Postal Service – PDX Branch (Post Office).

Solution 7-B involves replacement of existing 24-inch pipes across the Southeast Ramp with 48-inch pipes, and then extending this line to the northwest until it ties into the drainage system for the existing Post Office. Under existing conditions, the northern portion of the Post Office drains to the drainage system along NE Airport Way, and the southern portion of the Post Office drains to the drainage system serving the eastern end of the South Runway (10R-28L). Based on stormwater hydraulic modeling, the Post Office is subject to ponding under existing and future conditions, due to insufficient drainage capacity in both drainage systems. The proposed solution would divert flows from the southern portion of the Post Office directly to the trunk line to the east, bypassing the Runway 10R-28L drainage system, and would provide a larger pipe to handle the additional flows. Additionally the proposed solution will provide storage upstream of the surcharged trunk line. The proposed sizing for this solution assumes that SWM Solution 7-A serving the central part of Basin 7 has been implemented to reduce surcharging in the Basin 7 trunk line (serving the Southeast Ramp) as well as in the NE Airport Way line (serving the northern part of the Post Office).

The goal of SWM Solution 7-B is to provide additional drainage capacity in the drainage system serving the Post Office, as well as to address the risk of asset failure for the existing pipe across the Southeast Ramp, which has expended over 100% of its expected useful life. The proposed solution is based upon planned future development as provided by the Port in August 2014. The solution may need to be refined as development plans evolve.

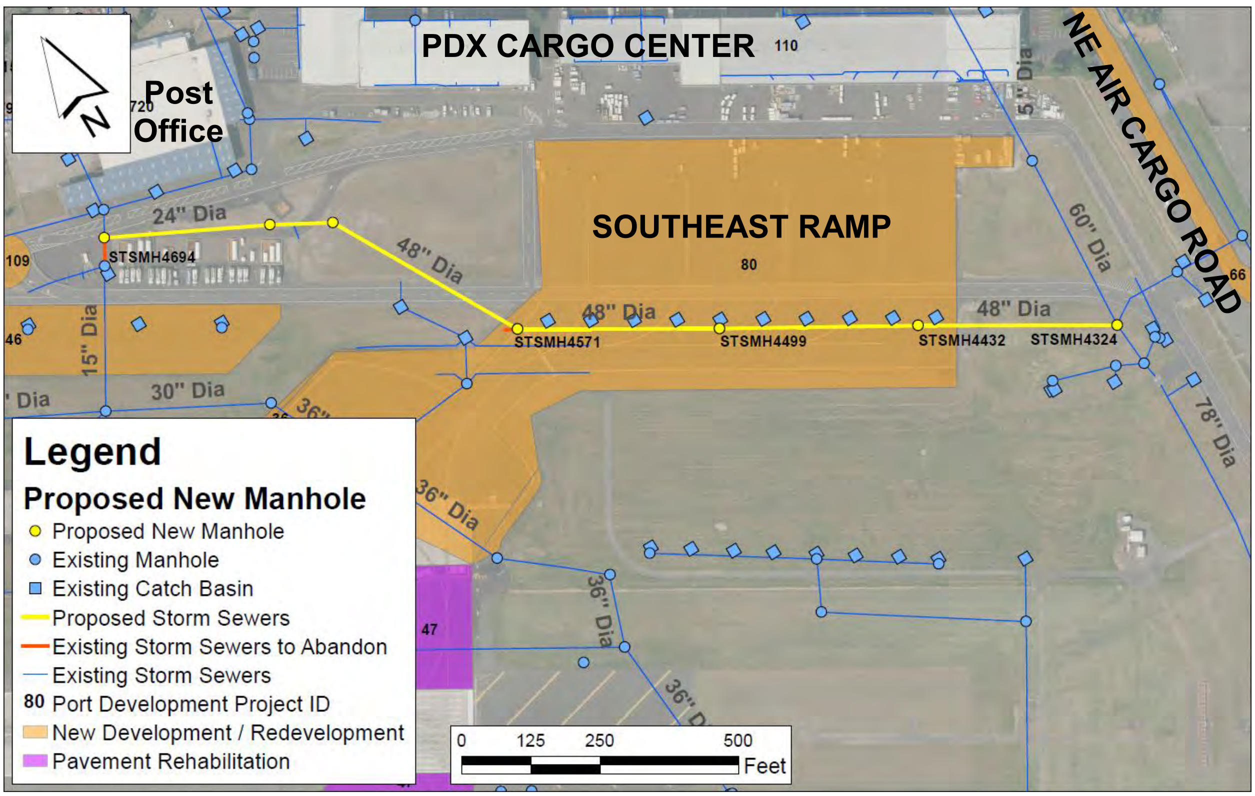


Figure 1: Plan View of Solution

Implementation Considerations

The following tables provide recommended considerations as the project moves from planning concept to implemented solution. The tables below address three phases of implementation, including planning and design, construction, and post-construction.

Planning and Design Considerations

Item	Description
Field Data Collection	• Underground utility location. • Geotechnical and hydrogeological studies may be needed to support detailed design. • Condition inspection of any existing structures where new pipe connections will be made.
Additional Technical Analysis	Confirm pipe size based on whether or not SWM Solutions 7-A and 7-H are implemented, the layouts of these solutions, and the timing of these solutions' implementation.
Permitting	None identified.
Siting	• During detailed design, optimize pipe alignment to avoid potential interference with operations, including cargo, glycol storage, and post office, as well as conflicts with facilities such as the perimeter road. • The solution layout (as shown in Figure 1) should also be adjusted as necessary to optimize land use, minimize excavation, avoid utilities, and meet setback requirements.
Coordination with Elements of Other Projects	• Coordinate catch basin replacement with the grading for the Southeast Apron Rehabilitation project. Also coordinate the pipe installation with this project to reduce mobilization costs for pavement reconstruction after placing the proposed pipes. • Coordinate with the Taxiway B Center and Exits Rehabilitation project or the Snow Pad and Glycol Apron Rehabilitation project to reduce mobilization costs for pavement reconstruction after placing the proposed pipes and to reduce the net duration of operational impacts to this region of the airfield. • Coordinate with SWM Solution 7-H due to overlap between these solutions.
Enabling Projects	None identified.
Related Solutions	The effectiveness of SWM Solution 7-B to address ponding associated with SWM Need 7-4 relies on the implementation of SWM Solution 7-A.
Coordination with Port Departments	• Planning and Development - Charter and Business Case Development • Engineering - pipe sizing, utility relocation, design coordination • Operations - temporary closure of Southeast Ramp • Maintenance - change in catch basins and manholes requiring routine maintenance • Asset Management - removal of existing assets, addition of new assets • Wildlife Management - identify significance of current risk, change in future management techniques in area

Item	Description
Coordination with Tenants	Coordinate design and construction planning as required with cargo tenants using ramp.
Coordination with Outside Agencies	Coordinate with FAA regarding potential crossings of FAA communication and electrical utilities.
Design Disciplines Involved	Civil, Structural, and others as needed to relocate utilities

Construction Considerations

Item	Description
Construction Components	• Demolish existing 24-inch pipe across Southeast Ramp and replace with new 48-inch pipe, which extends off the Southeast Ramp to the northwest and ties into drainage at the Post Office through a new 24-inch, as illustrated in Figure 1. Include associated structures. • Connect existing storm sewer laterals from existing catch basins that are maintained. • Connect existing or replacement (as part of Southeast Apron Rehabilitation project) underdrains under Southeast Ramp to replacement pipe • Maintain existing catch basins and storm sewer laterals, and connect to proposed pipe. • Demolish and reconstruct the perimeter road, Southeast Ramp, and Glycol Apron as needed to install solution. • Demolish and repair Basin 7 trunk line as needed to install replacement pipe. • Protect and/or relocate existing utilities as needed to install solution. • Abandon small segment of pipe and fill with controlled density fill.
Airport Operational Impacts	• Impacts to operations on the Southeast Ramp can be minimized if construction is coordinated with Southeast Apron Rehabilitation project. • Construction across the Southeast Ramp and the perimeter road should be phased to limit operational impacts. • Construction is recommended to take place outside of the deicing season to minimize impacts to operations at the Snow Pad and Glycol Apron.
Construction Challenges	• Tie-in of the replacement pipe into the trunk line as well as the drainage system for the Post Office may require bypass pumping of flows to minimize the potential for flooding. • Identify contractor laydown area that avoids interference with airport operations.

Post-Construction Considerations

Item	Description
Post-Construction Coordination with Airport Operations	None identified.
Considerations for Operation and Maintenance (O&M) of the Solution	No change from current.

Potential Risks if Solution is Implemented / Risk Mitigation Strategies

Item	Description	Mitigation Strategy
Regulatory Compliance	None identified.	Not applicable.
Airport or Tenant Operations	None identified.	Not applicable.
Aircraft Safety	None identified.	Not applicable.
Future Development Limitations	None identified.	Not applicable.

Schedule Analysis

Item	Description
Critical Schedule Drivers	Alignment of SWM Solution 7-B construction with the construction schedules for the following PDX development projects may reduce costs and operational impacts:[1] • Project #36: Taxiway B Center and Exits Rehabilitation (2018) • Project #46: Snow Pad and Glycol Apron Rehabilitation (2026) • Project #80: Southeast Apron Rehabilitation (2023) • SWM Solution 7-H: Improve Basin 7 Trunk Line to Address Risk of Asset Failure Specific benefits of coordinating with each project listed above are described in the Implementation Considerations section, under Planning and Design Considerations.
Target Construction Timeframe (2016-2020, 2021-2025, 2026-2035)	2016-2020 Timeframe selected based on: • Aligning with the development projects listed above. A pipe inspection to assess the risk of asset failure may help to refine the construction timeframe.
Planning and Design Lead Time (<6 months, 6-12 months, 12-24 months)	< 6 months

Notes:

1. Project numbers and timeframes are from the Port's list of future development projects (Appendix A).

Cost Analysis

Item	Description
Opinion of Probable Capital Cost (2015 Dollars)[1]	$1,500,000
Cost Estimate Class / Contingency (1-Bid received, 2-Construction, 3-Design, 4-Concept Design, 5- Screening/Planning)	5- Screening/Planning
Fixed Asset Modifications Excluded from Cost Estimate	Utility relocation costs not included.
Cost Assumptions	• Construction of the pipe across Southeast Ramp will be coordinated with Southeast Apron Rehabilitation project. • Includes 35% for hard cost contingency. • Includes 30% for soft cost contingency.
O&M Cost Considerations	No change from current.

Notes:

1. Supporting detailed cost tables are provided in Appendix B.

SWM SOLUTION FACT SHEET 7-C

Stormwater Management Solution Tracking Information

SWM Solution ID	Solution Name	Capital Cost Summary	Anticipated Implementation Timeframe	Author	Revision Date
7-C	Replace Lateral North of North Ramp	$4,100,000	2016-2020	GS&P	June 2015

Stormwater Management Needs Addressed by Solution

SWM Need ID	Need Name	Need Type		
		Address Ponding and Facilitate Drainage	Address Risk of Stormwater Asset Failure	Provide Required Stormwater Controls
7-6	Address Ponding North of Concourse D	X		
7-7	Address Risk of Asset Failure for Lateral North of North Ramp		X	

Solution Description

Solution Type	Summary Description
New or Modified Infrastructure	Replace the storm sewer line that is north of Concourse D and the North Ramp to address the risk of asset failure and the operational and safety risks posed by ponding of Taxiway K north of Concourse D.

As shown in Figure 1, the proposed infrastructure upgrades associated with SWM Solution 7-C are located north of the North Ramp and south of Taxiway A, beginning east of Taxiway T near Concourse D, and extending just east of Taxiway W, before tying into the Basin 7 trunk line. The goal of SWM Solution 7-C is to provide additional drainage capacity in the drainage system serving the North Ramp, as well as to address the risk of asset failure for the existing pipe north of the North Ramp, which has generally expended over 150% of its expected useful life.

SWM Solution 7-C involves replacement of the existing pipe north of the North Ramp, which currently ranges in size from 21-inch to 42-inch diameter and has varying slopes and an inconsistent grade, with a new 48-inch diameter pipe with a consistent slope and grade. Based on a stormwater hydraulic modeling analysis, a portion of Taxiway K north of Concourse D is subject to potential ponding under existing and future conditions, due to insufficient drainage capacity and a low-elevation area on the pavement that extends from the infield area to the north. The proposed solution would provide more in-pipe storage for stormwater, upstream of the surcharged Basin 7 trunk line, to alleviate ponding on the ramp. The proposed sizing for this solution assumes that SWM Solution 7-A serving the central part of Basin 7 has been implemented to reduce surcharging in the Basin 7 trunk line, which receives flow from the pipe north of the North Ramp. The proposed solution is also based upon planned future development as provided by the Port in August 2014. The solution may need to be refined as development plans evolve.

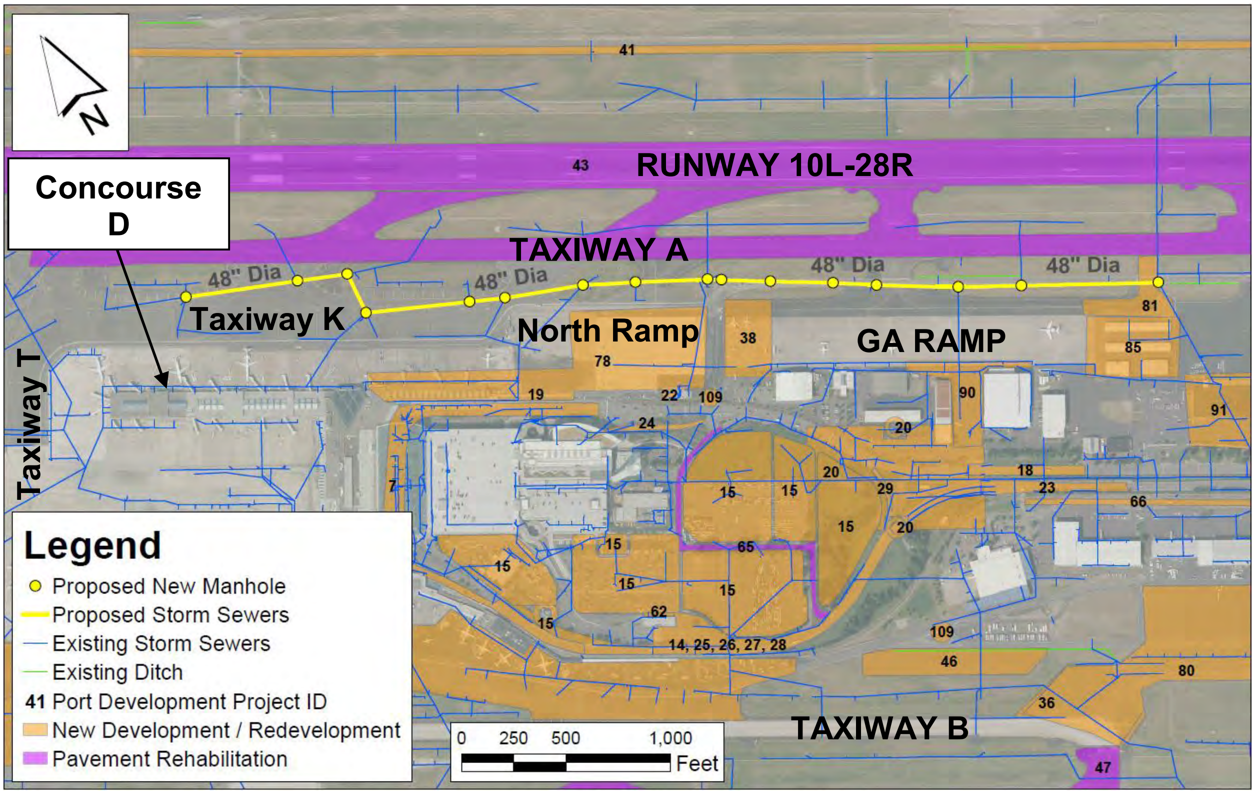


Figure 1: Plan View of Solution

Implementation Considerations

The following tables provide recommended considerations as the project moves from planning concept to implemented solution. The tables below address three phases of implementation, including planning and design, construction, and post-construction.

Planning and Design Considerations

Item	Description
Field Data Collection	• Underground utility location. • Geotechnical and hydrogeological studies may be needed to support detailed design. • Condition inspection of any existing structures where new pipe connections will be made.
Additional Technical Analysis	Confirm pipe size based on whether or not SWM Solutions 7-A and 7-H are implemented, the layouts of these solutions and the timing of these solutions' implementation.
Permitting	None identified.
Siting	• As the upstream portion of the existing pipe north of Concourses D and E crosses underneath Taxiway K, it is recommended that the pipe be realigned if possible to minimize impacts to airport operations. • The solution layout (as shown in Figure 1) should also be adjusted as necessary to optimize land use, minimize excavation, avoid utilities, and meet setback requirements.
Coordination with Elements of Other Projects	• Coordinate with the GA Taxi Lane Rehabilitation project to minimize operational impacts to pavement and reduce mobilization costs for pavement reconstruction after placing the proposed pipes. • Coordinate with SWM Solutions 7-A and 7-H due to overlap with these solutions.
Enabling Projects	None identified.
Related Solutions	None identified.
Coordination with Port Departments	• Planning and Development - development projects along pipe corridor that may intersect proposed pipe alignment, Charter and Business Case Development • Engineering - pipe sizing, utility relocation, design coordination among projects • Operations - temporary closure of taxiways and ramps • Maintenance - change in catch basins and manholes requiring routine maintenance • Asset Management - removal of existing assets, addition of new assets

Item	Description
Coordination with Tenants	• Coordinate project planning as required with airlines operating around Concourses D and E. • Coordinate potential taxiway closures and impacts to the North Ramp and GA Ramp with airlines.
Coordination with Outside Agencies	Coordinate with FAA regarding taxiway closures, as well as potential crossings of FAA communication and electrical utilities.
Design Disciplines Involved	Civil, Structural, and others as needed to relocate utilities

Construction Considerations

Item	Description
Construction Components	• If possible, realign storm sewer to better align with the infield areas south of Taxiway A to minimize construction impacts to the North Ramp and Taxiway K • Abandon any remaining portions of existing storm sewer in place and fill with controlled density fill to address risk of structural failure of aging pipe. • Demolish portions of existing pipe that are being replaced by new pipe, in locations where alignment is maintained. • Construct new 48-inch pipe to replace existing 21 to 42-inch pipe, including associated structures. • Maintain existing catch basins and storm sewer laterals, and connect to proposed 48-inch pipe. • Demolish and reconstruct the North Ramp, the perimeter road, and Taxiways K, A6, A5, V, A4, and W, as needed to install solution. • Demolish and repair Basin 7 trunk line as needed to remove existing pipe north of North Ramp and tie in replacement pipe. • Protect and/or relocate existing utilities as needed to install solution.
Airport Operational Impacts	• Impacts to airline operations on the North Ramp near Concourses D and E can be minimized if the pipe is able to be realigned to the infield areas north of the ramp. • Construction across taxiways will temporarily reduce the number of access points to Runway 10L-28R. • Pipe installation will involve open cut of the perimeter road, requiring the Port to designate an alternate route for vehicular traffic. • As the pipe needing to be replaced connects to and flows through deicing system pump station A (PS-A), construction is recommended to take place outside of the deicing season to minimize impacts to deicer collection operations (verify new line is flushed prior to starting pump station after construction).
Construction Challenges	• Tie-in of the replacement pipe into the trunk line may require bypass pumping of flows to minimize the potential for flooding. • Need to minimize potential for structural impacts to PS-A during construction of the pipe tie-in. • Identify contractor laydown area that avoids interference with airport operations. • Due to vicinity to runway, earthwork and equipment heights may need to be coordinated with FAA requirements.

Post-Construction Considerations

Item	Description
Post-Construction Coordination with Airport Operations	None identified.
Considerations for Operation and Maintenance (O&M) of the Solution	No change from current.

Potential Risks if Solution is Implemented / Risk Mitigation Strategies

Item	Description	Mitigation Strategy
Regulatory Compliance	None identified.	Not applicable.
Airport or Tenant Operations	None identified.	Not applicable.
Aircraft Safety	None identified.	Not applicable.
Future Development Limitations	None identified.	Not applicable.

Schedule Analysis

Item	Description
Critical Schedule Drivers	Alignment of SWM Solution 7-C construction with the construction schedules for the following PDX development projects may reduce costs and operational impacts:[1] • Project #81: GA Taxi Lane Rehabilitation (2020) • SWM Solution 7-A: Provide Pump Station to Address Basin 7 Capacity Limitations • SWM Solution 7-H: Improve Basin 7 Trunk Line to Address Risk of Asset Failure Specific benefits of coordinating with each project listed above are described in the Implementation Considerations section, under Planning and Design Considerations.
Target Construction Timeframe (2016-2020, 2021-2025, 2026-2035)	2016-2020 Timeframe selected based on: • Aligning with the development projects listed above. A pipe inspection to assess the risk of asset failure may help to refine the construction timeframe.
Planning and Design Lead Time (<6 months, 6-12 months, 12-24 months)	6-12 months

Notes:

1. Project numbers and timeframes are from the Port's list of future development projects (Appendix A).

Cost Analysis

Item	Description
Opinion of Probable Capital Cost (2015 Dollars)[1]	$4,100,000
Cost Estimate Class / Contingency (1-Bid received, 2-Construction, 3-Design, 4-Concept Design, 5- Screening/Planning)	5- Screening/Planning
Fixed Asset Modifications Excluded from Cost Estimate	Utility relocation costs not included.
Cost Assumptions	• Assumes reconstruction of airfield pavement will be coordinated with adjacent projects, where possible. • Assumes open cut for pipe installation. • Assumes existing pipes for north lateral will be removed, rather than abandoned. • Includes 40% for hard cost contingency. • Includes 35% for soft cost contingency.
O&M Cost Considerations	No change from current.

Notes:
1. Supporting detailed cost tables are provided in Appendix B.

SWM SOLUTION FACT SHEET 7-D

Stormwater Management Solution Tracking Information

SWM Solution ID	Solution Name	Capital Cost Summary	Anticipated Implementation Timeframe	Author	Revision Date
7-D	Provide Regional Water Quality Treatment for BMP Strategy Area (BMP SA)-7.1	$1,000,000	2021-2025	GS&P and Geosyntec	June 2015

Stormwater Management Needs Addressed by Solution

SWM Need ID	Need Name	Need Type		
		Address Ponding and Facilitate Drainage	Address Risk of Stormwater Asset Failure	Provide Required Stormwater Controls
0-1	Post-Construction Stormwater Pollutant and Runoff Control			X

Development projects planned by the Port will trigger stormwater quality treatment requirements of the MS4 permit as outlined in the Port of Portland Stormwater Design Standards Manual (DSM) and described in SWM Need Fact Sheet 0-1. The proposed solution addresses the need to provide treatment for future development projects in this BMP Strategy Area (BMP SA-7.1), as summarized in the table below. The subsequent table provides a summary of the BMP sizing requirements, as calculated based on DSM criteria.

Future Development Projects Treated by BMP

Project #[1]	Drainage Basin	Planned Development / Redevelopment Project Name	Acres Treated by BMP
36[2]	7	Taxiway B Center & Exits Rehabilitation	2.6
37[2]	7	Taxiway T SE Taxiway B East & CCA Apron 2	8.4
46[2]	7	Snow Pad & Glycol Apron Rehabilitation	2.2
80[2]	7	SE Apron Rehabilitation	2.9
14, 25, 26, 27, 28[2]	7	• Terminal Area Exit Lane (Link K) • 1 New Lane at Enplaning Level Departure (Link F) • 1 New Lane at Deplaning Level Departure (Link G) • 1 New Lane at Parking Exit (Link H) • 1 New Lane at Terminal Exit (Link I)	0.6
Total Acres of Development Treated			16.7

Notes:

1. Project numbers correspond to future development areas displayed on Figure 1, and included in the Port's list of future development projects (Appendix A).
2. Project crosses into an adjacent BMP Strategy Area. Acreage reflects portion in this BMP Strategy Area.

Water Quality Treatment BMP Sizing Basis

Area to be Treated	Impervious Acres to be Treated	Annual Runoff Volume (ac-ft)	WQ Design Flow Rate (cfs)[1]	WQ Design Volume (ac-ft)[2]
Planned Development/Redevelopment Area Only	16.7	39.9	1.4	0.5
Entire BMP Strategy Area[3]	67.6	165.4	5.8	2.2

Notes:

1. Based on 0.1 in/hr design intensity, per DSM requirements for offline flow-based BMPs.
2. Based on 0.45 inch design depth, per DSM requirements for volume-based BMPs with 24-hr drawdown time.
3. Provided for planning purposes only. BMP sizing and costs based on Planned Development / Redevelopment Area Only.

Solution Description

Solution Type	Summary Description
New or Modified Infrastructure	Construction of subsurface flow wetlands (SSF) wetlands, cartridge filters, and lift station.

Figure 1 depicts the BMP Strategy Area with the planned future development projects and proposed BMP location. Figure 2 shows the BMP footprint, existing storm sewer, new diversion structures, and lift station. The proposed project will divert runoff from STSMH162 to a lift station. A force main from the lift station will route runoff to a cartridge filter unit vault (or similar). Pretreated runoff will be routed to a subsurface flow (SSF) wetland via gravity flow for final treatment and polishing. Runoff will then be returned to the storm sewer trunk line via gravity flow at a new manhole down gradient of STSMH162. The Port is also considering alternatives for spill control in Basin 7 and may install a containment BMP upstream of the stormwater BMP, which is not included in this fact sheet.

While a variety of alternative treatment solutions are possible at this location that could meet the Port's treatment requirements, the proposed solution was selected to provide reliable treatment for multiple pollutants while minimizing potential wildlife attractants and interactions with groundwater. The need for cartridge filters for pretreatment depends on pollutant loadings, but pretreatment is generally recommended to increase the life of the SSF wetland. Characterization of typical TSS concentrations and loads at this location is recommended prior to conceptual design.

The Port could choose to install the BMP solution in phases, starting with the lift station and cartridge filter while reserving the space for future installation of the SSF wetland to treat additional pollutants if required by future regulations or deemed necessary through monitoring.

Figure 3 illustrates a cross section of the proposed solution. Assuming treatment would only be provided for the planned development/redevelopment area only, the lift station and cartridge filters were preliminarily sized using the water quality design flow rate and the SSF wetlands were preliminary sized using the water quality design volume with an assumed 3-foot gravel depth.

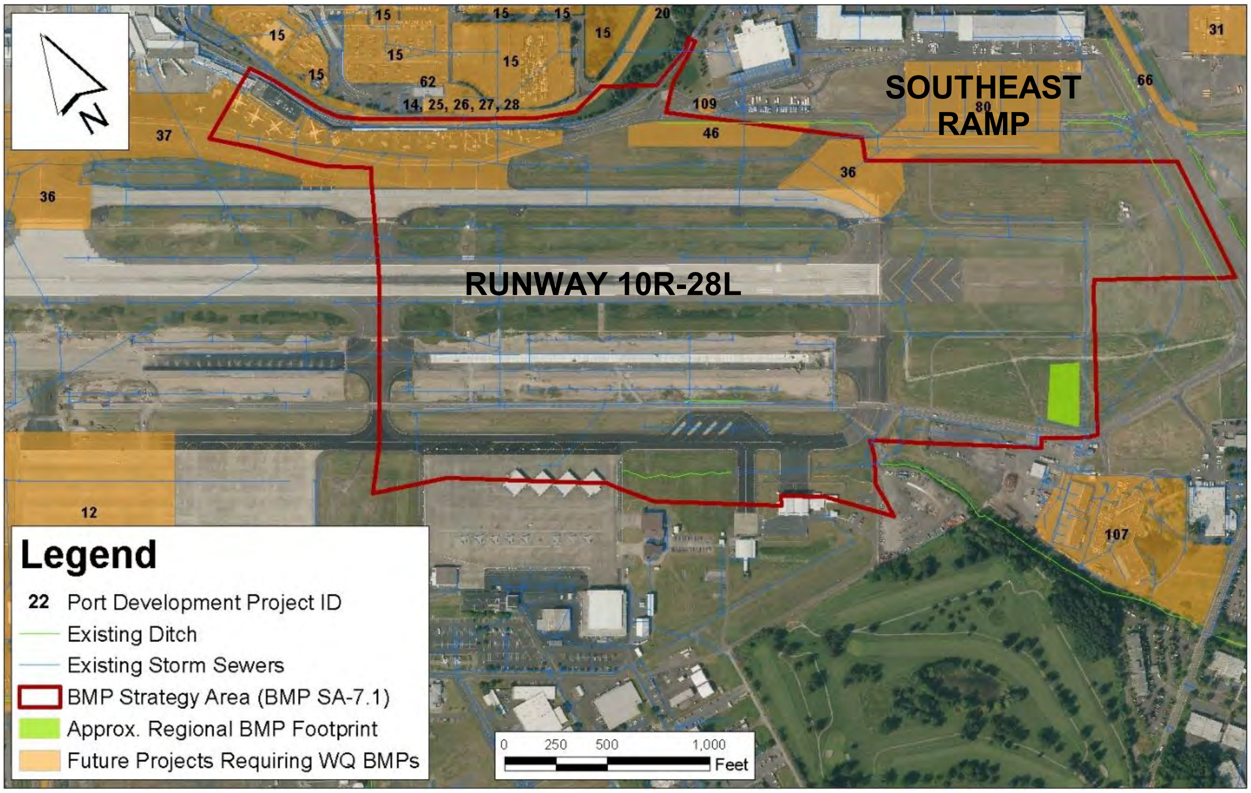


Figure 1: BMP SA-7.1 Vicinity

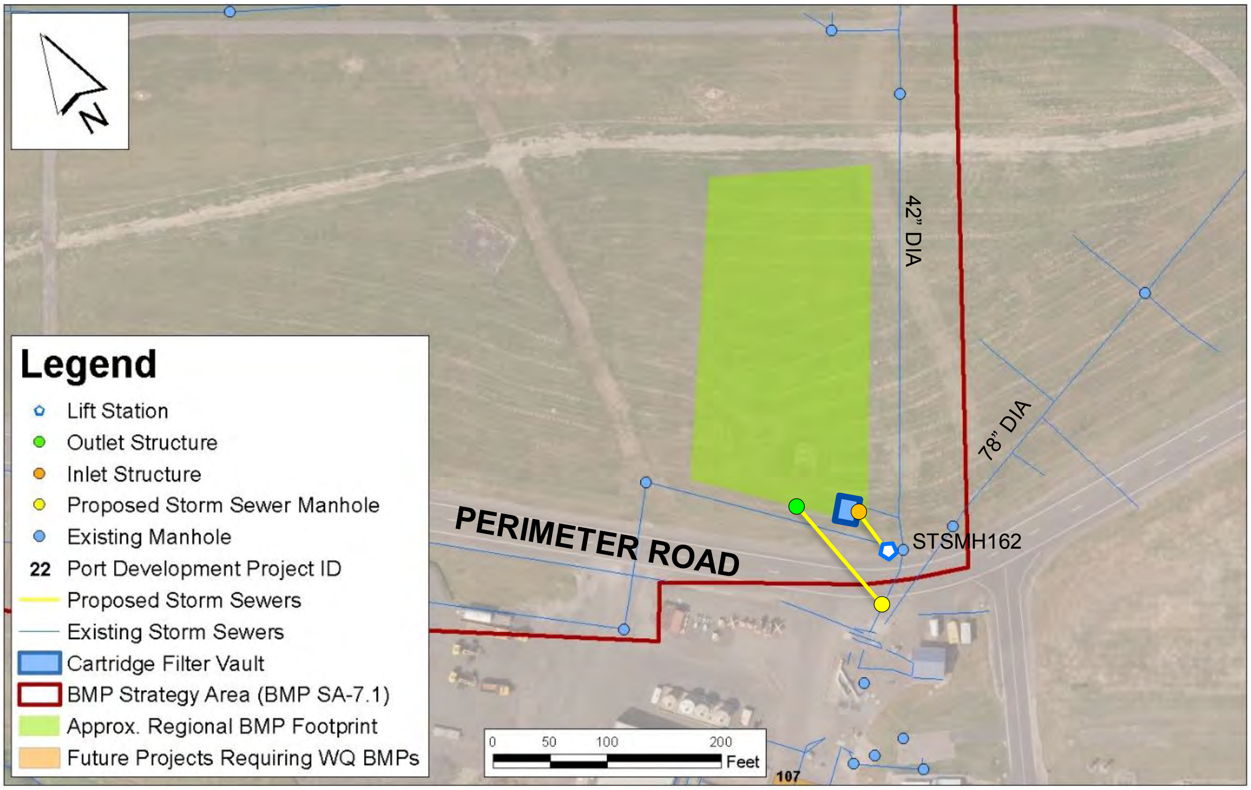


Figure 2: Proposed Layout of Cartridge Filter and SSFW for BMP SA-7.1

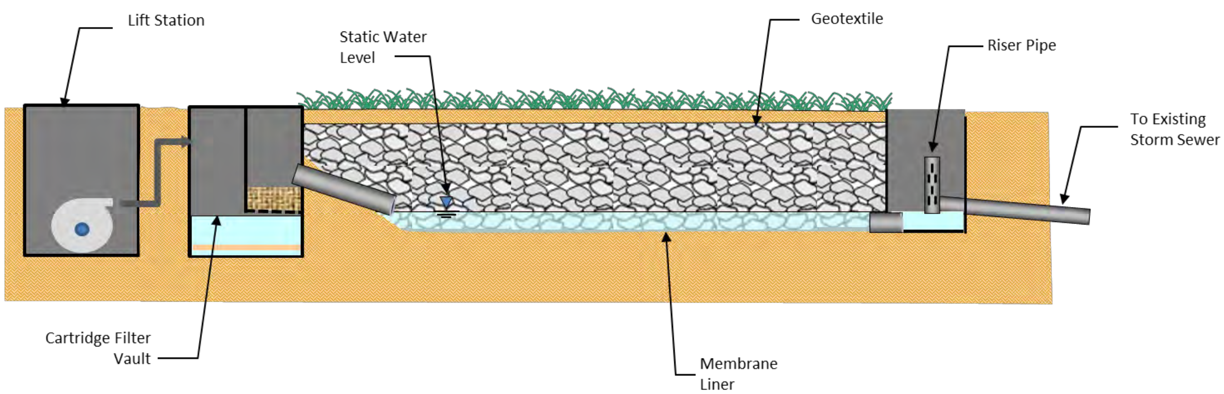


Figure 3: Cross-Section of Proposed SSF Wetland

Implementation Considerations

The following tables provide recommended considerations as the project moves from planning concept to implemented solution. The tables below address implementation considerations for planning and design, construction, and post-construction.

Planning and Design Considerations

Item	Description
Field Data Collection	• Underground utility location • Local topographic surface to support design • Local groundwater elevations to support structural design • Stormwater sampling for TSS and flows to determine if pretreatment needed for SSF wetland
Additional Technical Analysis	• Geotechnical and hydrogeological studies may be needed to support detailed design. • Detailed analysis of the proposed system using the PDX stormwater model is recommended prior to design to assess hydraulic impacts.
Permitting	No permits required for installation. Coordinate with SPCC plan if spill control installed.
Siting	During detailed design, review the extents and layout and adjust as necessary to optimize land use, avoid utilities and meet setback requirements.
Coordination with Elements of Other Projects	• Post-construction BMPs must be installed to address the MS4 permit requirements following completion of the associated development/redevelopment projects. • Coordinate design with potential spill control BMP which may be installed upstream of the water quality BMP.
Enabling Projects	None identified.
Related Solutions	None identified.
Coordination with Port Departments	• Environmental - MS4 compliance, BMP tracking, possible spill control • Planning and Development - Charter and Business Case Development • Engineering - pump sizing, utility relocation, design coordination • Maintenance - pump, cartridge filter solids, SSF wetland plants • Asset Management - addition of new assets • Wildlife Management - SSF wetland plants, observation
Coordination with Tenants	None identified.
Coordination with Outside Agencies	None identified.
Design Disciplines Involved	Civil, Structural, Mechanical, Electrical, and others as needed to relocate utilities

Construction Considerations

Item	Description
Construction Components	• Construct one 1.4 cfs lift station. • Construct one 1.4 cfs cartridge filter unit. • Construct 0.3 acres of subsurface flow wetland. • Decommission existing storm sewer within BMP footprint.
Airport Operational Impacts	• Construction access within the Air Operations Area (AOA) is required. • Construction is planned on the perimeter road. • Truck traffic and heavy equipment operation is anticipated during construction.
Construction Challenges	• An estimated 2,400 CY of excavation spoils would need to be exported and disposed of and 1,450 CY of stone aggregate imported. • Equipment and material staging areas would need to be identified as well as soil and aggregate stockpile areas. • Line power needed to the lift station

Post-Construction Considerations

Item	Description
Post-Construction Coordination with Airport Operations	None identified.
Considerations for Operation and Maintenance (O&M) of the Solution	• Access to lift station for scheduled maintenance • Access to cartridge filters for scheduled maintenance

Potential Risks if Solution is Implemented / Risk Mitigation Strategies

Item	Description	Mitigation Strategy
Regulatory Compliance	Effectively tracking development project treatment needs and BMPs to which it is assigned	Develop BMP tracking tool.
Airport or Tenant Operations	None identified.	Not applicable.
Aircraft Safety	None identified.	Not applicable.
Future Development Limitations	BMP footprint area will be unavailable for other development.	Coordinate siting with project planners to confirm location minimizes conflicts with future development.

Schedule Analysis

Item	Description
Critical Schedule Drivers	Coordinate the construction with the following project timeframes:[1] • Project #14: Terminal Area Exit Lane – Link K (2022) • Project #25: 1 New Lane at Enplaning Level Departure – Link F (2027) • Project #26: 1 New Lane at Deplaning Level Departure – Link G (2027) • Project #27: 1 New Lane at Terminal Exit – Link H (2027) • Project #28: 1 New Lane at Terminal Exit – Link I (2027) • Project #36: Taxiway B Center & Exits Rehabilitation (2018) • Project #37: Taxiway T SE, Taxiway B East & CCA Apron (2021) • Project #46: Snow Pad & Glycol Apron Rehabilitation (2026) • Project #80: Southeast Apron Rehabilitation (2023)
Target Construction Timeframe (2016-2020, 2021-2025, 2026-2035)	2021-2025 Timeframe based on time for implementation of development projects. Assumed that BMP will be implemented by end of timeframe.
Planning and Design Lead Time (<6 months, 6-12 months, 12-24 months)	12-24 months to allow for water quality monitoring and SSF wetland pilot testing prior to full scale design

Notes:

1. Project numbers and timeframes are from the Port's list of future development projects (Appendix A).

Cost Analysis

Item	Description
Opinion of Probable Capital Cost (2015 Dollars)[1]	$1,000,000
Cost Estimate Class / Contingency (1-Bid received, 2-Construction, 3-Design, 4-Concept Design, 5- Screening/Planning)	5- Screening/Planning
Fixed Asset Modifications Excluded from Cost Estimate	None identified.
Cost Assumptions	• Includes 40% for hard cost contingency. • Includes 30% for soft cost contingency. • Other relevant assumptions provided in "BMP Sizing Basis" and "Construction Considerations" sections in this fact sheet.
O&M Cost Considerations	• Pump replacement at 5-10 years • Estimated annual O&M labor for SSFW 50 mhr/year [2] • Estimated annual O&M labor for Cartridge Filter at 24 mhr/year [2]

Notes:

1. Supporting detailed cost tables are provided in Appendix B.
2. O&M level of effort estimated based on DSM Appendix O values.

SWM SOLUTION FACT SHEET 7-E

Stormwater Management Solution Tracking Information

SWM Solution ID	Solution Name	Capital Cost Summary	Anticipated Implementation Timeframe	Author	Revision Date
7-E	Provide Regional Water Quality Treatment for BMP Strategy Area (BMP SA)-7.2	$3,300,000	2016-2020	GS&P and Geosyntec	June 2015

Stormwater Management Needs Addressed by Solution

SWM Need ID	Need Name	Need Type		
		Address Ponding and Facilitate Drainage	Address Risk of Stormwater Asset Failure	Provide Required Stormwater Controls
0-1	Post-Construction Stormwater Pollutant and Runoff Control			X

Development projects planned by the Port will trigger stormwater quality treatment requirements of the MS4 permit as outlined in the Port of Portland Stormwater Design Standards Manual (DSM) and described in SWM Need Fact Sheet 0-1. The proposed solution addresses the need to provide treatment for future development projects in this BMP Strategy Area (BMP SA-7.2), as summarized in the table below. The subsequent table provides a summary of the BMP sizing requirements, as calculated based on DSM criteria.

Future Development Projects Treated by BMP

Project # [1]	Drainage Basin	Planned Development / Redevelopment Project Name	Acres Treated by BMP
11	7	DD - PrimeView Taxiway Y & Perimeter Road	5.3
19	7	1 New Lane at Enplaning Level Approach (Link D)	0.2
22	7	North Fuel Island Reconstruction	0.1
31 [2]	7	P4 Garage	5.3
38 [2]	7	MP RON Aircraft Parking Phase 1 (North Ramp Expansion)	0.8
41 [2]	7	Perimeter Road Rehabilitation	3.8
51 [2]	7	North Frontage Road	0.5
66 [2]	7	Air Cargo Road Rehabilitaiton	1.4
68 [2]	7	MP Intersection of NE 82nd Way & Airport Way	0.7
78	7	TEIP / PDXNext Concourse E & Ramp Widening	8.8
80	7	SE Apron Rehabilitation	8.6
81	7	DD-GA West Redevelopment Phase 1	1.3
85 [2]	7	DD-GA East Redevelopment	1.9
91 [2]	7	Replace Access Control	5.7
109 [2]	7	DD - PrimeView Taxiway Y & Perimeter Road	0.3
Total Acres of Development Treated			44.7

Notes:

1. Project numbers correspond to future development areas displayed on Figure 1, and included in the Port's list of future development projects (Appendix A).
2. Project crosses into an adjacent BMP Strategy Area. Acreage reflects portion in this BMP Strategy Area.

Water Quality Treatment BMP Sizing Basis

Area to be Treated	Impervious Acres to be Treated	Annual Runoff Volume (ac-ft)	WQ Design Flow Rate (cfs)	WQ Design Volume (ac-ft)[3]
Planned Development/Redevelopment Area Only	44.7	107.7	3.8 [1] 2.0 [2]	0.98
Entire BMP Strategy Area [4]	207.0	502.3	9.2	4.6

Notes:

1. For lift station, based on 0.1 in/hr design intensity, per DSM requirements for offline flow-based BMPs.
2. For cartridge filter, based on a discharge from the detention system of 6-hour drain time
3. For underground detention, based on 0.31 inch design depth, per DSM requirements for volume-based BMPs with 12-hr drawdown time.
4. Provided for planning purposes only. BMP sizing and costs based on Planned Development / Redevelopment Area Only.

Solution Description

Solution Type	Summary Description
New or Modified Infrastructure	Lift station and subsurface detention system with cartridge filter.

Figure 1 depicts the BMP Strategy Area with the planned future development projects and proposed BMP location. Figure 2 shows the BMP footprint, existing storm sewer, new diversion structures, and lift station. The proposed project will divert runoff downstream of STSMH8379 to a lift station. A force main from the lift station will route runoff to an underground detention system for equalization storage and pretreatment followed by a cartridge filter unit vault (or similar) for final treatment and polishing. Runoff will then be returned to the storm sewer trunk line via gravity flow at a new manhole down gradient of STSMH8379. The Port is also considering alternatives for spill control in Basin 7 and may install a containment BMP upstream of the stormwater BMP, which is not included in this fact sheet.

While a variety of alternative treatment solutions are possible at this location that could meet the Port's treatment requirements, the proposed solution was selected to provide treatment for multiple pollutants while minimizing potential wildlife attractants and interactions with groundwater. Figure 3 illustrates a cross section of the proposed solution. Assuming treatment would only be provided for the planned development/redevelopment area only, the lift station was preliminarily sized using the water quality design flow rate, the underground detention was preliminary sized using the water quality design volume, and the cartridge filter was sized using the equalized flow from the detention system assuming a 6-hour drain time. The underground storage is assumed to consist of an array of 3-foot diameter HDPE pipe sections or similar chamber system.

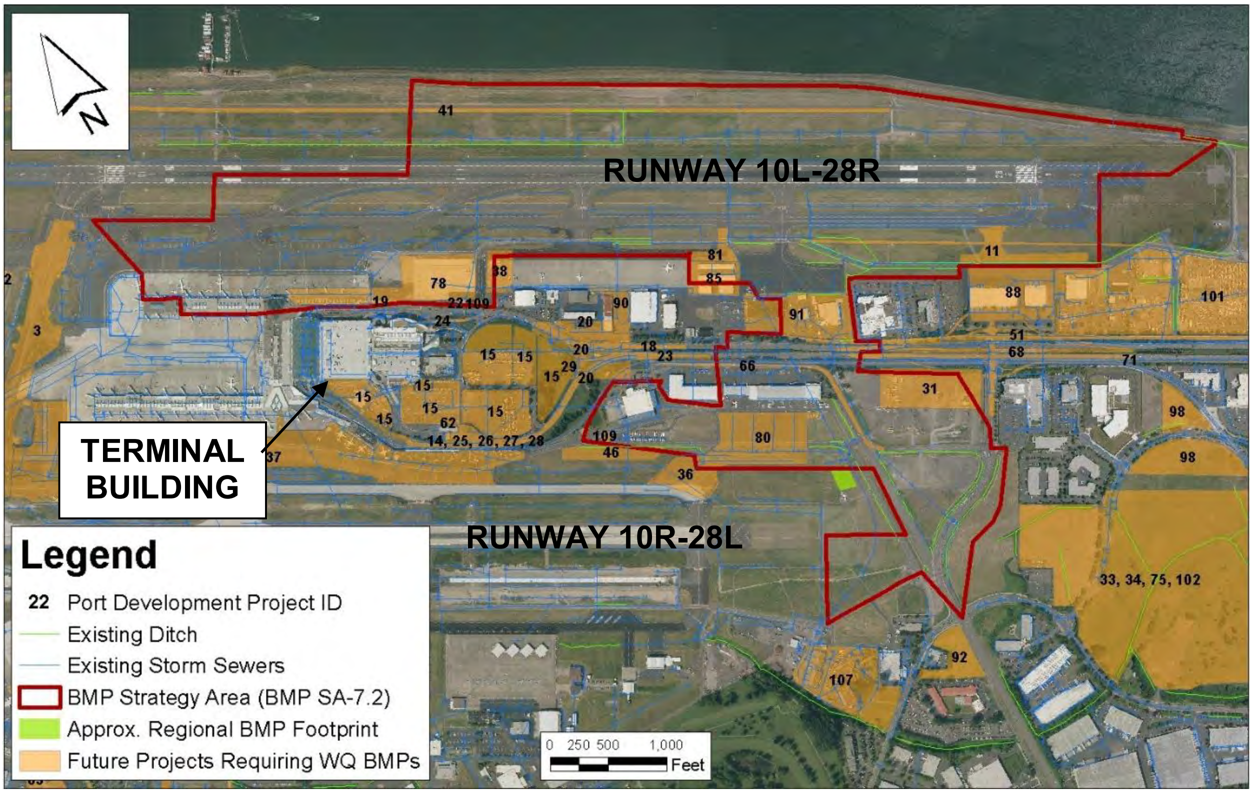


Figure 1: BMP SA-7.2 Vicinity

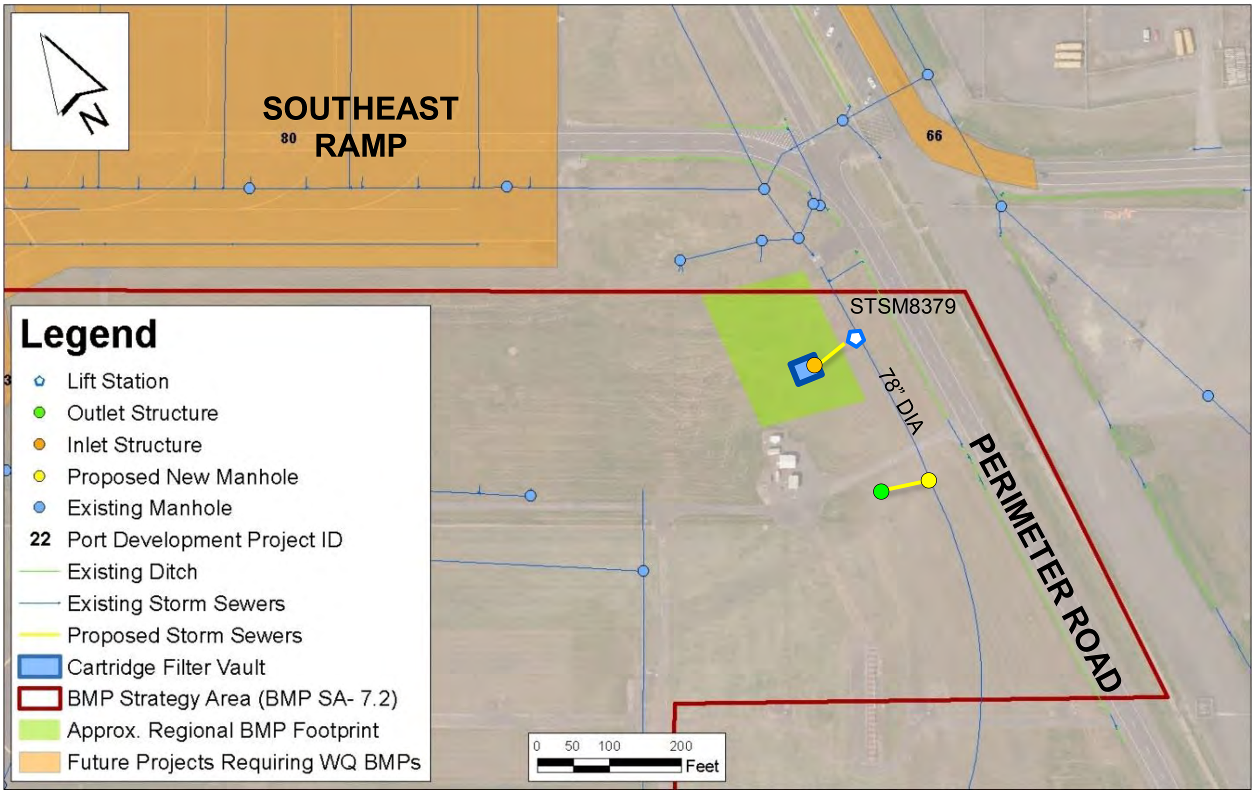


Figure 2: BMP SA-7.2 Vicinity

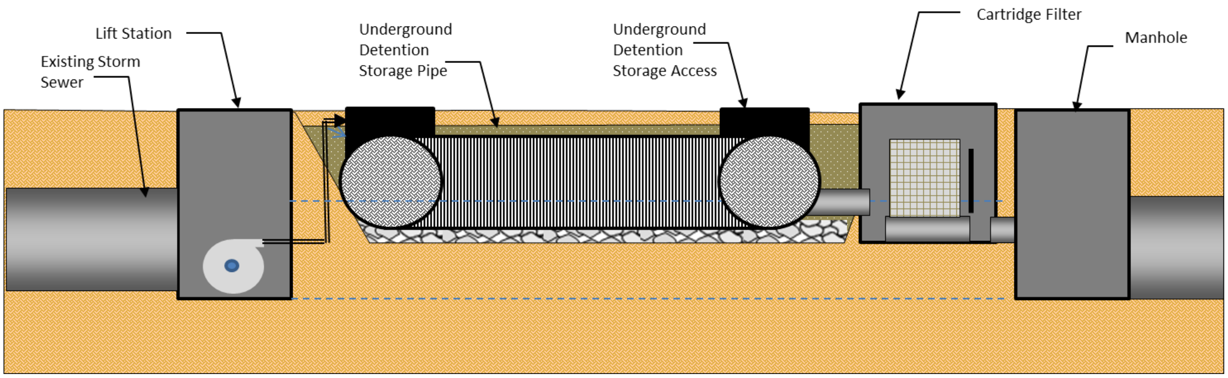


Figure 3: Underground Storage with Cartridge Filter and Lift Station

Implementation Considerations

The following tables provide recommended considerations as the project moves from planning concept to implemented solution. The tables below address implementation considerations for planning and design, construction, and post-construction.

Planning and Design Considerations

Item	Description
Field Data Collection	Underground utility location
Additional Technical Analysis	• Geotechnical and hydrogeological studies may be needed to support detailed design. • Detailed analysis of the proposed system using the PDX stormwater model is recommended prior to design to assess hydraulic impacts.
Permitting	No permits needed for installation. Coordinate with SPCC plan if spill control added.
Siting	During detailed design, review the extents and layout and adjust as necessary to optimize land use, avoid utilities and meet setback requirements
Coordination with Elements of Other Projects	• Post-construction BMPs must be installed to address the MS4 permit requirements following completion of the associated development/redevelopment projects. • Coordinate design with potential spill control BMP which may be installed upstream of the water quality BMP.
Enabling Projects	None identified.
Related Solutions	None identified.
Coordination with Port Departments	• Environmental - MS4 permitting, BMP tracking, potential spill control • Planning and Development - Charter and Business Case Development • Engineering - pump sizing, utility relocation, design coordination • Maintenance - lift station, cartridge filter, below ground storage • Asset Management - addition of new assets
Coordination with Tenants	None identified.
Coordination with Outside Agencies	None identified.
Design Disciplines Involved	Civil, Structural, Mechanical, Electrical, and others as needed to relocate utilities

Construction Considerations

Item	Description
Construction Components	• Construct one large diversion manhole. • Construct one 3.8 cfs lift station. • Construct 0.98 acre-feet of underground detention storage. • Construct a 2.0 cfs cartridge filter unit. • Construct one return manhole.
Airport Operational Impacts	• Construction access within the Air Operations Area (AOA) is required. • Construction is planned on the perimeter road, near the approach to the South Runway (10R-28L) and Taxiway B • Truck traffic and heavy equipment operation is anticipated during construction.
Construction Challenges	• Due to the volume of the underground storage required, it will likely be necessary to balance cut and fill to minimize export of soils. It may therefore be necessary to consider raising the grade elevation in the area of and surrounding the BMP. • Approximately 2,800 LF of 48-inch HDPE storage pipe will need to be delivered to the location. • Equipment and material staging areas would need to be identified as well as soil and aggregate stockpile areas.

Post-Construction Considerations

Item	Description
Post-Construction Coordination with Airport Operations	None identified.
Considerations for Operation and Maintenance (O&M) of the Solution	Access to lift station, cartridge filters, and underground detention cleanouts for scheduled maintenance

Potential Risks if Solution is Implemented / Risk Mitigation Strategies

Item	Description	Mitigation Strategy
Regulatory Compliance	Effectively tracking development project treatment needs and BMPs to which it is assigned	Develop BMP tracking tool.
Airport or Tenant Operations	None identified.	Not applicable.
Aircraft Safety	None identified.	Not applicable.
Future Development Limitations	BMP footprint area will be unavailable for other development.	Coordinate siting with project planners to confirm location minimizes conflicts with future development.

Schedule Analysis

Item	Description
Critical Schedule Drivers	Coordinate the construction with the following project timeframes:[1] • Project #11: DD - PrimeView Taxiway Y & Perimeter Road (unknown timeframe) • Project #19: 1 New Lane at Enplaning Level Approach – Link D (2022) • Project #22: North Fuel Island Reconstruction (2018) • Project #31: P4 Garage (2035) • Project #38: MP RON Aircraft Parking Phase 1 – North Ramp Expansion (2014) • Project #41: Perimeter Road Rehabilitation (2017) • Project #51: North Frontage Road (2020) • Project #66: Air Cargo Road Rehabilitation (2016) • Project #68: MP Intersection of NE 82nd Way and Airport Way (2020) • Project #78: TEIP / PDXNext Concourse E & Ramp Widening (2015) • Project #80: SE Apron Rehabilitation (2023) • Project #81: GA Taxi Lane Rehabilitation (2020) • Project #85: DD – GA West Redevelopment Phase 1 (2015) • Project #91: DD – GA West Redevelopment Phase 2 (Atlantic Aviation) (2016) • Project #109: Replace Access Control (2016)
Target Construction Timeframe (2016-2020, 2021-2025, 2026-2035)	2016-2020 Timeframe selected based on development project implementation schedule.
Planning and Design Lead Time (<6 months, 6-12 months, 12-24 months)	6-12 months

Notes:

1. Project numbers and timeframes are from the Port's list of future development projects (Appendix A).

Cost Analysis

Item	Description
Opinion of Probable Capital Cost (2015 Dollars)[1]	$3,300,000
Cost Estimate Class / Contingency (1-Bid received, 2-Construction, 3-Design, 4-Concept Design, 5- Screening/Planning)	5- Screening/Planning
Fixed Asset Modifications Excluded from Cost Estimate	None identified.
Cost Assumptions	• Includes 40% for hard cost contingency. • Includes 30% for soft cost contingency. • Other relevant assumptions provided in "BMP Sizing Basis" and "Construction Considerations" sections in this fact sheet.
O&M Cost Considerations	• Pump replacement at 5-10 years • Annual O&M labor for underground detention storage 20 mhr/year [2] • Annual O&M labor for cartridge filter 24 mhr/year [2]

Notes:
1. Supporting detailed cost tables are provided in Appendix B.
2. O&M level of effort estimated based on DSM Appendix O values.

SWM SOLUTION FACT SHEET 7-F

Stormwater Management Solution Tracking Information

SWM Solution ID	Solution Name	Capital Cost Summary	Anticipated Implementation Timeframe	Author	Revision Date
7-F	Provide Regional Water Quality Treatment for BMP Strategy Area (BMP SA)-7.3 (not including pump station and force main in SWM Solution 7-A)	$390,000	2016-2020	GS&P and Geosyntec	June 2015

Stormwater Management Needs Addressed by Solution

SWM Need ID	Need Name	Need Type		
		Address Ponding and Facilitate Drainage	Address Risk of Stormwater Asset Failure	Provide Required Stormwater Controls
0-1	Post-Construction Stormwater Pollutant and Runoff Control			X

Development projects planned by the Port will trigger stormwater quality treatment requirements of the MS4 permit as outlined in the Port of Portland Stormwater Design Standards Manual (DSM) and described in SWM Need Fact Sheet 0-1. The proposed solution addresses the need to provide treatment for future development projects in this BMP Strategy Area (BMP SA-7.3), as summarized in the table below. The subsequent table provides a summary of the BMP sizing requirements, as calculated based on DSM criteria.

Future Development Projects Treated by BMP

Project # [1]	Drainage Basin	Planned Development / Redevelopment Project Name	Acres Treated by BMP
15 [2]	7	RAC QTA Expansion	20.1
18	7	New Lane at NE Airport Way Westbound (Link A)	0.6
20	7	P3 Garage	9.7
23	7	1 New Lane at NE Airport Way, Eastbound (Link B)	0.8
24	7	1 New Lane at Parking Entrance (Link C)	0.3
29	7	New Lane at Return-to-Terminal Road (Link J)	0.1
38	7	North Ramp Expansion	1.2
62	7	Parking Exit Plaza Expansion	0.2
66 [2]	7	Air Cargo Road Rehabilitation	0.3
85 [2]	7	DD-GA West Redevelopment Phase 1	1.1
90	7	GA Apron Central Rehabilitation	2.0
91 [2]	7	DD-GA West Redevelopment Phase 2 (Atlantic Aviation)	2.3
14, 25, 26, 27, 28 [2]	7	• Terminal Area Exit Lane (Link K) • 1 New Lane at Enplaning Level Departure (Link F) • 1 New Lane at Deplaning Level Departure (Link G) • 1 New Lane at Parking Exit (Link H) • 1 New Lane at Terminal Exit (Link I)	2.8
Total Acres of Development Treated			41.5

Notes:

1. Project numbers correspond to future development areas displayed on Figure 1, and included in the Port's list of future development projects (Appendix A).
2. Project crosses into an adjacent BMP Strategy Area. Acreage reflects portion in this BMP Strategy Area.

Water Quality Treatment BMP Sizing Basis

Area to be Treated	Impervious Acres to be Treated	Annual Runoff Volume (ac-ft)	WQ Design Flow Rate (cfs)[1]	WQ Design Volume (ac-ft)[2]
Planned Development/Redevelopment Area Only	41.5	98.7	3.5	1.3
Entire BMP Strategy Area[3]	80.1	191.3	6.8	2.5

Notes:
1. Based on 0.1 in/hr design intensity, per DSM requirements for offline flow-based BMPs.
2. Based on 0.45 inch design depth, per DSM requirements for volume-based BMPs with 24-hr drawdown time.
3. Provided for planning purposes only. BMP sizing and costs based on Planned Development / Redevelopment Area Only.

Solution Description

Solution Type	Summary Description
New or Modified Infrastructure	Cartridge Filter upstream of new pump station to Columbia River.

Figure 1 depicts the BMP Strategy Area with the planned future development projects and proposed BMP location. Figure 2 shows the BMP footprint and existing storm sewer, as well as components of SWM Solution 7-A including the new diversion structure, conceptual pump station, and force main to the Columbia River. SWM Solution 7-F in this fact sheet describes only the post-construction BMP, assuming the related stormwater infrastructure will be provided in SWM Solution 7-A as discussed in the planning and design considerations. The Port is also considering alternatives for spill control in Basin 7 and may install a containment BMP upstream of the stormwater BMP, which is not included in this fact sheet.

The proposed project will divert runoff from proposed manholes and the existing storm drain system to a cartridge filter unit vault (or similar). The cartridge filter vault will drain to the regional pump station. A force main from the lift station will route treated runoff from the cartridge filter vault to the Columbia River. While a variety of alternative treatment solutions are possible at this location that could meet the Port's treatment requirements, the proposed solution was selected to provide treatment within a small footprint for this densely developed area while minimizing impacts to existing operations. Figure 3 illustrates a cross section of the proposed solution. Assuming treatment would only be provided for the planned development/redevelopment area only, the cartridge filter unit vault were preliminarily sized using the water quality design flow rate.

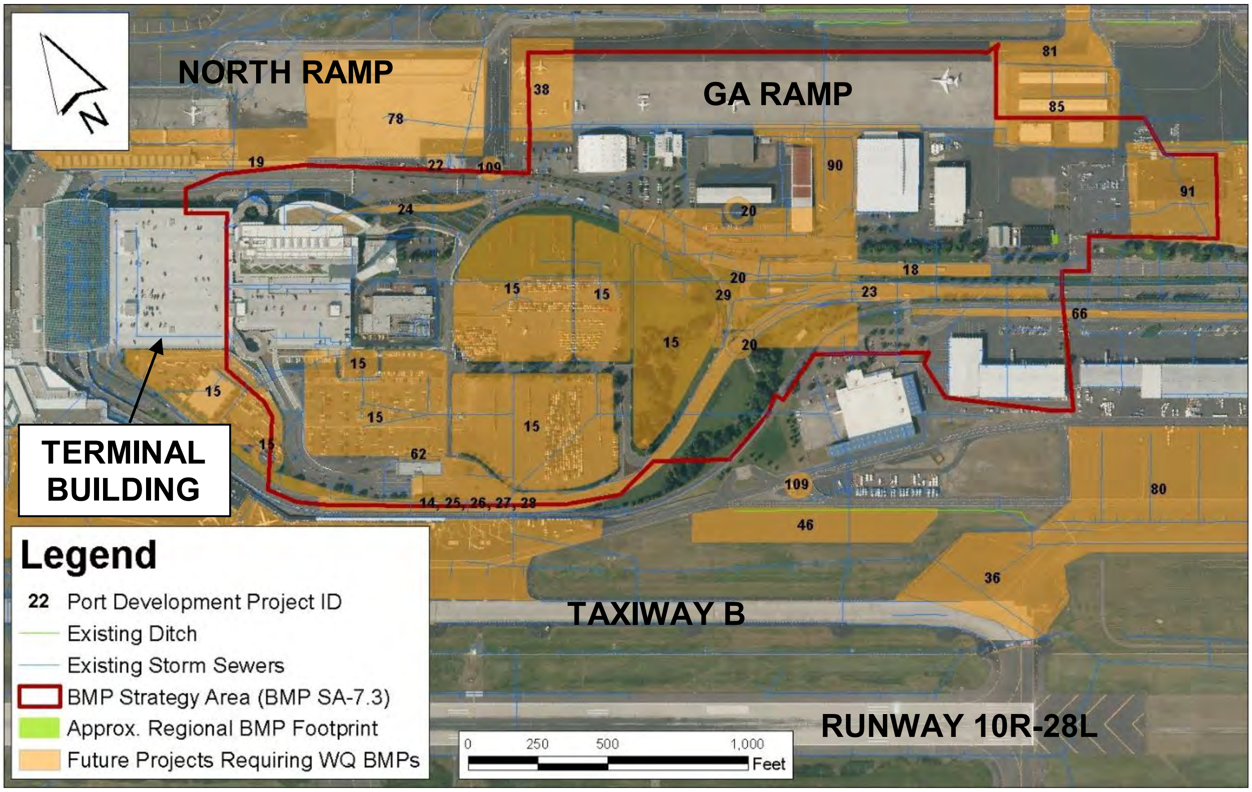


Figure 1: BMP SA-7.3 Vicinity

Figure 2: Layout of Proposed Lift Station and Cartridge Filter for BMP SA-7.3

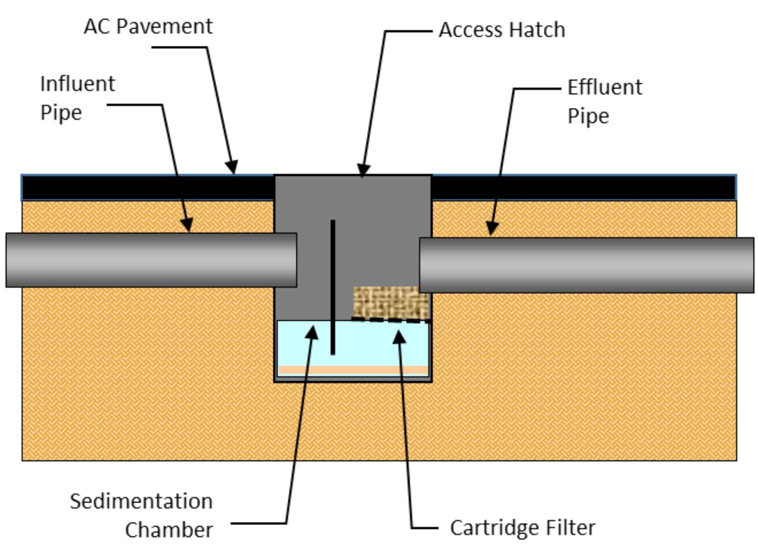


Figure 3: Cross-Section of Cartridge Filter

Implementation Considerations

The following tables provide recommended considerations as the project moves from planning concept to implemented solution. The tables below address implementation considerations for planning and design, construction, and post-construction.

Planning and Design Considerations

Item	Description
Field Data Collection	Underground utility location
Additional Technical Analysis	• Geotechnical and hydrogeological studies may be needed to support detailed design. • Detailed analysis of the proposed system using the PDX stormwater model is recommended prior to design to assess hydraulic feasibility and conveyance mechanisms.
Permitting	None identified.
Siting	During detailed design, review the extents and layout and adjust as necessary to optimize land use, avoid utilities and meet setback requirements.
Coordination with Elements of Other Projects	• Post-construction BMPs must be installed to address the MS4 permit requirements following completion of the associated development/redevelopment projects. • Coordinate design with potential spill control BMP which may be installed upstream of the water quality BMP. • Coordinate design and construction of SWM Solution 7-F with SWM Solution 7-A. The two solutions should be considered one project for the purpose of implementation.
Enabling Projects	None identified.
Related Solutions	None identified.
Coordination with Port Departments	• Environmental - MS4 permit compliance, BMP tracking • Planning and Development - Charter and Business Case Development • Engineering - pipe sizing, design coordination • Maintenance - sediment removal, pump • Asset Management - addition of new assets
Coordination with Tenants	Port to determine the timeline for construction of water quality treatment BMPs in coordination with the development projects in the BMP Strategy Area and their respective tenants.
Coordination with Outside Agencies	None identified.
Design Disciplines Involved	Civil, Structural, Mechanical, Electrical, and others as needed to relocate utilities

Construction Considerations

Item	Description
Construction Components	None identified.
Airport Operational Impacts	None identified.
Construction Challenges	Coordinate with SWM Solution 7-A for construction challenges.

Post-Construction Considerations

Item	Description
Post-Construction Coordination with Airport Operations	None identified.
Considerations for Operation and Maintenance (O&M) of the Solution	Access to cartridge filters for scheduled maintenance

Potential Risks if Solution is Implemented / Risk Mitigation Strategies

Item	Description	Mitigation Strategy
Regulatory Compliance	None identified.	Not applicable.
Airport or Tenant Operations	None identified.	Not applicable.
Aircraft Safety	None identified.	Not applicable.
Future Development Limitations	BMP footprint area will be unavailable for other development.	Coordinate siting with project planners to confirm location minimizes conflicts with future development.

Schedule Analysis

Item	Description
Critical Schedule Drivers	Coordinate the construction with the following project timeframes:[1] • Project #14: Terminal Area Exit Lane – Link K (2022) • Project #15: RAC QTA Expansion (2016) • Project #18: New Lane at NE Airport Way Westbound – Link A (2022) • Project #20: P3 Garage (2027) • Project #23: 1 New Lane at NE Airport Way, Eastbound – Link B (2027) • Project #24: 1 New Lane at Parking Entrance – Link C (2027) • Project #25: 1 New Lane at Enplaning Level Departure – Link F (2027) • Project #26: 1 New Lane at Deplaning Level Departure – Link G (2027) • Project #27: 1 New Lane at Parking Exit – Link H (2027) • Project #28: 1 New Lane at Terminal Exit – Link I (2027) • Project #29: New Lane at Return-to-Terminal Road – Link J (2027) • Project #38: MP RON Aircraft Parking Phase 1 – North Ramp Expansion (2014) • Project #62: Parking Exit Plaza Expansion (2017) • Project #66: Air Cargo Road Rehabilitation (2016) • Project #85: DD – GA West Redevelopment Phase 1 (2015) • Project #90: GA Apron Central Rehabilitation (2020) • Project #91: DD - GA West Redevelopment Phase 2 (Atlantic Aviation) (2016) • SWM Solution 7-A: Provide Pump Station to Address Basin 7 Capacity Limitations
Target Construction Timeframe (2016-2020, 2021-2025, 2026-2035)	2016-2020 Timeframe selected to correspond to development projects and SWM Solution 7-A. Assume BMP to be constructed by end of timeframe.
Planning and Design Lead Time (<6 months, 6-12 months, 12-24 months)	6-12 months

Notes:
1. Project numbers and timeframes are from the Port's list of future development projects (Appendix A).

Cost Analysis

Item	Description
Opinion of Probable Capital Cost (2015 Dollars)[1]	$390,000
Cost Estimate Class / Contingency (1-Bid received, 2-Construction, 3-Design, 4-Concept Design, 5- Screening/Planning)	5- Screening/Planning
Fixed Asset Modifications Excluded from Cost Estimate	Cost components from SWM Solution 7-A are excluded, such as diversion structure, pump station, pipes, and manholes associated with stormwater conveyance to the BMP.
Cost Assumptions	• Includes 40% for hard cost contingency. • Includes 30% for soft cost contingency. • Other relevant assumptions provided in “BMP Sizing Basis” and “Construction Considerations” sections in this fact sheet.
O&M Cost Considerations	Annual O&M labor for Cartridge Filter at 24 mhr/year [2]

Notes:

1. Supporting detailed cost tables are provided in Appendix B.
2. O&M level of effort estimated based on DSM Appendix O values.

SWM SOLUTION FACT SHEET 7-G

Stormwater Management Solution Tracking Information

SWM Solution ID	Solution Name	Capital Cost Summary	Anticipated Implementation Timeframe	Author	Revision Date
7-G	Water Quality Planning Recommendations for BMP Strategy Area (BMP SA)-7.4	$490,000	2016-2020	GS&P and Geosyntec	June 2015

Stormwater Management Needs Addressed by Solution

SWM Need ID	Need Name	Need Type		
		Address Ponding and Facilitate Drainage	Address Risk of Stormwater Asset Failure	Provide Required Stormwater Controls
0-1	Post-Construction Stormwater Pollutant and Runoff Control			X

Development projects planned by the Port will trigger stormwater quality treatment requirements of the MS4 permit as outlined in the Port of Portland Stormwater Design Standards Manual (DSM) and described in SWM Need Fact Sheet 0-1. The proposed solution addresses the need to provide treatment for future development projects in this BMP Strategy Area (BMP SA-7.4), as summarized in the table below. The subsequent table provides a summary of the BMP sizing requirements, as calculated based on DSM criteria.

Future Development Projects Treated by BMP

Project # [1]	Drainage Basin	Planned Development / Redevelopment Project Name	Acres Treated by BMP
92	7	PDX Travel Center	2.9
107	7	Future Planning	9.8
Total Acres of Development Treated			12.7

Notes:

1. Project numbers correspond to future development areas displayed on Figure 1, and included in the Port's list of future development projects (Appendix A).

Water Quality Treatment BMP Sizing Basis

Area to be Treated	Impervious Acres to be Treated	Annual Runoff Volume (ac-ft)	WQ Design Flow Rate (cfs)[1]	WQ Design Volume (ac-ft)[2]
Planned Development/Redevelopment Area Only	12.7	30.3	1.1	0.3
Entire BMP Strategy Area [3]	21.2	51.4	1.8	0.5

Notes:

1. Based on 0.1 in/hr design intensity, per DSM requirements for offline flow-based BMPs.
2. Based on 0.45 inch design depth, per DSM requirements for volume based BMPs with 24-hr drawdown time.
3. Provided for planning purposes only. BMP sizing and costs based on Planned Development / Redevelopment Area Only.

Solution Description

Solution Type	Summary Description
Future Planning Considerations	Select and construct BMPs such as planter boxes, bioretention, vegetated swales, and/or LID approaches as part of construction activities for development projects within the BMP strategy area. This solution does not include use of a regional treatment facility.

Figure 1 depicts the BMP Strategy Area with the planned future development projects. Proposed BMP locations are omitted since the proposed BMPs can be either distributed controls or sub-regional facilities whose locations are dependent on the type of development and the location and distribution of pervious areas within the development. A regional BMP is not practical to treat this BMP Strategy Area because the Strategy Area currently has three separate outfalls to the Columbia Slough. For building-based projects with roofs, parking lots, and landscaped areas, distributed stormwater controls such as planter box filters, bioretention facilities, infiltration trenches, vegetated swales, and/or other low impact development (LID) design elements can be used to reduce effective impervious areas and treat runoff.

Alternatively, sub-regional facilities can be used to provide combined treatment for an entire project or combination of projects. The location and size of the proposed BMPs can be determined once the extents of the improvements are known.

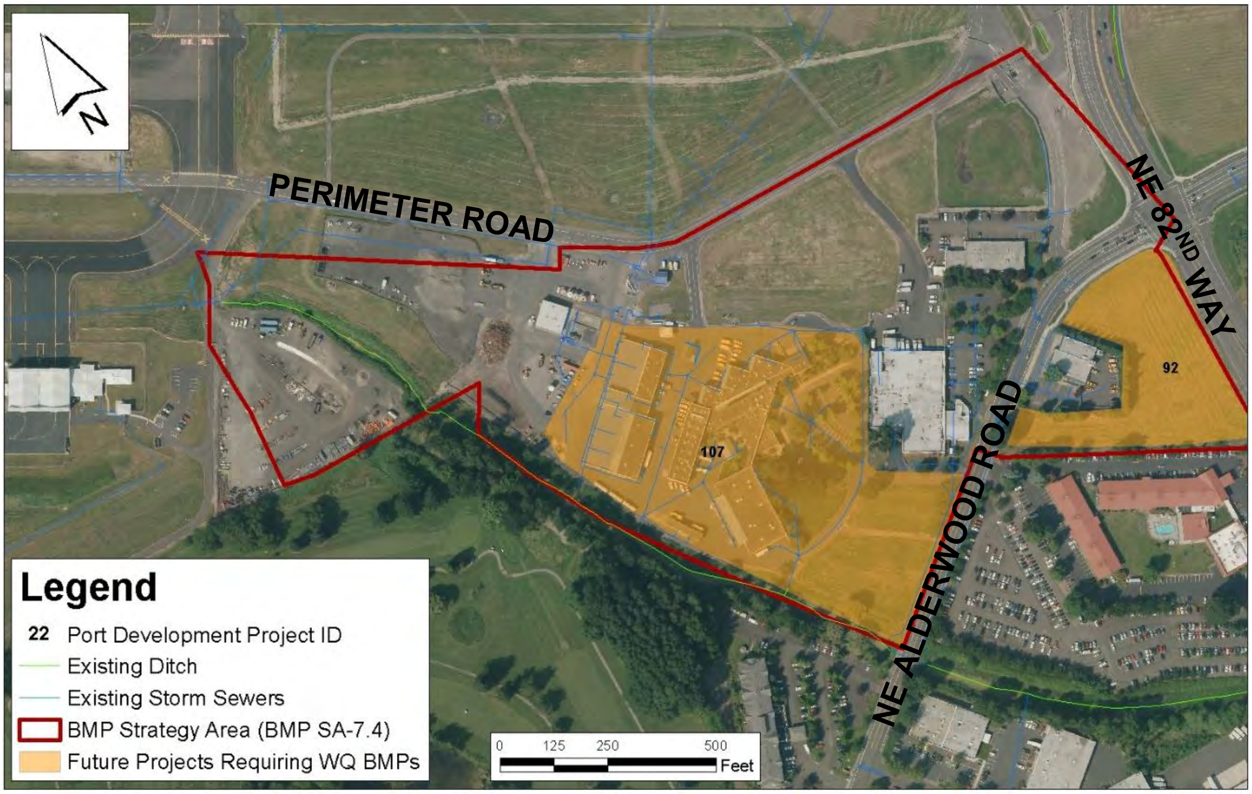


Figure 1: BMP SA-7.4 Vicinity

Implementation Considerations

The following tables provide recommended considerations as the project moves from planning concept to implemented solution. The tables below address implementation considerations for planning and design, construction, and post-construction.

Planning and Design Considerations

Item	Description
Field Data Collection	None identified.
Additional Technical Analysis	Individual BMP sizing needed once the type and location determined. Hydraulic analyses that consider influent flows, head losses, and tailwater conditions for the discharge.
Permitting	None identified.
Siting	During detailed design, review the development project extents and layout, with subsequent adjustment as needed to optimize land use, avoid utilities and meet setback requirements
Coordination with Elements of Other Projects	Post-construction BMPs must be installed to address the MS4 permit requirements following completion of the associated development/redevelopment projects.
Enabling Projects	None identified.
Related Solutions	None identified.
Coordination with Port Departments	• Planning and Development - Charter and Business Case Development • Engineering - pipe sizing, utility relocation, design coordination • Maintenance - change in catch basins and manholes requiring routine maintenance • Asset Management - removal of existing assets, addition of new assets • Wildlife Management - identify significance of potential risks
Coordination with Tenants	Port to determine the timeline for construction of water quality treatment BMPs in coordination with the development projects in the BMP Strategy Area and their respective tenants.
Coordination with Outside Agencies	None identified.
Design Disciplines Involved	Civil, Landscape Architect, and others as needed depending on BMPs selected.

Construction Considerations

Item	Description
Construction Components	Depends on BMPs selected.
Airport Operational Impacts	None identified.
Construction Challenges	Routing new gravity conveyance pipelines among project areas, BMPs, and existing stormwater conveyance may be challenging given conflicts with existing infrastructure and hydraulic needs.

Post-Construction Considerations

Item	Description
Post-Construction Coordination with Airport Operations	None identified.
Considerations for Operation and Maintenance (O&M) of the Solution	Depends on BMP selected. Refer to DSM Appendix O for guidance on O&M level of effort for various BMPs.

Potential Risks if Solution is Implemented / Risk Mitigation Strategies

Item	Description	Mitigation Strategy
Regulatory Compliance	Effectively tracking development project treatment needs and BMPs to which it is assigned.	Develop BMP tracking tool.
Airport or Tenant Operations	None identified.	Not applicable.
Aircraft Safety	Risk of wildlife attraction	Selected BMP will not have exposed water surface to minimize wildlife attraction. Coordinate design features with Port Natural Resources staff.
Future Development Limitations	BMP footprint area will be unavailable for other development.	Coordinate siting with project planners to confirm location minimizes conflicts with future development.

Schedule Analysis

Item	Description
Critical Schedule Drivers	Coordinate the construction with the following project timeframes:[1] • Project #92: PDX Travel Center (2015) • Project #107: Future Planning – New Airport Maintenance Facilities (unknown timeframe)
Target Construction Timeframe (2016-2020, 2021-2025, 2026-2035)	2016-2020 Timeframe selected to be conservative due to unknown timeframe of some development projects. Assumed that BMP will be installed by end of timeframe.
Planning and Design Lead Time (<6 months, 6-12 months, 12-24 months)	6-12 months from beginning of development project design

Notes:

1. Project numbers and timeframes are from the Port's list of future development projects (Appendix A).

Cost Analysis

Item	Description
Opinion of Probable Capital Cost (2015 Dollars)	$490,000
Cost Estimate Class / Contingency (1-Bid received, 2-Construction, 3-Design, 4-Concept Design, 5- Screening/Planning)	5- Screening/Planning
Fixed Asset Modifications Excluded from Cost Estimate	None identified.
Cost Assumptions	• Includes 30% for hard cost contingency. • Includes 30% for soft cost contingency. • Other relevant assumptions provided in "BMP Sizing Basis" section in this fact sheet. • Assumes bioretention BMPs as representative for cost planning purposes, using unit costs from DSM Appendix N.
O&M Cost Considerations	Reference DSM Appendix O for information on O&M level of effort for BMPs.

SWM SOLUTION FACT SHEET 7-H

Stormwater Management Solution Tracking Information

SWM Solution ID	Solution Name	Capital Cost Summary	Anticipated Implementation Timeframe	Author	Revision Date
7-H	Improve Basin 7 Trunk Line to Address Risk of Asset Failure	$4,200,000	2016-2020	GS&P	June 2015

Stormwater Management Needs Addressed by Solution

SWM Need ID	Need Name	Need Type		
		Address Ponding and Facilitate Drainage	Address Risk of Stormwater Asset Failure	Provide Required Stormwater Controls
7-3	Address Risk of Asset Failure for Basin 7 Trunk Line		X	

Solution Description

Solution Type	Summary Description
New or Modified Infrastructure	Replace and rehabilitate portions of the Basin 7 main trunk line to reduce risk of asset failure.

As shown in Figure 1, the proposed infrastructure upgrades associated with Solution 7-H are located east of the PDX Terminal Building, between the North Runway (10L-28R) and South Runway (10R-28L). Significant portions of the solution lie in the PDX Air Operations Area (AOA), particularly the portions of the solution that involve pipe replacement, which can be coordinated with planned development projects or located in areas where construction will have relatively minimal pavement and operational impacts. At the upstream end of the Basin 7 trunk line, SWM Solution 7-H crosses Taxiway A and runs along the eastern edge of Taxiway W. Moving downstream, the solution crosses under the Northeast Ramp, PDX Cargo Center North, NE Airport Way Frontage Road, NE Airport Way, PDX Cargo Center East, and the Port's East Perimeter Road. Pipes passing under the Port's North Perimeter Road (just south of Taxiway A), the MAX Light Rail and NE Air Cargo Road have sufficient useful life remaining to be excluded from Solution 7-D, unless a field inspection indicates that these pipes should also be replaced or rehabilitated.

The solution involves replacement, in-kind, of existing 21-inch to 60-inch pipes along the Drainage Basin 7 trunk line as well as a short segment of an upstream lateral, north of NE Airport Way Frontage Road. Along this section of pipe (shown in yellow in Figure 1), only the pipe under the Port's perimeter road is to be maintained, assuming that this pipe is found to be in good condition. South of this in-kind pipe replacement, the Basin 7 trunk line pipes crossing under NE Airport Way Frontage Road and NE Airport Way are recommended for rehabilitation with cured-in-place pipe (CIPP) liner (pipes recommended for rehabilitation shown in purple in Figure 1). Pipes passing under PDX Cargo Center East are also recommended for rehabilitation with CIPP liner rather than in-kind replacement. This pipe rehabilitation approach will minimize impacts to the existing building and building foundation. Under PDX Cargo Center East, the proposed pipe rehabilitation extends from STSMH5129 to STSMH4371. Downstream of STSMH4371, through STSMH8379, the existing 60-inch to 78-inch pipes in the Basin 7 trunk line are proposed for in-kind replacement. Along the entire length of replaced pipes, it is recommended that existing manholes also be replaced. New manholes should also be installed at all locations where the proposed in-kind pipe replacements connect to maintained existing pipes, including those pipes that are proposed for rehabilitation.

The goal of Solution 7-H is to replace or rehabilitate the portions of the Basin 7 storm sewer trunk line that have expended more than 100% of their estimated useful life in an effort to reduce the risk of asset failure (SWM Need 7-3). The proposed solution is based upon planned future development as provided by the Port in August 2014. The solution may need to be refined as development plans evolve.

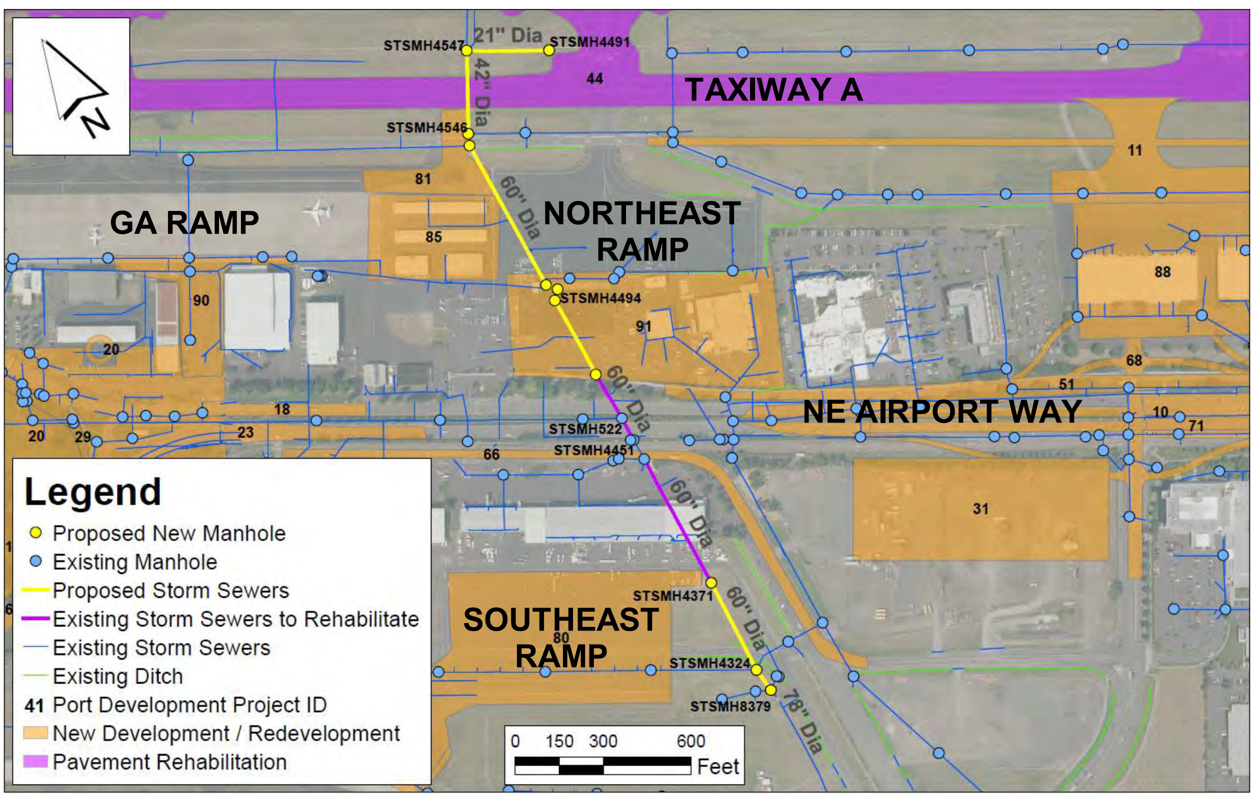


Figure 1: Plan View of Solution

Implementation Considerations

The following tables provide recommended considerations as the project moves from planning concept to implemented solution. The tables below address three phases of implementation, including planning and design, construction, and post-construction.

Planning and Design Considerations

Item	Description

Field Data Collection	• Underground utility location.
	• Perform field inspections of the following pipes to confirm that they are in good condition and do not require replacement or rehabilitation at the time that this solution is implemented:
	  ○ Pipes under the perimeter road, near Taxiway W
	  ○ Pipes under the MAX Light Rail and NE Air Cargo Road
	• Geotechnical and hydrogeological studies may be needed to support detailed design.
	• Condition inspection of any existing structures where new pipe connections will be made.

Additional Technical Analysis	• Investigate more specifically the feasibility and cost of using CIPP liner to extend the life of the appropriate sections of the trunk line. • Once the details of pipe rehabilitation have been determined, the Port's stormwater hydraulic model may need to be updated to reflect any changes to hydraulic capacity and verify that the approach will not have negative drainage system impacts.
Permitting	None identified.
Siting	During detailed design, review the extents and layout (as shown in Figure 1) and adjust as necessary to minimize taxiway impacts, optimize land use, minimize excavation, avoid utilities, meet setback requirements and avoid interference with airport operations.

Item	Description

Coordination with Elements of Other Projects	• Where possible, coordinate in-kind pipe replacements with the following development projects to minimize operational impacts to pavement and buildings:
	  ○ Project #81: GA Taxi Lane Rehabilitation
	  ○ Project #85: DD-GA West Redevelopment Phase 1
	  ○ Project #91: DD-GA West Redevelopment Phase 2 (Atlantic Aviation)
	• Coordinate in-kind pipe replacements under and near Taxiway A with the Taxiway A and Exits Rehabilitation project to minimize equipment mobilization costs and net impacts to airport operations.
	• Coordinate in-kind replacement of the upstream lateral with the North Runway Rehabilitation project to reduce the net duration of runway closure time and reduce the overall impact to airport operations.
	• Coordinate with SWM Solutions 7-A, 7-B, and 7-C due to the potential for overlap between these projects. If the SWM Solution 7-A drainage area is expanded to include all drainage north of NE Airport Way, the portion of the existing Basin 7 trunk line underneath NE Airport Way and the MAX Light Rail could be abandoned, rather than rehabilitated.

Enabling Projects	SWM Solution 7-A (re-routing 15% of Basin 7 to Columbia River) is considered an enabling project because using the CIPP method to rehabilitate the Basin 7 trunk line will reduce the trunk line's diameter, thereby exacerbating ponding at some need locations if SWM Solution 7-A is not implemented.
Related Solutions	None identified.
Coordination with Port Departments	• Planning and Development - Charter and Business Case Development • Engineering - pipe sizing, utility relocation, design coordination • Operations - temporary closure of taxiways and ramps • Maintenance - change in catch basins and manholes requiring routine maintenance • Asset Management - removal of existing assets, addition of new assets • Wildlife Management - Identify significance of current risk, change in future management techniques in area
Coordination with Tenants	• Coordinate the CIPP liner placement with any tenants impacted by the liner placement activities. • Coordinate solution location for pipe replacement sections with other planned development projects and tenant facilities. • Coordinate the closure of the perimeter road (near Taxiway W) with tenants using the road. • Coordinate with airlines when impacting Taxiway A, Taxiway W, and the Runway 10L-28R Safety Area (RSA).

Item	Description
Coordination with Outside Agencies	Coordinate with FAA regarding taxiway closures, as well as potential crossings of FAA communication and electrical utilities.
Design Disciplines Involved	Civil, Structural, and others as needed to relocate utilities

Construction Considerations

Item	Description
Construction Components	• Rehabilitate existing 60-inch pipes under NE Airport Way Frontage Road, NE Airport Way and PDX Cargo Center East using CIPP liner. • Demolish existing 21-inch to 60-inch pipes along the Basin 7 trunk line north of NE Airport Way Frontage Road, and replace in-kind. Include associated structures. • Demolish existing 60-inch to 78-inch pipes along the Basin 7 trunk line between PDX Cargo Center East and STSMH8379, and replace in-kind. • Maintain existing catch basins and storm sewer laterals, and connect to the replaced portions of the Basin 7 trunk line. • Maintain pipes found to be in good condition, particularly pipes under the North Perimeter Road, MAX Light Rail, and NE Air Cargo Road. • Demolish and reconstruct the perimeter road, Taxiway A, Taxiway W, and the Northeast Ramp as needed to install solution. • Protect and/or relocate existing utilities as needed to install solution.
Airport Operational Impacts	• Pipe replacement near the Runway 10L-28R RSA may require temporary runway closure. • Pipe installation will involve open cut of Taxiways A and W, temporarily reducing the number of access points to Runway 10L-28R. • Pipe installation will involve open cut of the perimeter road, requiring the Port to designate an alternate route for vehicular traffic.
Construction Challenges	• Construction within the Runway 10L-28R RSA and Runway Object Free Area (ROFA) will need to be performed in accordance with FAA requirements. • Identify contractor laydown area(s) that avoid(s) interference with airport and tenant operations.

Post-Construction Considerations

Item	Description
Post-Construction Coordination with Airport Operations	None identified.
Considerations for Operation and Maintenance (O&M) of the Solution	No change from current.

Potential Risks if Solution is Implemented / Risk Mitigation Strategies

Item	Description	Mitigation Strategy
Regulatory Compliance	None identified.	Not applicable.
Airport or Tenant Operations	None identified.	Not applicable.
Aircraft Safety	None identified.	Not applicable.
Future Development Limitations	None identified.	Not applicable.

Schedule Analysis

Item	Description
Critical Schedule Drivers	Alignment of SWM Solution 7-H construction with the construction schedules for the following PDX development projects may reduce costs and operational impacts:[1] • Project #43: North Runway Rehabilitation (2024) • Project #44: Taxiway A & Exits Rehabilitation (2023) • Project #81: GA Taxi Lane Rehabilitation (2020) • Project #85: DD-GA West Redevelopment Phase 1 (2015) • Project #91: DD-GA West Redevelopment Phase 2 (Atlantic Aviation) (2016) • SWM Solution 7-A: Pump Station to Address Basin 7 Capacity Limitations • SWM Solution 7-B: Replace and Extend Pipe Across Southeast Ramp to Post Office • SWM Solution 7-C: Replace Lateral North of North Ramp Specific benefits of coordinating with each project listed above are described in the Implementation Considerations section, under Planning and Design Considerations.
Target Construction Timeframe (2016-2020, 2021-2025, 2026-2035)	2016-2020, with potential for phasing into the 2021-2025 timeframe Portions of this solution involving disturbance to existing pavement should be aligned with planned development projects to the extent possible. The remainder of the project may be delayed to an extent that is acceptable to the Port.
Planning and Design Lead Time (<6 months, 6-12 months, 12-24 months)	6-12 months

Notes:

1. Project numbers and timeframes are from the Port's list of future development projects (Appendix A).

Cost Analysis

Item	Description
Opinion of Probable Capital Cost (2015 Dollars)[1]	$4,200,000
Cost Estimate Class / Contingency (1-Bid received, 2-Construction, 3-Design, 4-Concept Design, 5- Screening/Planning)	5- Screening/Planning
Fixed Asset Modifications Excluded from Cost Estimate	• Utility relocation costs not included. • Costs for removal and replacement of any impacted airfield signage have not been included.
Cost Assumptions	• The perimeter road will be open cut to allow for pipe installation. • Taxiway A will be open cut to allow for pipe installation, and pavement restoration costs have been included since the Taxiway A & Exits Rehabilitation project is assumed not to include full depth pavement restoration. • Additional incurred costs for implementing this solution in phases have not been included. • No traffic control is needed for work adjacent to or within roadways. • Assumes 40% contingency on hard costs. • Assumes 30% contingency on soft costs.
O&M Cost Considerations	No change from current.

Notes:

1. Supporting detailed cost tables are provided in Appendix B.

BASIN 8 STORMWATER MANAGEMENT FACT SHEETS

BASIN 8 STORMWATER MANAGEMENT FACT SHEETS

The SWM needs identified in Basin 8 are associated with ponding and water quality treatment requirement issues. SWM needs in Basin 8 are summarized in Table 19 below, and SWM solutions proposed to address these needs are described in Table 20. Both tables indicate how the SWM solutions align with each SWM need, and vice versa. Basin 8 SWM need and solution fact sheets immediately follow the tables.

The Basin 8 SWM needs are primarily associated with ponding as it affects existing development operations, safety (including hazardous wildlife attractant concerns), and potential future development. The key to the Basin 8 SWM solutions is Solution 8-A, the replacement of the existing Basin 8 outfall with a large, and better aligned outfall. This solution is needed to relieve inherent drainage capacity constraints for the basin as a whole. The effectiveness of Solutions 8-B and 8-C are dependent upon Solution 8-A being implemented.

Table 19 – Basin 8 SWM Needs

SWM Need ID	Issue Type	Need Description	Corresponding SWM Solution ID
0-1	Stormwater Controls	Address Requirement for Post-Construction Stormwater Pollutant and Runoff Control	8-E, 8-F, 8-G
8-1	Ponding	Address Ponding in Economy Lots and Airport Way Off-Ramp	8-A, 8-B
8-2	Ponding	Address Ponding Near the Intersection of NE Airport Way and NE 82nd Way	8-A, 8-C
8-3	Ponding	Address Ponding Southeast of North Runway (10L-28R)	8-A, 8-D

Table 20 – Basin 8 SWM Solutions

SWM Solution ID	Solution Type	Solution Description	Corresponding SWM Need ID
8-A	New or Modified Infrastructure	Replace Basin 8 Outfall Pipe	8-1, 8-2, 8-3
8-B	New or Modified Infrastructure	Replace Portion of Eastern Basin 8 Trunk Line Along Airport Way	8-1
8-C	New or Modified Infrastructure	Replace Pipe Along NE Airport Way Frontage Road in Northwest Basin 8	8-2
8-D	New or Modified Infrastructure	Add Fill and Pipe Storage Southeast of North Runway (10L-28R)	8-3
8-E	New or Modified Infrastructure	Provide Regional Water Quality Treatment for BMP Strategy Area (BMP SA)-8.1	0-1
8-F	Future Planning Considerations	Water Quality Planning Recommendations for BMP Strategy Area (BMP SA)-8.2	0-1
8-G	Future Planning Considerations	Water Quality Planning Recommendations for BMP Strategy Area (BMP SA)-8.3	0-1

SWM NEED FACT SHEET 8-1

Stormwater Management Need Tracking Information

SWM Need ID	Need Name	Issue Type	Author	Revision Date
8-1	Address Ponding in Economy Lots and NE Airport Way Off-Ramp	Ponding	GS&P	June 2015

Stormwater Management Solutions Identified to Address Need

SWM Solution ID	Solution Name	Solution Type		
		New or Modified Infrastructure	Operational Change	Future Planning Considerations
8-A[1]	Replace Basin 8 Outfall Pipe	X		
8-B[1]	Replace Portion of Eastern Basin 8 Trunk Line along NE Airport Way	X		

Notes:

1. Both SWM Solution 8-A and SWM Solution 8-B are needed to address SWM Need 8-1.

Issue Characterization

Issue Type	Issue Description
Ponding	Based on existing (2015) conditions stormwater hydraulic modeling for PDX Drainage Basin 8, ponding is expected to occur during both the 10-year and 100-year, 24-hour storm events at select locations in the Economy Blue Lot and on the nearby off-ramp from NE Airport Way westbound. Under future (2035) development conditions, stormwater hydraulic modeling indicates that the simulated ponding at these locations will be exacerbated by the added impervious area associated with the full build-out of planned new development at Portland International Center (PIC), which is located in the downstream portion of Basin 8. See Figure 1 for the estimated 10-year and 100-year, 24-hour storm ponding extents under future development conditions. The ponding creates risks for operations and hazardous wildlife attraction that the Port wants to mitigate.

Factors Potentially Contributing to Issue

Factor	Characterization Basis
Insufficient Drainage System Capacity	Assessments using the PDX stormwater hydraulic model indicate that ponding during the 10-year and 100-year storm events is created by insufficient drainage capacity at the following points in the Basin 8 storm sewer system: • Outfall 008 pipe (due to small size and relatively high elevation that restricts drainage from upstream portions of the system) • Open channels at PIC (due to inconsistent channel bottom slopes that create bowl-like features in the channel bed, which cannot fully drain) • Basin 8 East trunk line (due to small size)
Columbia Slough Water Levels	Tailwater from the Columbia Slough extends into the drainage system and reduces available drainage capacity.

Recommendations to Further Characterize Issue and Define Need

The following are actions recommended for further characterizing the issue before designing and implementing the identified solution(s).

Action	Description
Surveying / Field Data Collection	Site surveying or the collection of more detailed topographic data (e.g., Metro LiDAR) is recommended to determine if existing pavement and catch basin elevations are consistent with those used in the stormwater hydraulic modeling effort, particularly in areas where simulated ponding occurs near recently rehabilitated pavement or modified storm sewer catch basins. If the existing grade and/or catch basin grate elevations have changed significantly, updates to the Port's stormwater hydraulic model may be needed to confirm the extent of ponding and the sizing of the corresponding solution.
Field Observations During Storm Events	Field observations are recommended in this area to confirm the occurrence of problematic ponding, prior to implementing SWM Solution 8-B. This may be accomplished by monitoring the area for drainage issues during or following large storm events, or by consulting with staff or tenants that may be familiar with drainage in this area.

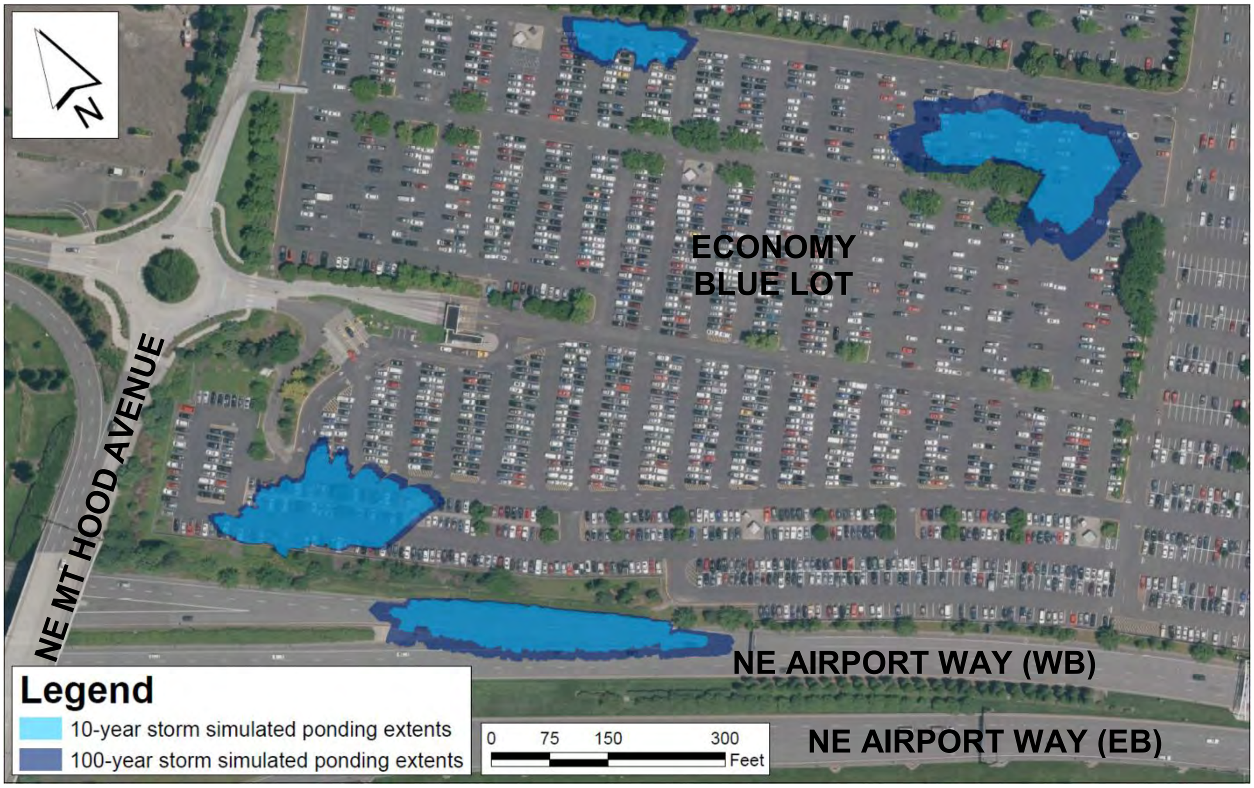


Figure 1: Plan View of Need

Regulatory Drivers for Stormwater Management Need

Driver	Description
FAA Hazardous Wildlife Attractant Criteria (FAA AC 150/5200-33)	Due to its proximity to PDX and location within the FAA 10,000 foot separation area, ponding at this location poses a risk for attracting wildlife into the runways' approach or departure airspace or into the Air Operations Area (AOA). According to FAA AC 150/5200-33, this poses a wildlife strike risk to aircraft.
FAA Airport Drainage Design Criteria (FAA AC 150/5320-5)	Pavement ponding is likely to occur during both the 10-year and 100-year storm events in the Economy Blue Lot and on the nearby off-ramp from NE Airport Way westbound. Both of these ponding locations may serve as access routes for airport operational vehicles. According to FAA AC 150/5320-5, "the objective of storm drainage design is to provide for safe passage of vehicles or operation of the facility during the design storm event." Therefore, the need to address ponding in the Economy Blue Lot and on the nearby off-ramp from NE Airport Way westbound is driven by a regulatory need to provide for safe vehicle passage.

Consequence of Not Mitigating Stormwater Management Need

Item	Description
Operations	Failure to address ponding in the Economy Blue Lot and on the nearby off-ramp from NE Airport Way westbound may compromise the safety of airport operational vehicles (and other vehicles) passing through these areas during storm events. Additionally, ponding may require that alternative access routes be established. Such detours may have negative impacts on the timeliness of buses serving the Economy Parking Lots and the timely arrival of airline passengers parking in the Economy Lots and arriving via the off-ramp from NE Airport Way westbound.
Wildlife Hazard Management	Standing water in close proximity to the airport poses an increased risk of hazardous wildlife attraction and for wildlife strikes.

Criteria to be Addressed by Stormwater Management Solutions

Item	Description
Flooding of Existing/Future Pavement	Eliminate ponding in the Economy Blue Lot and on the nearby off-ramp from NE Airport Way westbound during the 10-year storm.
Flooding of Existing/Future Buildings	Not applicable.
Ponding in Unpaved Areas Identified as Critical for Ponding Reduction	Reduce the 10-year storm peak ponding elevation to the lowest known ground elevation.
Asset Management Criteria	Not applicable.
Water Quality Treatment Criteria	Not applicable.

SWM NEED FACT SHEET 8-2

Stormwater Management Need Tracking Information

SWM Need ID	Need Name	Issue Type	Author	Revision Date
8-2	Address Ponding Near the Intersection of NE Airport Way and NE 82nd Way	Ponding	GS&P	June 2015

Stormwater Management Solutions Identified to Address Need

SWM Solution ID	Solution Name	Solution Type		
		New or Modified Infrastructure	Operational Change	Future Planning Considerations
8-A[1]	Replace Basin 8 Outfall Pipe	X		
8-C[1]	Replace Pipe Along NE Airport Way Frontage Road in Northwest Basin 8	X		

Notes:

1. Both SWM Solution 8-A and SWM Solution 8-C are needed to address SWM Need 8-2.

Issue Characterization

Issue Type	Issue Description
Ponding	Based on stormwater hydraulic modeling of the existing (2015) conditions in PDX Drainage Basin 8, ponding is expected to occur near the intersection of NE Airport Way and NE 82nd Way during the 10-year and 100-year, 24-hour storm events. Under future (2035) development conditions, ponding at this location will be exacerbated by the added impervious area associated with the full build-out of planned new development at Portland International Center (PIC), which is located in the downstream portion of Basin 8. See Figure 1 for the estimated 10-year and 100-year storm ponding extents under future development conditions. The ponding creates risks for operations and hazardous wildlife attraction that the Port wants to mitigate.

Factors Potentially Contributing to Issue

Factor	Characterization Basis
Insufficient Drainage System Capacity	Assessments using the Port's stormwater hydraulic model indicate that ponding during the 10-year and 100-year storm events is created by insufficient drainage capacity at the following points in the Basin 8 storm sewer system: • Outfall 008 pipe (due to small size and relatively high elevation that restricts drainage from upstream portions of the system) • Open channels at PIC (due to inconsistent channel bottom slopes that create bowl-like features in the channel bed, which cannot fully drain) • Basin 8 West trunk line (due to small size) • Storm sewer lateral serving NE Airport Way Frontage Road (due to small size)
Columbia Slough Water Levels	Tailwater from the Columbia Slough extends into the drainage system and reduces available drainage capacity.

Recommendations to Further Characterize Issue and Define Need

The following actions are recommended to further characterize the issue before designing and implementing the identified solution(s).

Action	Description
Field Observations During Storm Events	Field observations are recommended in this area to confirm the occurrence of problematic ponding along NE Airport Way Frontage Road prior to implementing SWM Solution 8-C.[1] This may be accomplished by monitoring the area for drainage issues during or following large storm events, or by consulting with staff or tenants that may be familiar with drainage in this area.

Notes:

1. Ponding areas south of NE Airport Way (eastbound), as shown in Figure 1, are addressed by SWM Solution 8-A. SWM Solution 8-C is needed only to address the ponding along NE Airport Way Frontage Road.

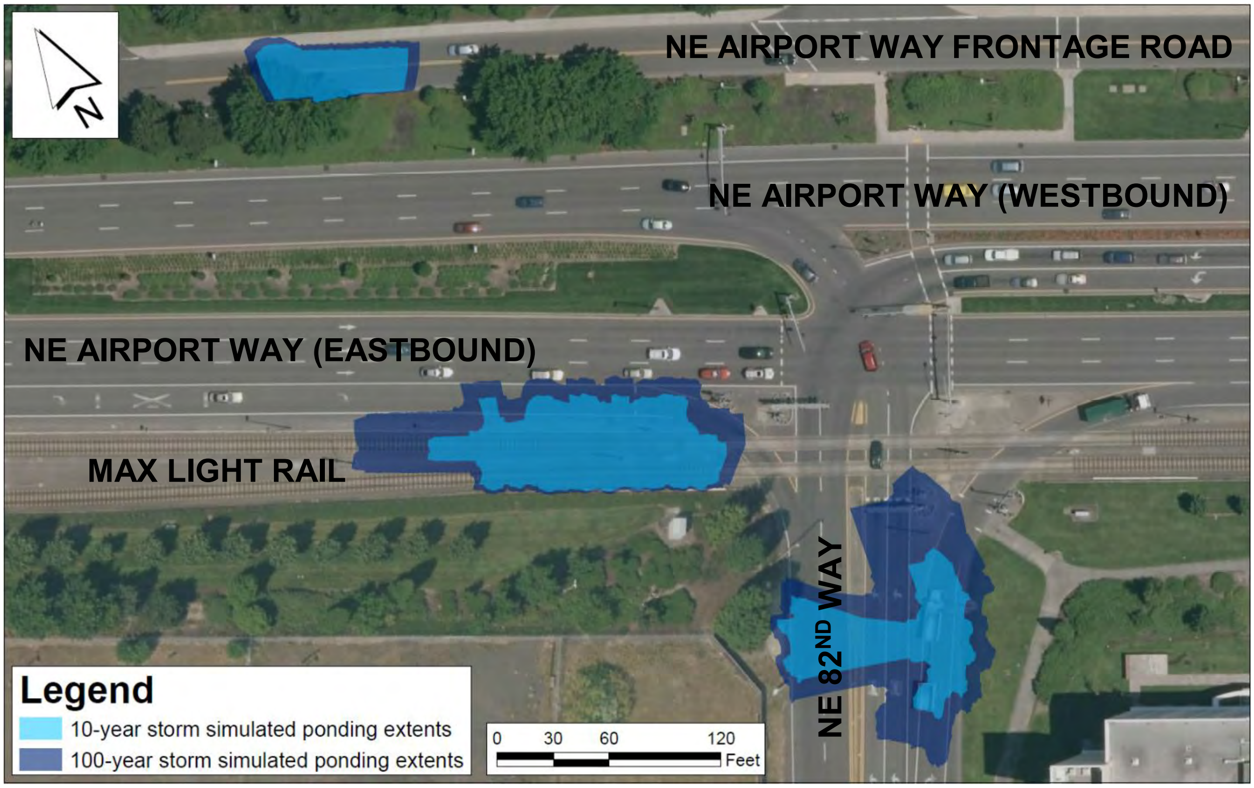


Figure 1: Plan View of Need

Regulatory Drivers for Stormwater Management Need

Driver	Description
FAA Hazardous Wildlife Attractant Criteria (FAA AC 150/5200-33)	Due to its proximity to PDX and location within the FAA 10,000 foot separation area, ponding at this location poses a risk for attracting wildlife into the runways' approach or departure airspace or into the Air Operations Area (AOA). According to FAA AC 150/5200-33, this poses a wildlife strike risk to aircraft.
FAA Airport Drainage Design Criteria (FAA AC 150/5320-5)	Pavement ponding is likely to occur near the intersection of NE Airport Way and NE 82nd Way during both the 10-year and 100-year storm events. Roadways near this location (i.e., NE Airport Way, NE 82nd Way and NE Airport Way Frontage Road) serve as access routes for airport operational vehicles. According to FAA AC 150/5320-5, "the objective of storm drainage design is to provide for safe passage of vehicles or operation of the facility during the design storm event." Therefore, the need to address ponding near the intersection of NE Airport Way and NE 82nd Way is driven by a regulatory need to provide for safe vehicle passage.

Consequence of Not Mitigating Stormwater Management Need

Item	Description
Operations	Failure to address ponding near the intersection of NE Airport Way and NE 82nd Way may compromise the safety of airport operational vehicles (and other vehicles) that travel along NE Airport Way, NE 82nd Way and NE Airport Way Frontage Road during storm events. The ponding may result in damage to passing vehicles or may interfere with airport operations because vehicles, including vehicles belonging to airline passengers, are required to travel via alternate routes.
Wildlife Hazard Management	Standing water in close proximity to the airport poses an increased risk of hazardous wildlife attraction and for wildlife strikes.

Criteria to be Addressed by Stormwater Management Solutions

Item	Description
Flooding of Existing/Future Pavement	Eliminate ponding along NE Airport Way, NE 82nd Way and NE Airport Way Frontage Road during the 10-year storm.
Flooding of Existing/Future Buildings	Not applicable.
Ponding in Unpaved Areas Identified as Critical for Ponding Reduction	Reduce the 10-year storm peak ponding elevation to the lowest known ground elevation.
Asset Management Criteria	Not applicable.
Water Quality Treatment Criteria	Not applicable.

SWM NEED FACT SHEET 8-3

Stormwater Management Need Tracking Information

SWM Need ID	Need Name	Issue Type	Author	Revision Date
8-3	Address Ponding Southeast of North Runway (10L-28R)	Ponding	GS&P	June 2015

Stormwater Management Solutions Identified to Address Need

SWM Solution ID	Solution Name	Solution Type		
		New or Modified Infrastructure	Operational Change	Future Planning Considerations
8-A[1]	Replace Basin 8 Outfall Pipe	X		
8-D[1]	Add Fill and Pipe Storage Southeast of North Runway (10L-28R)	X		

Notes:

1. Both SWM Solution 8-A and SWM Solution 8-D are needed to address SWM Need 8-3.

Issue Characterization

Issue Type	Issue Description
Ponding	Ponding has been regularly observed by Port Natural Resources staff in the grassy area southeast of Runway 10L-28R. Stormwater hydraulic modeling of the Basin 8 drainage system under future (2035) development conditions indicates that the large increase in impervious area at Portland International Center (PIC), in the downstream portion of Basin 8, will exacerbate the ponding currently observed southeast of the runway, giving it potential to reach the elevation of the perimeter road during the 10-year, 24-hour storm event. Ponding will also likely be present in the low-lying grassy area south of the perimeter road, which presents an issue if the Northside Service Center Redevelopment project involves siting pavement or buildings in this area. See Figure 1 for the estimated 10-year and 100-year storm ponding extents under future development conditions, if the current site grading is maintained. The ponding observed and simulated at this location creates risks for development, operations, and hazardous wildlife attraction that the Port wants to mitigate.

Factors Potentially Contributing to Issue

Factor	Characterization Basis
Insufficient Drainage System Capacity	Assessments using the Port's stormwater hydraulic model indicate that ponding during the 10-year and 100-year storm events is created by insufficient drainage capacity at the following points in the Basin 8 storm sewer system: • Outfall 008 pipe (due to small size and relatively high elevation that restricts drainage from upstream portions of the system) • Open channels at PIC (due to inconsistent channel bottom slopes that create bowl-like features in the channel bed, which cannot fully drain) • Basin 8 West trunk line (due to small size)
Potential Grading Inconsistencies or Maintenance Needs	Field observations suggest that some adjacent local areas of ponding may be caused by inconsistent grading and potentially damaged or blocked storm sewer inlets.
Columbia Slough Water Levels	Tailwater from the Columbia Slough extends into the drainage system and reduces available drainage capacity.

Recommendations to Further Characterize Issue and Define Need

The following actions are recommended for further characterizing the issue before designing and implementing the identified solution(s).

Action	Description
Surveying / Field Data Collection	A site walk should occur to check for any inconsistencies in grading. If inconsistencies are observed, site surveying or updated topographic data collection (e.g., Metro LiDAR) is recommended to determine if ponding areas have grading that creates localized pockets for surface storage. Fine grading may be necessary to facilitate drainage, depending on findings.
Inspections / Condition Assessment	Regular catch basin inspection and maintenance is recommended to remove storm sewer grate obstructions such as grass, soil and other debris that may inhibit effective drainage.
Field Observations of Ponding	Site walks are recommended during both wet and dry weather conditions to determine if ponding is observed at this location. If ponding is observed, determine if the ponding is associated with storm events. If observed ponding is not associated with storm events, a field study is recommended to characterize depth to groundwater and potential influence of groundwater on ponding.

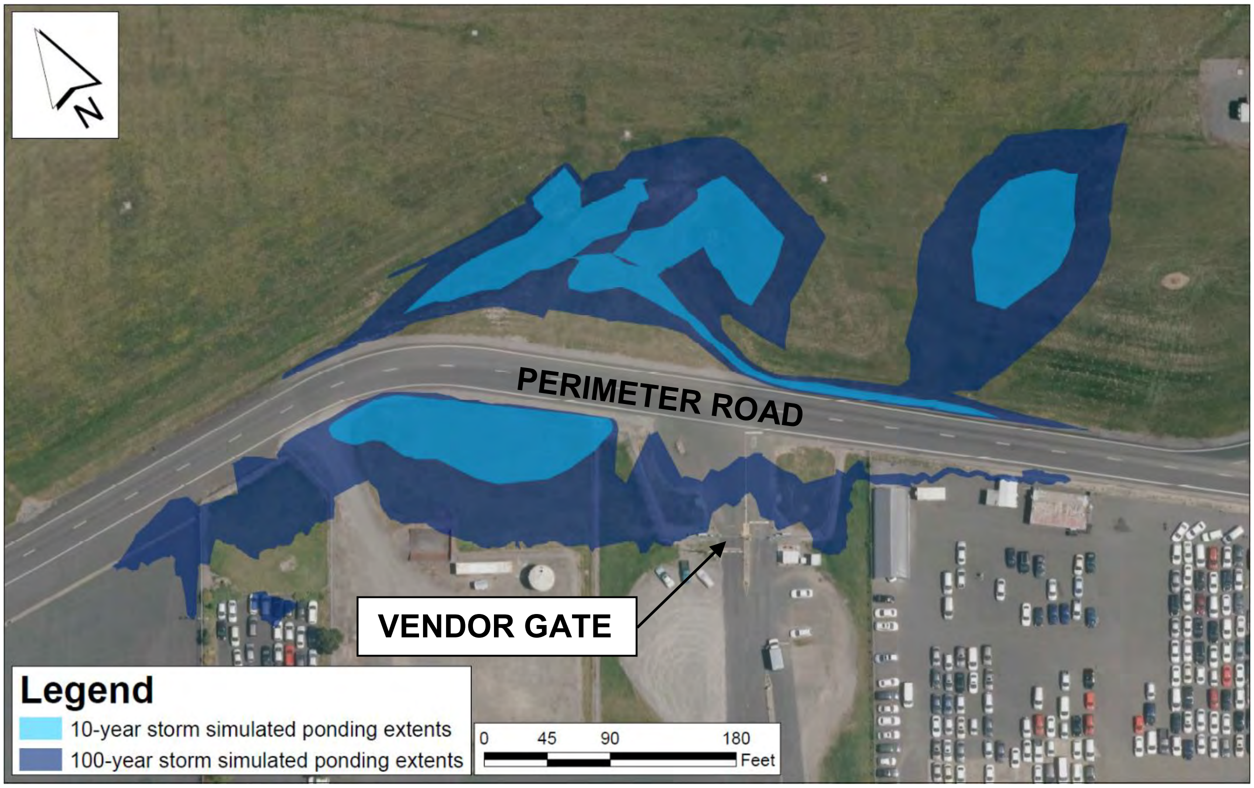


Figure 1: Plan View of Need

Regulatory Drivers for Stormwater Management Need

Driver	Description
FAA Hazardous Wildlife Attractant Criteria (FAA AC 150/5200-33)	Due to its proximity to the runway, ponding at this location may attract wildlife into the runway's approach or departure airspace or into the Air Operations Area (AOA). According to FAA AC 150/5200-33, this poses a wildlife strike risk to aircraft.
FAA Airport Drainage Design Criteria (FAA AC 150/5320-5)	Stormwater hydraulic modeling indicates a potential for ponding onto the perimeter road southeast of Runway 10L-28R after the new PIC development occurs in the downstream portion of Basin 8. This roadway serves as an access route for airport operational vehicles. According to FAA AC 150/5320-5, "the objective of storm drainage design is to provide for safe passage of vehicles or operation of the facility during the design storm event." Therefore, the need to address ponding southeast of Runway 10L-28R is driven by a regulatory need to provide for safe vehicle passage along the perimeter road.

Consequence of Not Mitigating Stormwater Management Need

Item	Description
Operations	Under future (2035) development conditions, ponding southeast of Runway 10L-28R may reach the elevation of the PDX perimeter road during the 10-year storm. Ponding onto the roadway may compromise the safety of airport operational vehicles traveling along the roadway during storm events. The ponding may result in damage to passing vehicles or may interfere with airport operations because vehicles are required to travel via alternate routes.
Wildlife Hazard Management	Standing water near the end of Runway 10L-28R poses an increased risk of hazardous wildlife attraction and for wildlife strikes.
Planning and Development	Ponding south of the perimeter road occurs within the extents of the planned Northside Service Center Redevelopment project. If the existing grade is maintained at the low spot within this development area, new pavement or buildings located south of the perimeter road are at risk of flooding during the 10-year and 100-year storm events.

Criteria to be Addressed by Stormwater Management Solutions

Item	Description
Flooding of Existing / Future Pavement	Eliminate ponding onto the perimeter road and any new pavement constructed as part of the Northside Service Center Redevelopment project during the 10-year storm.
Flooding of Existing / Future Buildings	Eliminate risk of flooding future buildings during the 100-year storm.
Ponding in Unpaved Areas Identified as Critical for Ponding Reduction	Reduce the 10-year storm peak ponding elevation to the lowest known ground elevation.
Asset Management Criteria	Not applicable.
Water Quality Treatment Criteria	Not applicable.

SWM SOLUTION FACT SHEET 8-A

Stormwater Management Solution Tracking Information

SWM Solution ID	Solution Name	Capital Cost Summary	Anticipated Implementation Timeframe	Author	Revision Date
8-A	Replace Basin 8 Outfall Pipe	$1,000,000	2021-2025	GS&P	June 2015

Stormwater Management Needs Addressed by Solution

SWM Need ID	Need Name	Need Type		
		Address Ponding and Facilitate Drainage	Address Risk of Stormwater Asset Failure	Provide Required Stormwater Controls
8-1	Address Ponding in Economy Lots and NE Airport Way Off-Ramp	X		
8-2	Address Ponding Near the Intersection of NE Airport Way and NE 82nd Way	X		
8-3	Address Ponding Southeast of North Runway (10L-28R)	X		

Solution Description

Solution Type	Summary Description
New or Modified Infrastructure	Increase the storm sewer capacity along the existing Basin 8 outfall pipe that connects the open channels at Portland International Center (PIC) to the Columbia Slough. Also reduce the elevation of the outfall pipe to provide more efficient drainage from PDX Drainage Basin 8 to the Columbia Slough.

As shown in Figure 1, the proposed infrastructure upgrades associated with SWM Solution 8-A are located between NE Alderwood Road and the Columbia Slough, near NE 92nd Drive. The existing pipe at this location crosses directly through the intersection of NE Alderwood Road and NE 92nd Drive, falling partially within the roadways owned by the City and partially within a nearby property owned by the Port and leased to Coffee Bean International, Inc. Since this existing pipe is owned by the City, the Port has granted a drainage easement to the City for the portion of the pipe that crosses Port property. The easement follows the existing pipe geometry and extends 15 feet on either side of the pipe. The upstream end of the existing Basin 8 outfall pipe collects drainage from the channels at PIC, and the downstream end discharges Basin 8 stormwater to the Columbia Slough. As part of SWM Solution 8-A, it is recommended that the existing 48-inch pipe at Outfall 008 be abandoned in place and a new, 84-inch pipe be installed to the east. The proposed layout for the new pipe is shown in Figure 1. This layout was selected in an effort to minimize construction impacts to the Coffee Bean International, Inc. warehouse and to NE 92nd Drive. However, the proposed layout does involve some disturbance to pavement in the Port's Employee Parking Lot, and the crossing of NE Alderwood Road was considered unavoidable.

SWM Solution 8-A involves abandoning the existing 48-inch pipes that connect the PIC channel system to the Columbia Slough and installing new 84-inch diameter pipes to the east. It is also recommended that the following manholes along the 48-inch pipeline be abandoned or removed: STSMH3671 and STSMH3663. New manholes will need to be installed along the proposed 84-inch pipeline, particularly at locations where the pipeline direction changes or where major lateral connections are made. The existing manhole at NE Alderwood Road (STSMH8113) should be replaced and used as a tie-in point for the proposed pipe. Invert elevations of the new 84-inch pipes should be approximately 3 feet below the inverts of the existing 48-inch pipes, assuming that this elevation drop is feasible given existing inverts of the PIC channel upstream and the Columbia Slough downstream. Existing 18-inch City-owned pipes tying into the current 48-inch outfall pipe at NE Alderwood Road should be maintained and modified only as necessary to direct drainage toward the proposed 84-inch outfall. The existing 30-inch pipe conveying stormwater drainage from the Port's Employee Parking Lot to Outfall 008 should also be maintained and modified only as necessary to tie into the proposed 84-inch pipeline. Headwalls are assumed at the upstream and downstream ends of the proposed pipe.

The goal of SWM Solution 8-A is to provide additional drainage capacity in the Basin 8 outfall pipe while also decreasing the outfall pipe's invert elevations to promote gravity-induced flow from the Basin 8 storm sewers and PIC channels to the Columbia Slough. This SWM solution addresses two basin-wide root causes of ponding: insufficient drainage capacity in the Basin 8 outfall pipe and the relatively high elevation of the Basin 8 outfall pipe compared to upstream portions of the Basin 8 system. The sizing of the proposed solution is based on planned future development as provided by the Port in August 2014. The SWM solution may need to be refined as development plans for PIC evolve.

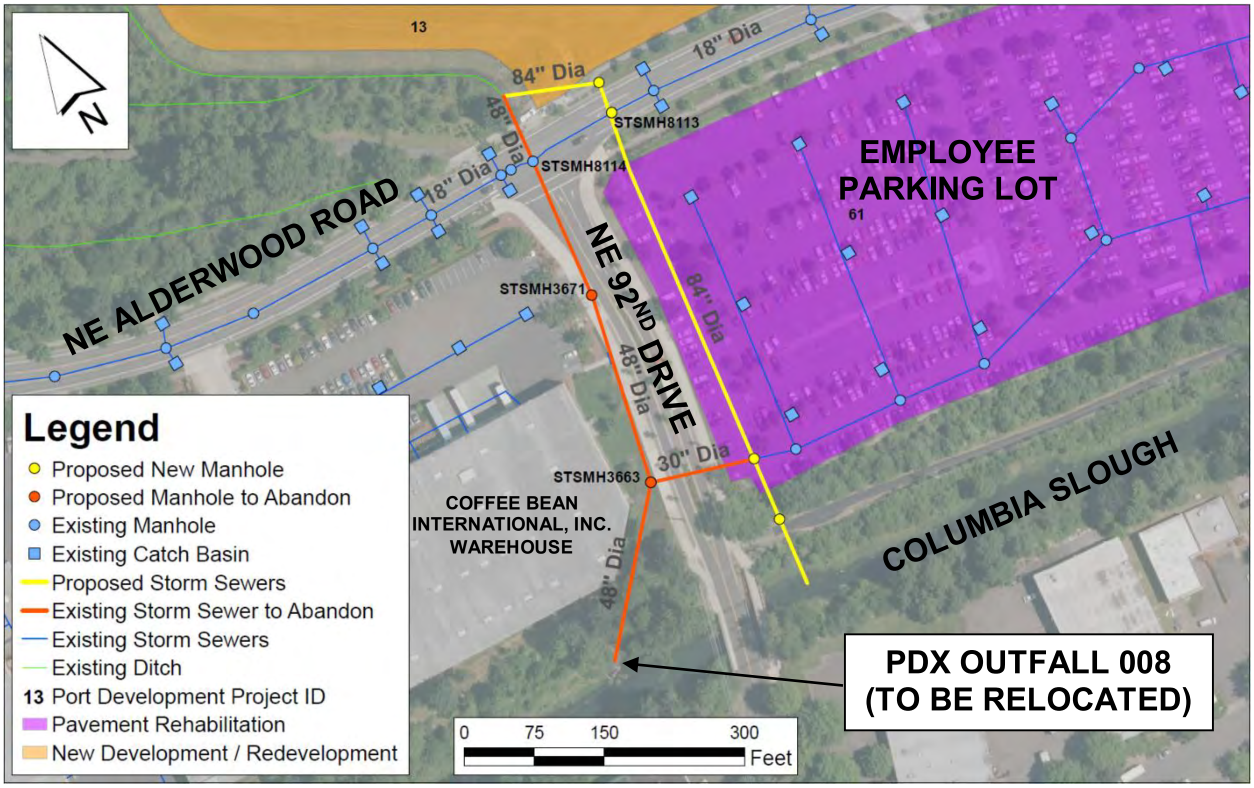


Figure 1: Plan View of Solution

Implementation Considerations

The following tables provide recommended considerations as the project moves from planning concept to implemented solution. The tables below address three phases of implementation, including planning and design, construction, and post-construction.

Planning and Design Considerations

Item	Description
Field Data Collection	• Site surveying is required to determine the feasibility of installing a new outfall pipe with an upstream invert elevation of 9.5 feet NAVD88 at the PIC channels and a downstream invert elevation of 9.0 feet NAVD88 at the Columbia Slough. • Underground utility location • Geotechnical and hydrogeological studies may be needed to support detailed design.
Additional Technical Analysis	If detailed plans or as-constructed drawings for the PIC Ditch Benching project become available, update the Port's stormwater hydraulic model to include the new channel inverts and cross-sections. Modify the sizing and inverts of the proposed Basin 8 outfall pipe as needed to address SWM Needs 8-1, 8-2 and 8-3.
Permitting	• Clean Water Act Section 401/404 permitting • National Marine Fisheries Service (NMFS) consultation • Potential need for National Environmental Policy Act (NEPA) approval • City of Portland Environmental Zones
Siting	• Since the existing alignment of the Basin 8 outfall pipe runs closely between NE 92nd Drive and the Coffee Bean International, Inc. warehouse, it is recommended that the replacement pipe be realigned to the east of the current pipe (as shown in Figure 1) to avoid construction impacts to NE 92nd Drive as well as the nearby warehouse. The proposed pipe realignment would place the new pipe under the Employee Parking Lot east of NE 92nd Drive. • During detailed design, review the SWM solution extents and layout (shown in Figure 1) and adjust as necessary to optimize land use, minimize excavation, avoid utilities and meet setback requirements.
Coordination with Elements of Other Projects	• Coordinate the detailed design of SWM Solution 8-A with the PIC Ditch Benching project, which will also have hydraulic impacts on the Basin 8 storm sewer system. • If possible, coordinate the construction of SWM Solution 8-A with the Employee Parking Lot Bus Route Rehabilitation project to reduce mobilization costs for pavement reconstruction in the Employee Parking Lot after placing the proposed pipes.
Enabling Projects	None identified.

Item	Description
Related Solutions	The effectiveness of SWM Solution 8-A to address ponding associated with SWM Needs 8-1, 8-2 and 8-3 relies on the implementation of SWM Solutions 8-B, 8-C and 8-D, respectively.
Coordination with Port Departments	• Planning and Development - timing of PIC development projects • Engineering - plans for PIC ditch benching • Maintenance - change in catch basins and manholes requiring routine maintenance • Asset Management - removal/abandonment of existing assets, addition of new assets • Wildlife Management - identify significance of current risk, change in future management techniques in area
Coordination with Tenants	Coordinate closure of NE Alderwood Road with tenants leasing nearby parcels and with any other tenants who frequently use the roadway.
Coordination with Outside Agencies	• Since the existing Basin 8 outfall pipe is owned by the City, coordinate with the City to plan for the pipe's abandonment and replacement. • Construction of SWM Solution 8-A will involve an open cut across NE Alderwood Road, which must be coordinated with the City. • SWM Solution 8-A will involve modifications to City-owned storm sewers along NE Alderwood Road, which will need to be coordinated with the City. • Coordinate with the MCDD to obtain detailed design drawings or as-constructed drawings of the PIC Ditch Benching project, which may provide additional storage and treatment for stormwater runoff generated in Basin 8.
Design Disciplines Involved	Civil, Structural, and others as needed to relocate utilities

Construction Considerations

Item	Description
Construction Components	• Realign Basin 8 outfall pipe from existing configuration to minimize construction impacts to NE 92nd Drive. • Install new Basin 8 outfall pipe (84-inch diameter) and associated structures to the east of NE 92nd Drive. • Maintain existing laterals and connect to proposed 84-inch pipe. • Abandon existing 48-inch outfall pipe in Basin 8. Fill abandoned pipes with controlled density fill prior to abandoning to address risk of structural failure. • Abandon or demolish existing manholes along the 48-inch outfall pipe, where appropriate. • Remove and replace the existing security fence around the Employee Parking Lot as needed to install solution. • Demolish and reconstruct portions of the Employee Parking Lot, NE Alderwood Road, adjacent sidewalks, and the bike path along the Columbia Slough. • Protect and/or relocate existing utilities as needed to install solution.
Operational Impacts	• Pipe installation in the Employee Parking Lot may reduce the number of available parking spaces for airport employees and require shuttles serving the parking lot to take alternate routes. • Pipe installation will involve an open cut at NE Alderwood Road, requiring an alternate route for vehicular traffic, including any airport operational vehicles that may frequently travel along NE Alderwood Road near NE 92nd Drive.
Construction Challenges	• Identify contractor laydown area that avoids interference with nearby developments, particularly if SWM Solution 8-A is constructed after the build-out at PIC. • Surface water dewatering will likely be required to allow the replacement of Outfall 008. • Open cut of the bike path adjacent to the Columbia Slough will be required to install solution.

Post-Construction Considerations

Item	Description
Post-Construction Coordination with Airport Operations	None identified.
Considerations for Operation and Maintenance (O&M) of the Solution	No change from current.

Potential Risks if Solution is Implemented / Risk Mitigation Strategies

Item	Description	Mitigation Strategy
Regulatory Compliance	None identified.	Not applicable.
Airport or Tenant Operations	None identified.	Not applicable.
Aircraft Safety	None identified.	Not applicable.
Future Development Limitations	None identified.	Not applicable.

Schedule Analysis

Item	Description
Critical Schedule Drivers	Coordinate appropriate portions of the construction and design with the following development project timeframes, to the extent that the construction and design of the solution can be aligned with these projects:[1] • Project #32: PIC Ditch Benching (2018) • Project #61: Employee Parking Lot Bus Route Rehabilitation (2015) Specific benefits of coordinating with each project listed above are described in the Implementation Considerations section, under Planning and Design Considerations.
Target Construction Timeframe (2016-2020, 2021-2025, 2026-2035)	2021-2025 If portions of SWM Solution 8-A align with the development projects above, those portions could be constructed with the development projects. Otherwise, SWM Solution 8-A should be implemented in advance of the PIC development. The increase in outfall capacity is foundational to the ability to develop the site, so SWM Solution 8-A should be in place prior to any development at PIC. The timeframe above can be adjusted as the understanding of the PIC development timeframe becomes better understood.
Planning and Design Lead Time (<6 months, 6-12 months, 12-24 months)	6-12 months Plan to define permitting and mitigation requirements for outfall reconstruction well before project design starts.

Notes:

1. Project numbers and timeframes are from the Port's list of future development projects (Appendix A).

Cost Analysis

Item	Description
Opinion of Probable Capital Cost (2015 Dollars)[1]	$1,000,000
Cost Estimate Class / Contingency (1-Bid received, 2-Construction, 3-Design, 4-Concept Design, 5- Screening/Planning)	5- Screening/Planning
Fixed Asset Modifications Excluded from Cost Estimate	• Utility relocation costs not included. • Costs to remove or abandon existing manholes and pipe inlet/outlet structures at open channel and Columbia Slough not included. • Costs to replace impacted sidewalks, street lamps, landscaping, etc. along NE Alderwood Road not included. • Costs for replacement fencing around the Employee Parking Lot not included.
Cost Assumptions	• NE Alderwood Road will be open cut to accommodate the pipe installation. • Additional erosion control materials and labor are required for work near open waterways. • Assumes feasibility of connecting the existing manhole STSMH8114 to a new manhole located in the 84-inch pipe alignment, which may result in a slightly adverse pipe slope. Potential impacts to a treatment device located within this manhole have not been evaluated. • Paving trench restoration costs in the Employee Parking Lot are included in the engineer’s opinion of probable cost despite potential coordination with the Employee Parking Lot Bus Route Rehabilitation project. • No additional costs are considered for permitting/construction related dredge/fill of inland waterways, or floodplain issues. • Includes 40% hard cost contingency. • Includes 30% soft cost contingency.
O&M Cost Considerations	No change from current.

Notes:
1. Supporting detailed cost tables are provided in Appendix B.

SWM SOLUTION FACT SHEET 8-B

Stormwater Management Solution Tracking Information

SWM Solution ID	Solution Name	Capital Cost Summary	Anticipated Implementation Timeframe	Author	Revision Date
8-B	Replace Portion of Eastern Basin 8 Trunk Line along NE Airport Way	$810,000	2016-2020	GS&P	June 2015

Stormwater Management Needs Addressed by Solution

SWM Need ID	Need Name	Need Type		
		Address Ponding and Facilitate Drainage	Address Risk of Stormwater Asset Failure	Provide Required Stormwater Controls
8-1	Address Ponding in Economy Lots and NE Airport Way Off-Ramp	X		

Solution Description

Solution Type	Summary Description
New or Modified Infrastructure	Increase the Port's storm sewer capacity along an existing undersized portion of the Basin 8 East trunk line along NE Airport Way to address ponding in the Economy Parking Lot and along the off-ramp to NE Mt Hood Avenue.

As shown in Figure 1, the proposed infrastructure upgrades associated with SWM Solution 8-B are located along NE Airport Way, near the interchange with NE Mt Hood Avenue. The existing pipe at this location lies primarily within the vegetated median between NE Airport Way westbound and the nearby off-ramps to NE Mt Hood Avenue. The existing pipe configuration passes directly beneath a bridge pier supporting the NE Mt Hood Avenue overpass; however, the layout of the proposed solution aims to avoid construction impacts to the bridge by reconfiguring the trunk line layout to pass under the outer lane of NE Airport Way. See Figure 1 for the proposed layout of SWM Solution 8-B.

The solution involves replacement of existing 30-inch pipes along the Basin 8 East trunk line from STSMH3589 to STSMH3677, with a pipe realignment under the NE Mt Hood Avenue overpass to avoid interference with the bridge pier structure. It is recommended that the pipes be replaced with 60-inch pipes for a total new pipe length of about 740 linear feet. The three existing manholes along the existing storm sewers are to be replaced, while four new manholes are proposed to accommodate the pipeline direction changes near the NE Mt Hood Avenue overpass. The catch basins and 10-inch to 12-inch laterals tying into the existing storm sewers between STSMH3589 and STSMH3677 are to be maintained and tied into the proposed pipes and structures. All other existing pipe connections should be maintained.

The goal of SWM Solution 8-B is to provide additional drainage capacity in the Basin 8 storm sewer trunk line along NE Airport Way to address the root cause of ponding in the Economy Blue Lot and on a nearby off-ramp from NE Airport Way westbound (SWM Need 8-1). Although the full length of the Basin 8 East trunk line is undersized, the portion along NE Airport Way is proposed for replacement in an effort to align the implementation of this solution with a planned development project: the Airport Way Rehabilitation. The sizing of the proposed solution is based on planned future development as provided by the Port in August 2014. The solution may need to be refined as development plans evolve.

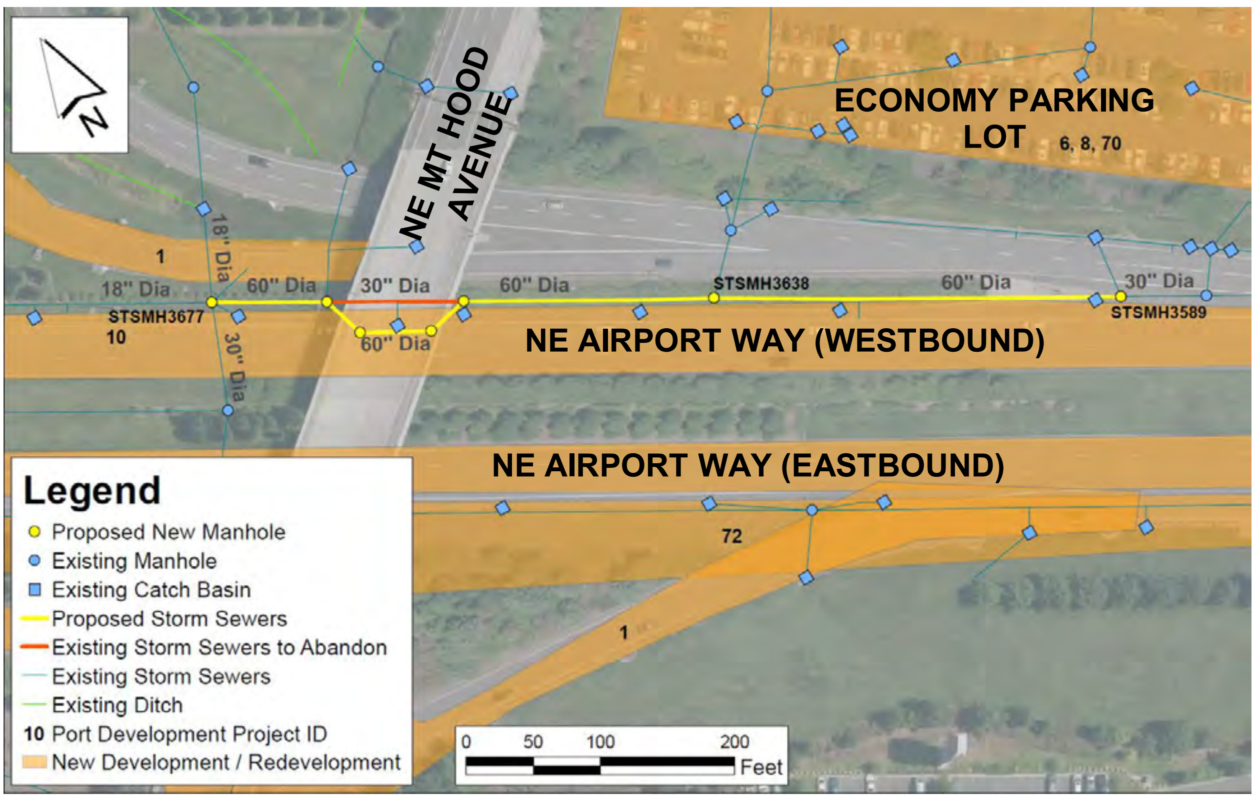


Figure 1: Plan View of Solution

Implementation Considerations

The following tables provide recommended considerations as the project moves from planning concept to implemented solution. The tables below address three phases of implementation, including planning and design, construction, and post-construction.

Planning and Design Considerations

Item	Description
Field Data Collection	• Underground utility location • Geotechnical and hydrogeological studies may be needed to support detailed design, particularly to identify the impacts of SWM Solution 8-B on the foundation zone of influence for the NE Mt Hood Avenue overpass bridge support. • Condition inspection of any existing structures where new pipe connections will be made
Additional Technical Analysis	Identify the impacts of SWM Solution 8-B on the foundation zone of influence for the NE Mt Hood Avenue overpass bridge support.
Permitting	None identified.
Siting	• Since the existing alignment of the Basin 8 East trunk line runs under the NE Mt Hood Avenue overpass bridge pier, it is recommended that the replacement trunk line be partially realigned to the south of the current pipe to minimize impacts to the bridge (as shown in Figure 1). • During detailed design, review the SWM solution extents and layout (shown in Figure 1) and adjust as necessary to optimize land use, minimize excavation, avoid utilities and meet setback requirements.
Coordination with Elements of Other Projects	Coordinate SWM Solution 8-B with the Airport Way Rehabilitation project to minimize net impacts to pavement and traffic.
Enabling Projects	None identified.
Related Solutions	The effectiveness of SWM Solution 8-B to address ponding associated with SWM Need 8-1 relies on the implementation of SWM Solution 8-A.
Coordination with Port Departments	• Planning and Development - Coordinate development plans, Charter and Business Case Development • Engineering - pipe sizing, utility relocation, design coordination • Maintenance - change in catch basins and manholes requiring routine maintenance • Asset Management - removal of existing assets, addition of new assets
Coordination with Tenants	Coordinate lane closures along NE Airport Way with any tenants leasing nearby parcels and with any tenants who frequently use the roadway.

Item	Description
Coordination with Outside Agencies	None identified.
Design Disciplines Involved	Civil, Structural, and others as needed to relocate utilities

Construction Considerations

Item	Description
Construction Components	• Realign storm sewer from existing configuration to minimize construction impacts to the existing bridge pier structure at the NE Mt Hood Avenue overpass. • Demolish existing 30-inch pipes in locations where the new 60-inch pipe will follow the same alignment. • Abandon the existing 30-inch pipe under the NE Mt Hood Avenue bridge pier, and fill with controlled density fill to address risk of structural failure. • Install new 60-inch pipes and associated structures to replace existing 30-inch pipes. • Maintain existing catch basins and storm sewer laterals, and connect to proposed 60-inch pipe. • Demolish and reconstruct NE Airport Way westbound as needed to install solution. • Protect and/or relocate existing utilities as needed to install solution.
Airport Operational Impacts	• Pipe installation will involve temporarily reducing the number of lanes along NE Airport Way westbound. Traffic congestion along this main access road to the Terminal Building may impact airport operations. Alternate routes for airport operational vehicles may need to be established.
Construction Challenges	• Identify contractor laydown area that avoids or minimizes interference with nearby developments. • Height restrictions associated with work under the NE Mt Hood Avenue overpass may require smaller construction equipment, which would increase costs. • Solution alignment is intended to minimize impacts to the bridge pier structure at NE Mt Hood Avenue. • The proposed sewer crosses into westbound lanes of NE Airport Way. Traffic control will be required if not coordinated with the Airport Way Rehabilitation project.

Post-Construction Considerations

Item	Description
Post-Construction Coordination with Airport Operations	None identified.
Considerations for Operation and Maintenance (O&M) of the Solution	No change from current.

Potential Risks if Solution is Implemented / Risk Mitigation Strategies

Item	Description	Mitigation Strategy
Regulatory Compliance	None identified.	Not applicable.
Airport or Tenant Operations	None identified.	Not applicable.
Aircraft Safety	None identified.	Not applicable.
Future Development Limitations	None identified.	Not applicable.

Schedule Analysis

Item	Description
Critical Schedule Drivers	Coordinate the construction with the following development project timeframe, to the extent that the construction of the solution can be aligned with construction of this project:[1] • Project #10: Airport Way Rehabilitation (2017) Specific benefits of coordinating with this project are described in the Implementation Considerations section, under Planning and Design Considerations.
Target Construction Timeframe (2016-2020, 2021-2025, 2026-2035)	2016-2020 Timeframe selected based on the timing of the Airport Way Rehabilitation project. Based on timing of that project, the planning and design work for SWM Solution 8-B should commence in the near future.
Planning and Design Lead Time (<6 months, 6-12 months, 12-24 months)	< 6 months

Notes:
1. Project numbers and timeframes are from the Port's list of future development projects (Appendix A).

Cost Analysis

Item	Description
Opinion of Probable Capital Cost (2015 Dollars)[1]	$810,000
Cost Estimate Class / Contingency (1-Bid received, 2-Construction, 3-Design, 4-Concept Design, 5- Screening/Planning)	5- Screening/Planning
Fixed Asset Modifications Excluded from Cost Estimate	• Utility relocation costs not included. • Costs to remove and replace specialty landscaping features (i.e., trees and shrubs) not included. • Costs for roadway signage removal and replacement not included.
Cost Assumptions	• Pipe realignment into NE Airport Way westbound is necessary to avoid conflicts with the nearby bridge pier structure. • Pavement restoration is necessary for immediate roadway service. • Includes 40% for hard cost contingency. • Includes 30% for soft cost contingency.
O&M Cost Considerations	No change from current.

Notes:

1. Supporting detailed cost tables are provided in Appendix B.

SWM SOLUTION FACT SHEET 8-C

Stormwater Management Solution Tracking Information

SWM Solution ID	Solution Name	Capital Cost Summary	Anticipated Implementation Timeframe	Author	Revision Date
8-C	Replace Pipe along NE Airport Way Frontage Road in Northwest Basin 8	$110,000	2016-2020	GS&P	June 2015

Stormwater Management Needs Addressed by Solution

SWM Need ID	Need Name	Need Type		
		Address Ponding and Facilitate Drainage	Address Risk of Stormwater Asset Failure	Provide Required Stormwater Controls
8-2	Address Ponding Near the Intersection of NE Airport Way and NE 82nd Way	X		

Solution Description

Solution Type	Summary Description
New or Modified Infrastructure	Increase the Port's storm sewer capacity along the existing undersized lateral serving NE Airport Way Frontage Road.

As shown in Figure 1, the proposed infrastructure upgrades associated with SWM Solution 8-C are located in the median between NE Airport Way westbound and NE Airport Way Frontage Road in Basin 8. The pipes proposed for replacement are situated between the PDX Air Cargo Buildings north of NE Airport Way Frontage Road and the Embassy Suites at PDX, which is located south of NE Airport Way. Overall, the pipe replacement affects a relatively short segment of the Basin 8 storm sewers, with only about 225 linear feet of proposed pipeline replacement.

SWM Solution 8-C involves replacement of existing 12-inch pipes with 18-inch pipes, as shown in Figure 1. Replacement of these pipes will require that one existing manhole be demolished and replaced, while two new manholes are constructed, one at each end of the proposed pipeline replacement. The existing catch basins and 8-inch to 10-inch laterals tying into the storm sewers are to be maintained and tied into the proposed piping. The existing 15-inch pipes upstream and downstream of the solution location should also be maintained and tied into the new manholes at either end of the pipe replacement.

The goal of SWM Solution 8-C is to provide additional drainage capacity in the Basin 8 storm sewer lateral serving NE Airport Way Frontage Road, west of the Basin 8 West trunk line. This solution aims to address the undersized nature of the existing lateral along NE Airport Way Frontage Road, which has been identified as a local contributor to stormwater-related ponding on the roadway (SWM Need 8-2). Although a major root cause of ponding at this location is the undersized Basin 8 West trunk line, this localized solution is recommended to better align with the planned future development in Basin 8. The sizing of the proposed solution is based upon planned future development as provided by the Port in August 2014. The solution may need to be refined as development projects evolve.

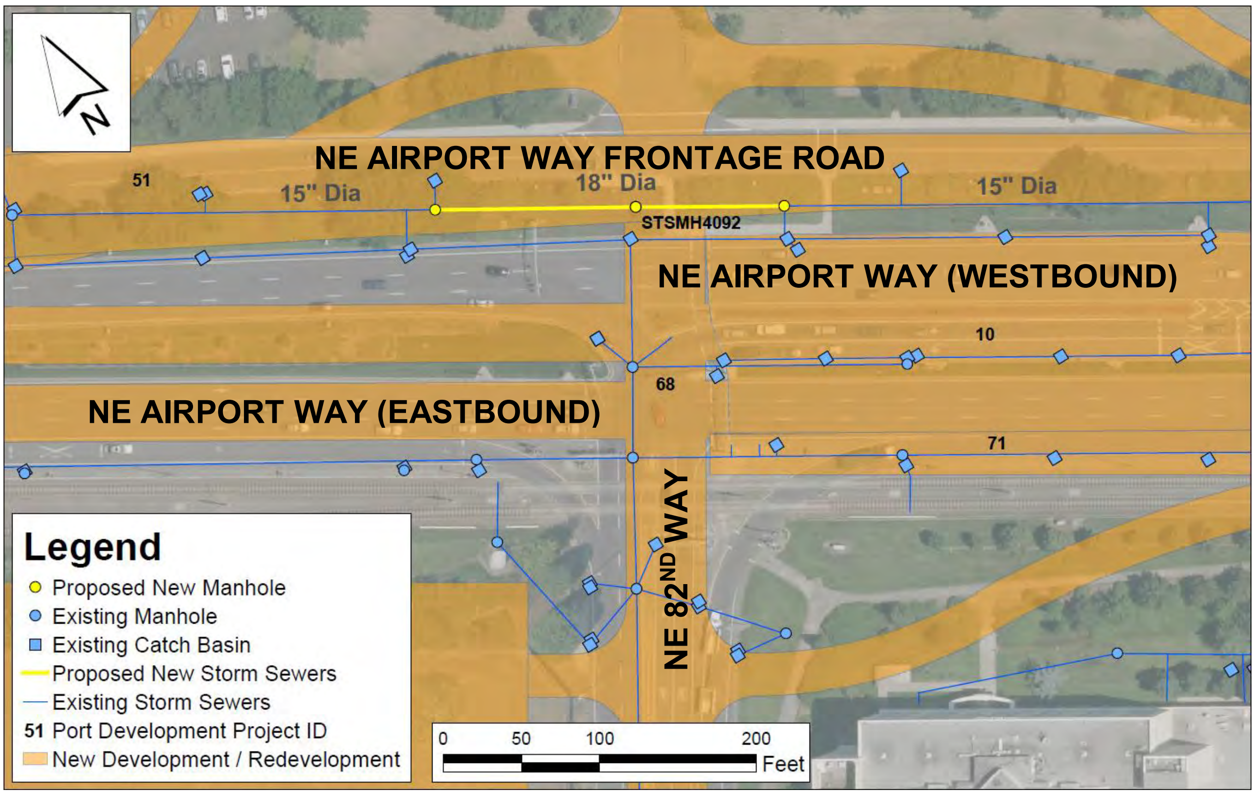


Figure 1: Plan View of Solution

Implementation Considerations

The following tables provide recommended considerations as the project moves from planning concept to implemented solution. The tables below address three phases of implementation, including planning and design, construction, and post-construction.

Planning and Design Considerations

Item	Description
Field Data Collection	• Underground utility location • Geotechnical and hydrogeological studies may be needed to support detailed design. • Condition inspection of any existing structures where new pipe connections will be made
Additional Technical Analysis	None identified.
Permitting	None identified.
Siting	During detailed design, review the SWM solution extents and layout (as shown in Figure 1) and adjust as necessary to optimize land use, minimize excavation, avoid utilities, and meet setback requirements.
Coordination with Elements of Other Projects	Coordinate SWM Solution 8-C with the Airport Way Rehabilitation project or the North Frontage Road Reconstruction project to minimize the net duration of lane closures along these roadways.
Enabling Projects	None identified.
Related Solutions	The effectiveness of SWM Solution 8-C to address ponding associated with SWM Need 8-2 relies on the implementation of SWM Solution 8-A.
Coordination with Port Departments	• Planning and Development - Coordinate development plans, Charter and Business Case Development • Engineering - pipe sizing, utility relocation, design coordination • Maintenance - change in catch basins and manholes requiring routine maintenance • Asset Management - removal of existing assets, addition of new assets
Coordination with Tenants	Coordinate potential lane closures along NE Airport Way westbound and NE Airport Way Frontage Road with tenants leasing parcels near the roadways and with any tenants who frequently use the impacted road(s).
Coordination with Outside Agencies	None identified.
Design Disciplines Involved	Civil, Structural, and others as needed to relocate utilities

Construction Considerations

Item	Description
Construction Components	• Demolish existing 12-inch pipes and associated structures. • Replace the existing pipes with 18-inch pipes, and install associated structures, where necessary. • Maintain existing sewer laterals and catch basins, and connect to proposed pipes. • Maintain existing 15-inch storm sewer pipes at the upstream and downstream ends of the proposed pipe replacement. • Protect and/or relocate existing utilities as needed to install solution.
Airport Operational Impacts	• Pipe installation may involve temporarily reducing the number of lanes along NE Airport Way westbound or NE Airport Way Frontage Road. Traffic congestion along these access roads may impact airport operations. Alternate routes for airport operational vehicles may need to be established.
Construction Challenges	• Identify contractor laydown area that avoids interference with nearby developments. Since the construction site and staging areas are limited in size, traffic control may be required if additional space in the travel lanes is needed. • SWM Solution 8-C is in close proximity to a traffic signal or sign structure. Temporary support for the structure will likely need to be addressed during construction.

Post-Construction Considerations

Item	Description
Post-Construction Coordination with Airport Operations	None identified.
Considerations for Operation and Maintenance (O&M) of the Solution	No change from current.

Potential Risks if Solution is Implemented / Risk Mitigation Strategies

Item	Description	Mitigation Strategy
Regulatory Compliance	None identified.	Not applicable.
Airport or Tenant Operations	None identified.	Not applicable.
Aircraft Safety	None identified.	Not applicable.
Future Development Limitations	None identified.	Not applicable.

Schedule Analysis

Item	Description
Critical Schedule Drivers	Coordinate the construction with the following development project timeframes, to the extent that the construction of the solution can be aligned with construction of these projects:[1] • Project #10: Airport Way Rehabilitation project (2017) • Project #51: North Frontage Road Reconstruction project (2020) Specific benefits of coordinating with each project listed above are described in the Implementation Considerations section, under Planning and Design Considerations.
Target Construction Timeframe (2016-2020, 2021-2025, 2026-2035)	2016-2020 Timeframe selected to align with the timeframes of development projects listed above.
Planning and Design Lead Time (<6 months, 6-12 months, 12-24 months)	< 6 months

Notes:

1. Project numbers and timeframes are from the Port's list of future development projects (Appendix A).

Cost Analysis

Item	Description
Opinion of Probable Capital Cost (2015 Dollars)[1]	$110,000
Cost Estimate Class / Contingency (1-Bid received, 2-Construction, 3-Design, 4-Concept Design, 5- Screening/Planning)	5- Screening/Planning
Fixed Asset Modifications Excluded from Cost Estimate	• Utility relocation costs not included. • Costs to remove and replace specialty landscaping features (i.e., trees and shrubs) not included. • Costs for roadway signage replacement not included.
Cost Assumptions	• No traffic control is needed for work in the median between NE Airport Way and NE Airport Way Frontage Road. • Includes 40% for hard cost contingency. • Includes 30% for soft cost contingency.
O&M Cost Considerations	No change from current.

Notes:
1. Supporting detailed cost tables are provided in Appendix B.

SWM SOLUTION FACT SHEET 8-D

Stormwater Management Solution Tracking Information

SWM Solution ID	Solution Name	Capital Cost Summary	Anticipated Implementation Timeframe	Author	Revision Date
8-D	Add Fill and Pipe Storage Southeast of North Runway (10L-28R)	$330,000	2021-2025	GS&P	June 2015

Stormwater Management Needs Addressed by Solution

SWM Need ID	Need Name	Need Type		
		Address Ponding and Facilitate Drainage	Address Risk of Stormwater Asset Failure	Provide Required Stormwater Controls
8-3	Address Ponding Southeast of North Runway (10L-28R)	X		

Solution Description

Solution Type	Summary Description
New or Modified Infrastructure	Increase the Port's storm sewer capacity in pipes southeast of Runway 10L-28R to provide local storage, and add fill between the Runway 10L-28R safety area (RSA) and the perimeter road to increase the grade at this location.

As shown in Figure 1, SWM Solution 8-D is located southeast of Runway 10L-28R. The SWM solution includes various recommendations for locations south of the Runway 10L-28R RSA and north of the current (2015) rental car facilities along NE Airport Way. The SWM solution involves adding fill in the Air Operations Area (AOA) between the Runway 10L-28R RSA and the perimeter road, in the low-lying area southeast of the runway. As shown in Figure 1, infrastructure improvements are also recommended at this location. The proposed infrastructure crosses the perimeter road, ending just inside the AOA fence line near the North Vendor Gate. Finally, future development recommendations associated with SWM Solution 8-D apply to the Northside Service Center Redevelopment project, which is planned for an area on both sides of the North Vendor Gate Access Road, south of the perimeter road.

The goal of SWM Solution 8-D is to reduce the risk of ponding southeast of Runway 10L-28R by:

- Adding fill to raise the existing grade in the AOA between the RSA and the perimeter road, as shown in Figure 1;
- Increasing local pipe sizes in the AOA to provide local storage; and,
- Considering minimum grade recommendations for future development to occur between the perimeter road and NE Airport Way, near the current (2015) rental car facilities.

Although SWM Solution 8-D does not address all root causes of ponding at this location, it was selected in an effort to align with the areas where future development is planned and where pavement disturbances can be minimized. The solution also addresses a localized root cause of ponding associated with SWM Need 8-3: inconsistent surface grading. The solution involves adding an estimated 3600 cubic yards of fill to the low-lying area between the Runway 10L-28R RSA and the perimeter road; the approximate fill and grading area is shown in Figure 1. When the fill is placed, it is recommended that a low area (with a minimum elevation of 19 feet NAVD88) be established approximately 65 feet north of the perimeter road, parallel to the roadway. This low area will serve as a concentration point for overland stormwater flows. Grading to the proposed low area, from both the RSA and the edge of the perimeter road, is recommended to have a slope of approximately 1.5%, with potential to reach approximately 2.0% between the low area and the RSA.

Infrastructure improvements to occur near this location will provide local stormwater storage and involve replacing the existing 8-inch to 12-inch pipes near the fill area with 24-inch pipes. It is recommended that the Port abandon the existing 16-inch pipe within the fill area. All catch basin grates and manhole rims impacted by the grade changes described above should be adjusted to match the proposed grade, and additional catch basins should be added as necessary to promote efficient flow from the newly designated low area into the Port's storm sewer system. All grading and infrastructure recommendations proposed as part of SWM Solution 8-D occur within the AOA fence line.

The future planning considerations included in SWM Solution 8-D are applicable outside the AOA fence line. Under existing conditions, the low-lying area within the Northside Service Center Redevelopment project site is mostly vegetated and lies directly south of the perimeter road, west of the North Vendor Gate Access Road. If the low-lying area at the Northside Service Center Redevelopment project site remains vegetated under future conditions, no action is required to meet ponding objectives unless the area is deemed high risk for hazardous wildlife attraction. However, if redevelopment occurs near this ponding area (shown in Figure 1 of the fact sheet for SWM Need 8-3) and buildings or pavement are placed at this location, the existing grade should be raised to reduce the risk of pavement flooding during the 10-year storm and building flooding during the 100-year storm. If the low area is to be paved, stormwater hydraulic modeling indicates that a minimum pavement grade of 20 feet NAVD88 be established. Any buildings constructed near the ponding location should have a minimum first floor elevation of 23 feet NAVD88 to address the risk of building flooding during the 100-year storm.

All recommendations associated with SWM Solution 8-D are based upon planned future development as provided by the Port in August 2014. The solution may need to be refined as development plans evolve.

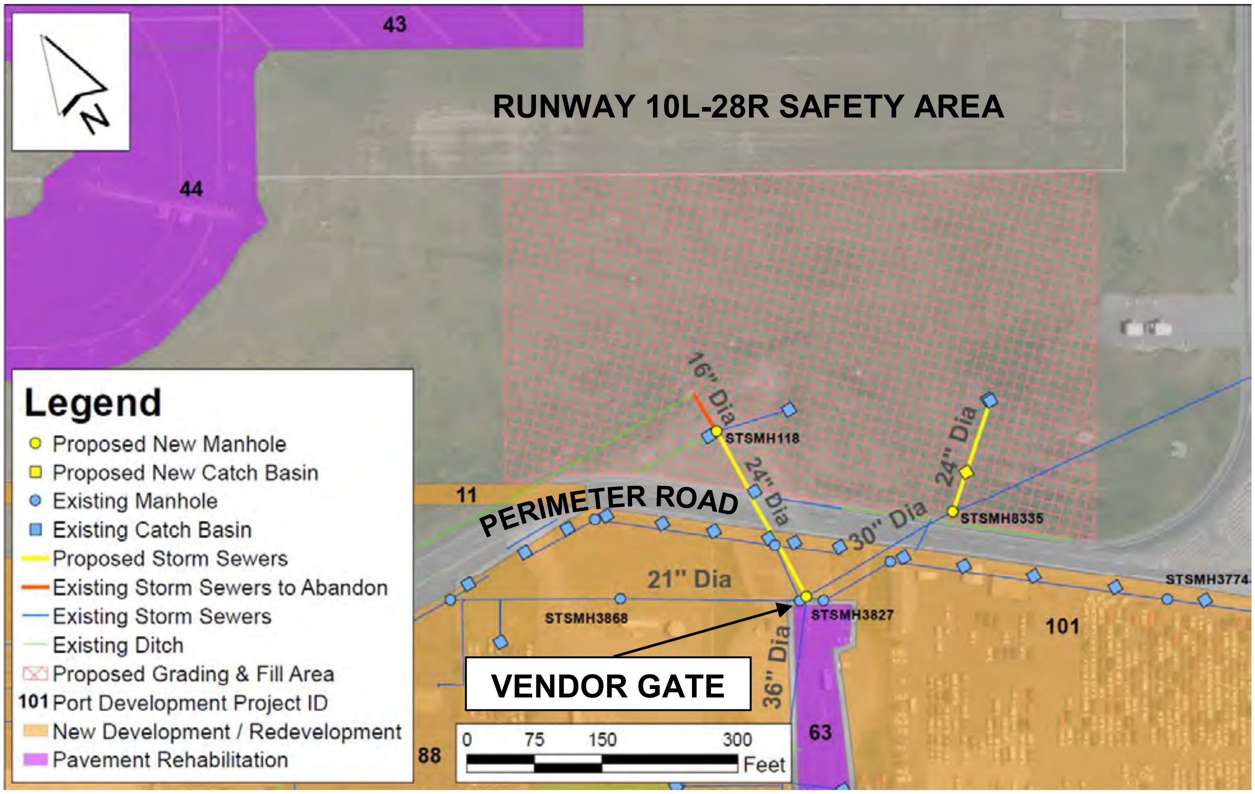


Figure 1: Plan View of Solution

Implementation Considerations

The following tables provide recommended considerations as the project moves from planning concept to implemented solution. The tables below address three phases of implementation, including planning and design, construction, and post-construction.

Planning and Design Considerations

Item	Description
Field Data Collection	• Underground utility location • Geotechnical and hydrogeological studies may be needed to support detailed design. • Condition inspection of any existing structures where new pipe connections will be made
Additional Technical Analysis	Update the PDX stormwater hydraulic model to incorporate the proposed development associated with the Northside Service Center Redevelopment project, and verify that the proposed grading and infrastructure are appropriate to address the risk of unacceptable ponding, particularly within the development project extents.
Permitting	None identified.
Siting	During detailed design, review the SWM solution extents and layout (shown in Figure 1) and adjust as necessary to optimize land use, minimize excavation, avoid utilities, meet setback requirements, and avoid interference with airport operations.
Coordination with Elements of Other Projects	• Coordinate SWM Solution 8-D with the Northside Service Center Redevelopment project to incorporate minimum grade recommendations where necessary and to install recommended infrastructure that falls within the development project site. • Coordinate with the PrimeView Taxiway Y and Perimeter Road project to reduce equipment mobilization costs and integrate the grading plans for both projects. • Coordinate with the North Runway Rehabilitation project to reduce the net duration of runway closure time and reduce the overall impact to airport operations.
Enabling Projects	None identified.
Related Solutions	The effectiveness of SWM Solution 8-D to address ponding associated with SWM Need 8-3 relies on the implementation of SWM Solution 8-A.

Item	Description
Coordination with Port Departments	• Planning and Development - Charter and Business Case Development • Engineering - pipe sizing, utility relocation, design coordination • Operations - temporary closure of taxiway and runway as necessary • Maintenance - change in catch basins and manholes requiring routine maintenance • Asset Management - removal of existing assets, addition of new assets • Wildlife Management - change in future management techniques in area
Coordination with Tenants	• Coordinate closure of the perimeter road with tenants using the road. • Coordinate closure of the North Vendor Gate with tenants using the gate. • Coordinate any need for a temporary closure of Runway 10L-28R with airlines.
Coordination with Outside Agencies	Coordinate with FAA regarding runway closures, as well as potential impacts to FAA communication and electrical utilities as a result of earthwork near the east end of the runway.
Design Disciplines Involved	Civil, Structural, and others as needed to relocate utilities

Construction Considerations

Item	Description
Construction Components	• Demolish existing 8-inch to 12-inch pipes (and associated structures) draining the vegetated area southeast of Runway 10L-28R, and replace with 24-inch pipes and associated structures. • The existing 16-inch pipe draining this area is to be abandoned and filled with controlled density fill. • Add fill between the perimeter road and the Runway 10L-28R RSA to create a road-side low area about 65 feet from the perimeter road and parallel to the roadway. Between the low area and the RSA, create a proposed grade of approximately 1.5% to 2.0%. From the low area to the perimeter road, create a grade of approximately 1.5%, sloping up to the roadway edge. • Maintain existing storm sewer laterals, and connect to proposed pipes. • Maintain all existing catch basins, but modify the catch basin grate elevations to match the proposed grade. • Install new catch basins as necessary to collect drainage from the low area parallel to the perimeter road, which should be created as part of this solution. • Demolish and reconstruct the perimeter road as needed to install solution. • Protect and/or relocate existing utilities as needed to install solution.
Airport Operational Impacts	• Construction near the Runway 10L-28R RSA and in the Runway Object Free Area (ROFA) may require temporary runway closure. • Pipe installation will involve open cut of the perimeter road, requiring the Port to designate an alternate route for vehicular traffic. • Replacement of pipes and manholes near the North Vendor Gate may impact vendors’ access to the AOA. An alternate AOA access point may need to be established for vendors.
Construction Challenges	• Earthwork within the ROFA and any work performed in the RSA will need to be performed in accordance with FAA requirements. • Identify contractor laydown area that avoids interference with airport operations. • Coordination with the Transportation Security Administration (TSA) may be required if construction activities impact the AOA security fence and North Vendor Gate.

Post-Construction Considerations

Item	Description
Post-Construction Coordination with Airport Operations	None identified.
Considerations for Operation and Maintenance (O&M) of the Solution	No change from current.

Potential Risks if Solution is Implemented / Risk Mitigation Strategies

Item	Description	Mitigation Strategy
Regulatory Compliance	None identified.	Not applicable.
Airport or Tenant Operations	None identified.	Not applicable.
Aircraft Safety	None identified.	Not applicable.
Future Development Limitations	None identified.	Not applicable.

Schedule Analysis

Item	Description
Critical Schedule Drivers	Coordinate the construction with the following development project timeframes, to the extent that the construction of the solution can be aligned with construction of these projects:[1] • Project #11: PrimeView Taxiway Y and Perimeter Road (unknown timeframe) • Project #43: North Runway Rehabilitation (2024) • Project #101: Northside Service Center Redevelopment (unknown timeframe) Specific benefits of coordinating with each project listed above are described in the Implementation Considerations section, under Planning and Design Considerations.
Target Construction Timeframe (2016-2020, 2021-2025, 2026-2035)	2021-2025 Timeframe based on coordination with the above development projects.
Planning and Design Lead Time (<6 months, 6-12 months, 12-24 months)	< 6 months

Notes:

1. Project numbers and timeframes are from the Port's list of future development projects (Appendix A).

Cost Analysis

Item	Description
Opinion of Probable Capital Cost (2015 Dollars)[1]	$330,000
Cost Estimate Class / Contingency (1-Bid received, 2-Construction, 3-Design, 4-Concept Design, 5- Screening/Planning)	5- Screening/Planning
Fixed Asset Modifications Excluded from Cost Estimate	Utility relocation costs not included.
Cost Assumptions	• The perimeter road will be open cut to allow for pipe installation, and no significant traffic control costs will be incurred. • Assumed no physical impacts to the AOA access gate located near Building #9297 and no impacts to the gate mechanism. • Assumed that fill material can be obtained from Port-owned stockpiles, and no fill material costs will be incurred. • Includes 40% for hard cost contingency. • Includes 30% for soft cost contingency.
O&M Cost Considerations	No change from current.

Notes:
1. Supporting detailed cost tables are provided in Appendix B.

SWM SOLUTION FACT SHEET 8-E

Stormwater Management Solution Tracking Information

SWM Solution ID	Solution Name	Capital Cost Summary	Anticipated Implementation Timeframe	Author	Revision Date
8-E	Provide Regional Water Quality Treatment for BMP Strategy Area (BMP SA)-8.1	$4,400,000	2016-2020	GS&P and Geosyntec	June 2015

Stormwater Management Needs Addressed by Solution

SWM Need ID	Need Name	Need Type		
		Address Ponding and Facilitate Drainage	Address Risk of Stormwater Asset Failure	Provide Required Stormwater Controls
0-1	Post-Construction Stormwater Pollutant and Runoff Control			X

Development projects planned by the Port will trigger stormwater quality treatment requirements of the MS4 permit as outlined in the Port of Portland Stormwater Design Standards Manual (DSM) and described in SWM Need Fact Sheet 0-1. The proposed solution addresses the need to provide treatment for future development projects in this BMP Strategy Area (BMP SA-8.1), as summarized in the table below. The subsequent table provides a summary of the BMP sizing requirements, as calculated based on DSM criteria. Some of the future development projects lie outside the current boundary of DSM applicability and may need to follow the City of Portland's Stormwater Management Manual, namely Project #98.

Future Development Projects Treated by BMP

Project # [1]	Drainage Basin	Planned Development / Redevelopment Project Name	Acres Treated by BMP
11 [2]	8	DD - PrimeView Taxiway Y & Perimeter Road	0.6
31 [2]	8	P4 Garage	1.6
51 [2]	8	North Frontage Road	3.7
68	8	MP Intersection of NE 82nd Way & Airport Way	8.2
71 [2]	8	Widen Airport Way Outbound East of 82nd	1.9
88	8	DD-GA East Redevelopment	12.4
98 [2]	8	Portland International Center (PIC) Portland Development Commission (PDC) Lots Development	1.4
101	8	Northside Service Center Redevelopment	30.6
Total Acres of Development Treated			60.4

Notes:

1. Project numbers correspond to future development areas displayed on Figure 1, and included in the Port's list of future development projects (Appendix A).
2. Project crosses into an adjacent BMP Strategy Area. Acreage reflects portion in this BMP Strategy Area.

Water Quality Treatment BMP Sizing Basis

Area to be Treated	Impervious Acres to be Treated	Annual Runoff Volume (ac-ft)	WQ Design Flow Rate (cfs)	WQ Design Volume (ac-ft) [3]
Planned Development/Redevelopment Area Only	60.4	144.3	5.1 [1] 2.7 [2]	1.3
Entire BMP Strategy Area [4]	105.1	253.1	8.9	2.3

Notes:

1. For lift station, based on a 0.1 in/hr design intensity, per DSM requirements for offline flow-based BMPs.
2. For cartridge filter, based on a discharge from the detention system of 6 hours drain time
3. For underground detention, based on 0.31 inch design depth, per DSM requirements for volume-based BMPs with 12-hr drawdown time.
4. Provided for planning purposes only. BMP sizing and costs based on Planned Development / Redevelopment Area Only.

Solution Description

Solution Type	Summary Description
New or Modified Infrastructure	Lift station, force main, and subsurface detention with cartridge filter.

Figure 1 depicts the BMP Strategy Area with the planned future development projects and proposed BMP location. Figure 2 shows the BMP footprint, existing storm sewer, new diversion structures, and lift station. The proposed project will divert runoff from STSMH3891 and STSMH3898 to a lift station. A force main from the lift station will route runoff to an underground detention storage followed by a cartridge filter unit vault (or similar) for final treatment and polishing. Runoff will then be returned to the storm sewer trunk line via gravity flow at a new manhole down gradient of STSMH3903.

While a variety of alternative treatment solutions are possible at this location that could meet the Port's treatment requirements, the proposed solution was selected to provide treatment for multiple pollutants while minimizing potential wildlife attractants and interactions with groundwater. A potential alternative solution for this Strategy Area would be to construct a subsurface flow (SSF) wetland immediately downstream of the outfall PIC channel. This alternative would eliminate the need for a pump station and the cartridge filter could be replaced by a pretreatment forebay. However, this alternative would require filling in a portion of the ditch which may require additional permitting and wetland mitigation.

Figure 3 illustrates a cross section of the proposed solution. Assuming treatment would only be provided for the planned development/redevelopment area only, the lift station and cartridge filters were preliminarily sized using the water quality design flow rate and the underground detention was preliminary sized using the water quality design volume assuming 3-foot diameter HDPE pipe would be used for storage.

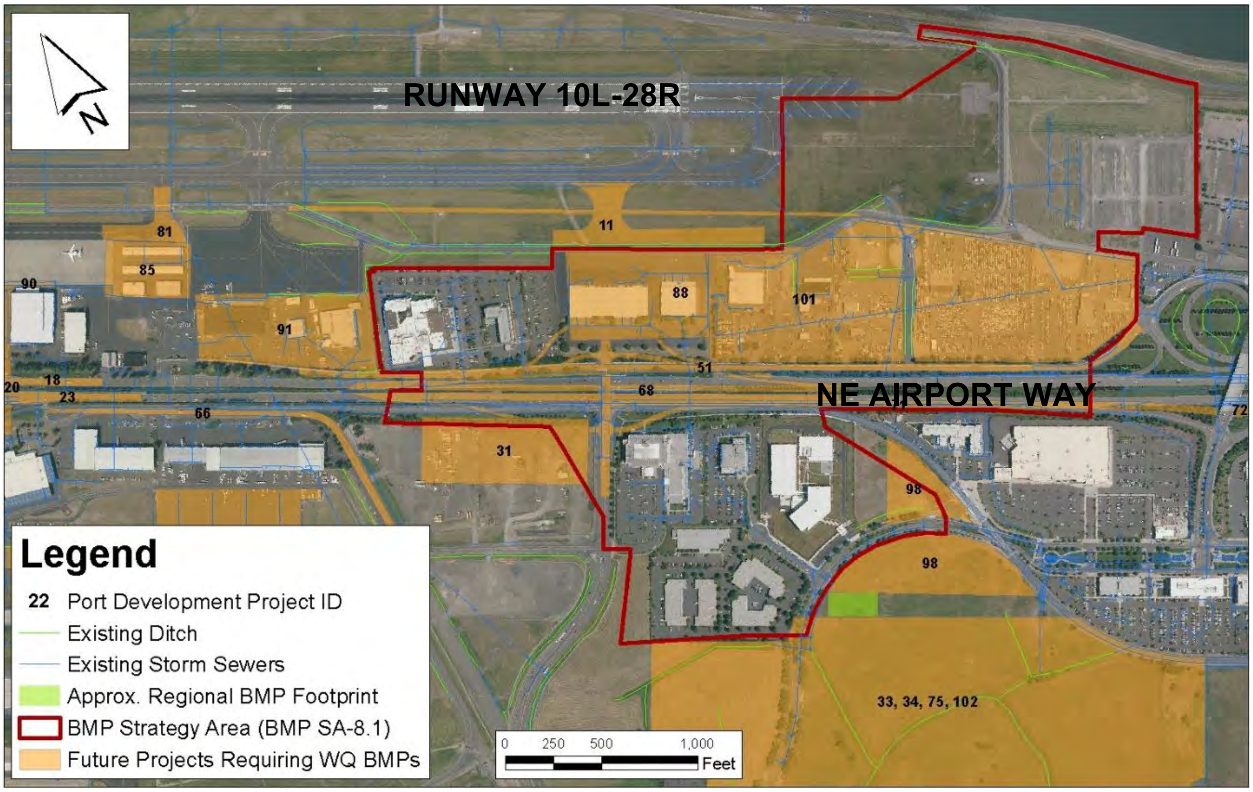


Figure 1: BMP SA-8.1 Vicinity

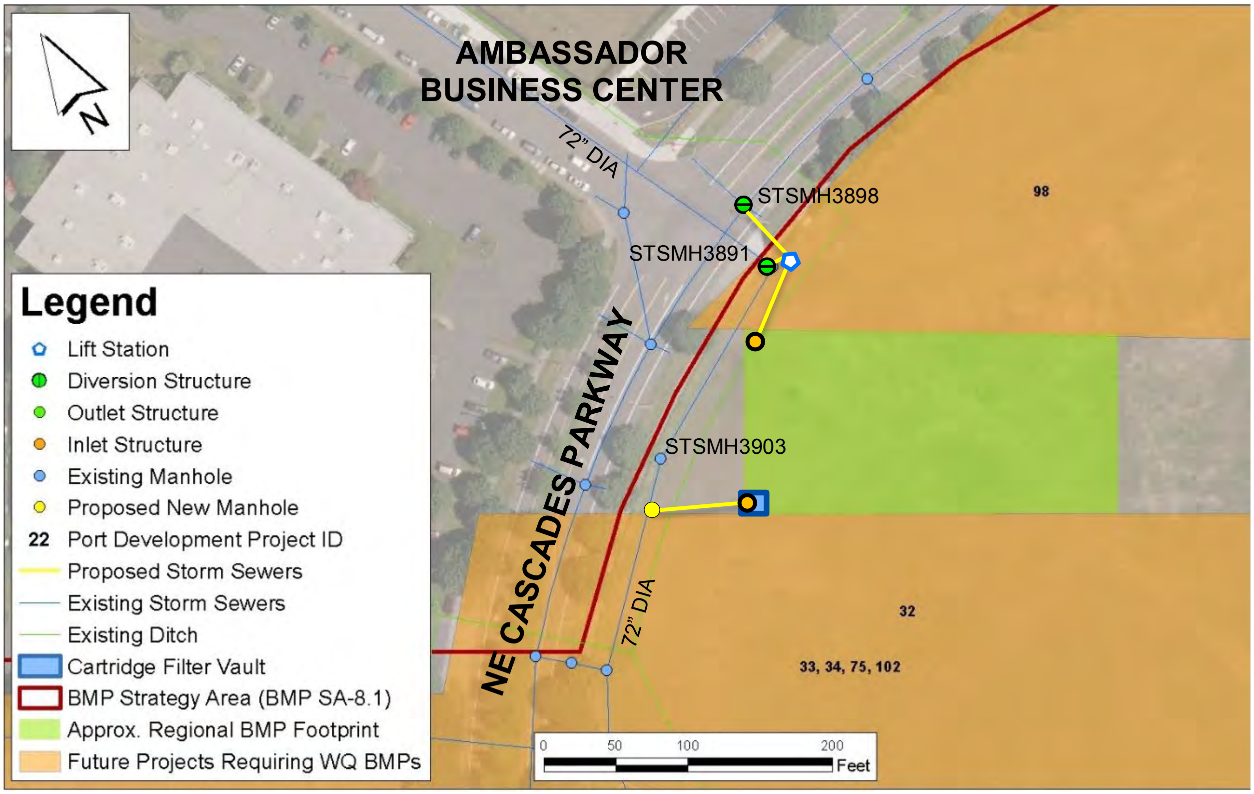


Figure 2: BMP SA-8.1 BMP Location

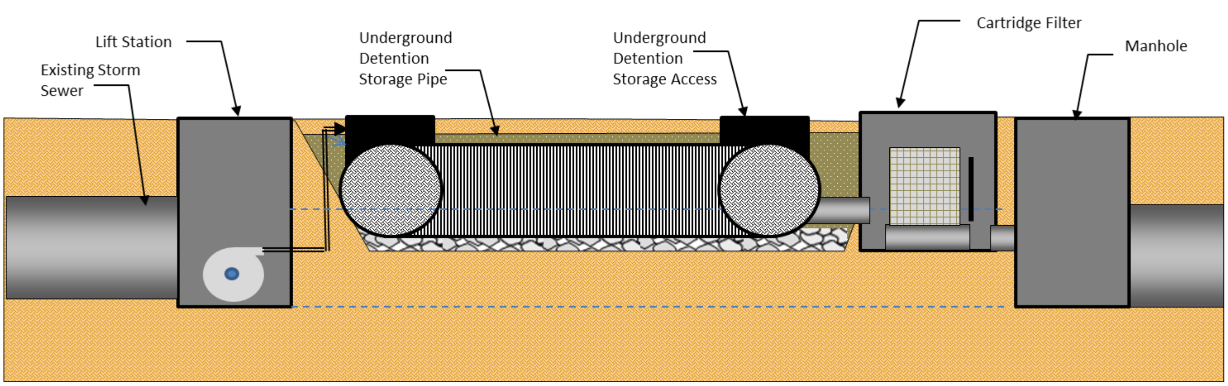


Figure 3: Underground Storage with Cartridge Filter and Lift Station

Implementation Considerations

The following tables provide recommended considerations as the project moves from planning concept to implemented solution. The tables below address implementation considerations for planning and design, construction, and post-construction.

Planning and Design Considerations

Item	Description
Field Data Collection	• Geotechnical and hydrogeological studies may be needed to support detailed design. • Detailed analysis of the proposed system using the PDX stormwater model is recommended prior to design to assess hydraulic feasibility and conveyance mechanisms.
Additional Technical Analysis	None identified.
Permitting	City of Portland, BES for Project #98
Siting	During detailed design, review the extents and layout and adjust as necessary to optimize land use, avoid utilities and meet setback requirements.
Coordination with Elements of Other Projects	• Post-construction BMPs must be installed to address the MS4 permit requirements following completion of the associated development/redevelopment projects. • It may be possible to treat Future Development Project #72 and additional areas of Projects #51, #71 and #98 with this system (refer to SWM Solution 8-F); however, additional analyses are necessary to evaluate the annual volume of runoff that can be treated.
Enabling Projects	None identified.
Related Solutions	None identified.
Coordination with Port Departments	• Environmental - MS4 permitting, BMP tracking • Planning and Development - Charter and Business Case Development • Engineering - pump sizing, utility relocation, design coordination • Maintenance - lift station, cartridge filter, below ground storage • Asset Management - addition of new assets
Coordination with Tenants	Port to determine the timeline for construction of sub-regional water quality treatment BMPs in coordination with the development projects in the BMP Strategy Area and their respective tenants.
Coordination with Outside Agencies	None identified.
Design Disciplines Involved	Civil, Structural, Mechanical, Electrical, and others as needed

Construction Considerations

Item	Description
Construction Components	• Construct one 5.1 cfs lift station. • Construct 50 LF of force main. • Construct 1.9 acre-feet of underground detention storage. • Construct one 2.7 cfs cartridge filter. • Construct 280 LF of 24-inch gravity storm sewer with 1 return manhole.
Airport Operational Impacts	None identified.
Construction Challenges	• Due to the volume of the underground storage required, it will likely be necessary to balance cut and fill to minimize export of soils. It may therefore be necessary to consider raising the grade elevation in the area of and surrounding the BMP. • Approximately 4,560 LF of 48-inch HDPE storage pipe will need to be delivered to the location. • Equipment and material staging areas would need to be identified as well as soil and aggregate stockpile areas. • Line power is needed to the lift station.

Post-Construction Considerations

Item	Description
Post-Construction Coordination with Airport Operations	None identified.
Considerations for Operation and Maintenance (O&M) of the Solution	Access to lift station, cartridge filters, and underground detention cleanouts for scheduled maintenance

Potential Risks if Solution is Implemented / Risk Mitigation Strategies

Item	Description	Mitigation Strategy
Regulatory Compliance	Effectively tracking development project treatment needs and BMPs to which it is assigned	Develop BMP tracking tool.
Airport or Tenant Operations	None identified.	Not applicable.
Aircraft Safety	None identified.	Not applicable.
Future Development Limitations	BMP footprint area will be unavailable for other development.	Coordinate siting with project planners to confirm location minimizes conflicts with future development.

Schedule Analysis

Item	Description
Critical Schedule Drivers	Coordinate the construction with the following project timeframes:[1] • Project #11: DD PrimeView Taxiway Y & Perimeter Road (unknown timeframe) • Project #31: P4 Garage (2035) • Project #51: North Frontage Road (2020) • Project #68: MP Intersection of NE 82nd Way & Airport Way (2020) • Project #71: Widen Airport Way Outbound East of 82nd (2017) • Project #88: DD-GA East Redevelopment (2017) • Project #98: Portland International Center (PIC) Portland Development Commission (PDC) Lots Development (unknown timeframe) • Project #101: Northside Service Center Redevelopment (unknown timeframe) • SWM Solution 8-F: Water Quality Planning Recommendations for BMP SA-8.2
Target Construction Timeframe (2016-2020, 2021-2025, 2026-2035)	2016-2020 Timeframe selected based on development project implementation schedule. Assumed that BMP will be installed by end of timeframe.
Planning and Design Lead Time (<6 months, 6-12 months, 12-24 months)	6-12 months

Notes:

1. Project numbers and timeframes are from the Port's list of future development projects (Appendix A).

Cost Analysis

Item	Description
Opinion of Probable Capital Cost (2015 Dollars)[1]	$4,400,000
Cost Estimate Class / Contingency (1-Bid received, 2-Construction, 3-Design, 4-Concept Design, 5- Screening/Planning)	5- Screening/Planning
Fixed Asset Modifications Excluded from Cost Estimate	None identified.
Cost Assumptions	• Includes 40% for hard cost contingency. • Includes 30% for soft cost contingency. • Other relevant assumptions provided in "BMP Sizing Basis" and "Construction Considerations" sections in this fact sheet.
O&M Cost Considerations	• Pump replacement at 5-10 years • Annual O&M labor for underground detention storage 20 mhr/year [2] • Annual O&M labor for cartridge filter 24 mhr/year [2]

Notes:
1. Supporting detailed cost tables are provided in Appendix B.
2. O&M level of effort estimated based on DSM Appendix O values.

SWM SOLUTION FACT SHEET 8-F

Stormwater Management Solution Tracking Information

SWM Solution ID	Solution Name	Capital Cost Summary	Anticipated Implementation Timeframe	Author	Revision Date
8-F	Water Quality Planning Recommendations for BMP Strategy Area (BMP SA)-8.2	$160,000	2021-2025	GS&P and Geosyntec	June 2015

Stormwater Management Needs Addressed by Solution

SWM Need ID	Need Name	Need Type		
		Address Ponding and Facilitate Drainage	Address Risk of Stormwater Asset Failure	Provide Required Stormwater Controls
0-1	Post-Construction Stormwater Pollutant and Runoff Control			X

Development projects planned by the Port will trigger stormwater quality treatment requirements of the MS4 permit as outlined in the Port of Portland Stormwater Design Standards Manual (DSM) and described in SWM Need Fact Sheet 0-1. The proposed solution addresses the need to provide treatment for future development projects in this BMP Strategy Area (BMP SA-8.2), as summarized in the table below. The subsequent table provides a summary of the BMP sizing requirements, as calculated based on DSM criteria. Project #98 lies outside the current boundary of DSM applicability and may need to follow the City of Portland's Stormwater Management Manual. Also, stormwater runoff from a portion of Projects #51, #71, and #98 that fall within BMP SA-8.2 may be routed to BMP SA-8.1 and treated in a regional facility as described in SWM Solution 8-E.

Future Development Projects Treated by BMP

Project # [1]	Drainage Basin	Planned Development / Redevelopment Project Name	Acres Treated by BMP
51 [2]	8	North Frontage Road	0.3
71 [2]	8	Widen Airport Way Outbound East of 82nd	0.6
72	8	Airport Way Braided Ramp Eastbound	1.5
98 [2]	8	Portland International Center (PIC) Portland Development Commission (PDC) Lots Development	1.4
Total Acres of Development Treated			3.8

Notes:

1. Project numbers correspond to future development areas displayed on Figure 1, and included in the Port's list of future development projects (Appendix A).
2. Project crosses into an adjacent BMP Strategy Area. Acreage reflects portion in this BMP Strategy Area.

Water Quality Treatment BMP Sizing Basis

Area to be Treated	Impervious Acres to be Treated	Annual Runoff Volume (ac-ft)	WQ Design Flow Rate (cfs) [1]	WQ Design Volume (ac-ft) [2]
Planned Development/Redevelopment Area Only	3.8	9.0	0.3	0.1
Entire BMP Strategy Area [3]	82.5	197.8	7.0	2.6

Notes:

1. Based on 0.1 in/hr design intensity, per DSM requirements for offline flow-based BMPs.
2. Based on 0.45 inch design depth, per DSM requirements for volume based BMPs with 24-hr drawdown time.
3. Provided for planning purposes only. BMP sizing and costs based on Planned Development / Redevelopment Area Only.

Solution Description

Solution Type	Summary Description
Future Planning Considerations	Select and construct BMPs, such as bioretention, infiltration trenches, vegetated swales, and/or pervious pavement as part of construction activities for development projects within BMP strategy area. This solution does not include use of a regional treatment facility.

Figure 1 depicts the BMP Strategy Area with the planned future development projects. Proposed BMP locations are omitted since the proposed BMPs can be either distributed controls or sub-regional facilities whose locations are dependent on the type of development and the location and distribution of pervious areas within the development. The majority of the projects in this strategy area consist of parking lots (Project #98) and roadway rehab/expansion (Projects #51, #71, and #72). Bioretention facilities, infiltration trenches, vegetated swales, or pervious pavement are recommended BMP options for these types of projects. Sub-regional facilities are not recommended here due to the sparseness of future development projects. The entirety of development Projects #51, #71, and #98 could potentially be routed to the regional facility in BMP SA-8.1 (refer to SWM Solution 8-E). The location and size of the proposed BMPs can be determined once the extents of the improvements are known.

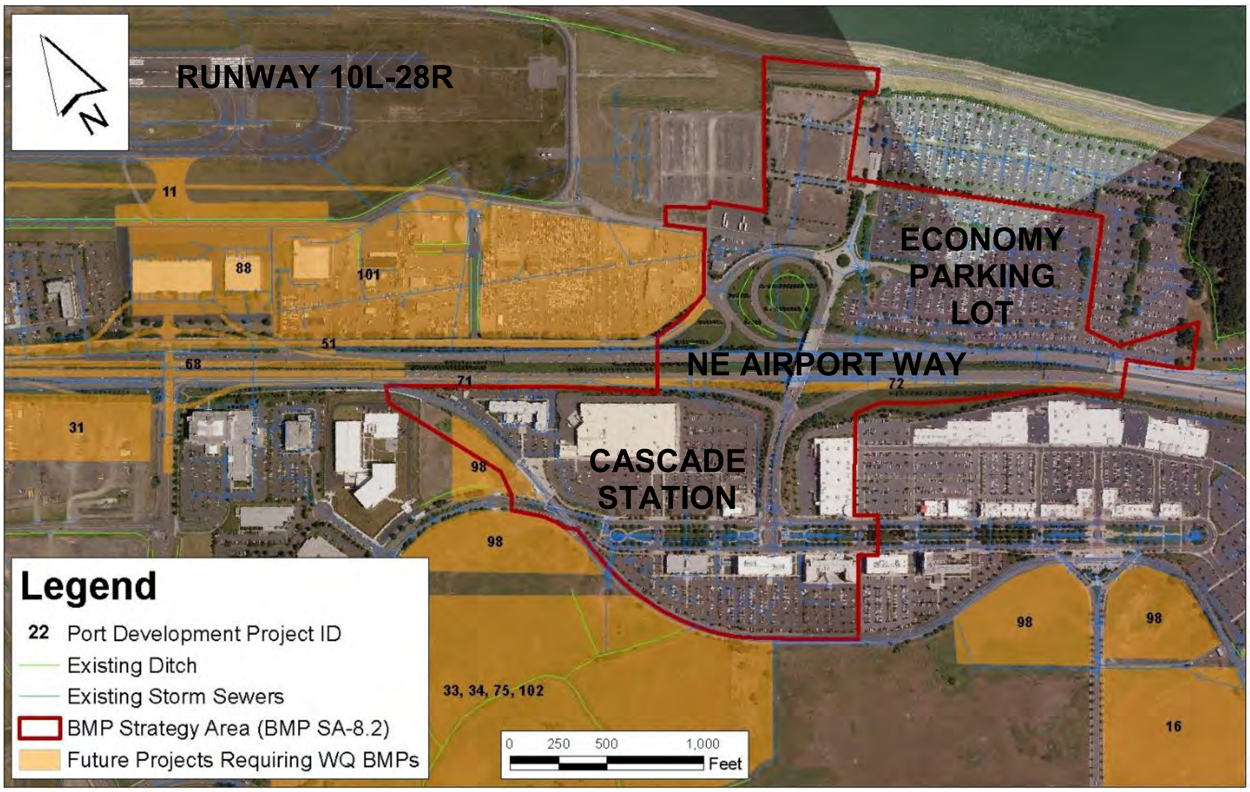


Figure 1: BMP SA-8.2 Vicinity

Implementation Considerations

The following tables provide recommended considerations as the project moves from planning concept to implemented solution. The tables below address implementation considerations for planning and design, construction, and post-construction.

Planning and Design Considerations

Item	Description
Field Data Collection	None identified.
Additional Technical Analysis	Individual BMP sizing needed once the type and location determined. Hydraulic analyses that considers influent flows, head losses, and tailwater conditions for the discharge.
Permitting	City of Portland, BES for Project #98
Siting	During detailed design, review the development project extents and layout, with subsequent adjustment as needed to optimize land use, avoid utilities and meet setback requirements
Coordination with Elements of Other Projects	• Post-construction BMPs must be installed to address the MS4 permit requirements following completion of the associated development/redevelopment projects. • Coordinate with SWM Solution 8-E (Provide Regional Water Quality Treatment for BMP SA-8.1) to evaluate the possibility of routing development project areas to the proposed regional facility.
Enabling Projects	None identified.
Related Solutions	None identified.
Coordination with Port Departments	• Planning and Development - Charter and Business Case Development • Engineering - pipe sizing, utility relocation, design coordination • Maintenance - change in catch basins and manholes requiring routine maintenance • Asset Management - removal of existing assets, addition of new assets • Wildlife Management - identify significance of potential risks
Coordination with Tenants	Port to determine the timeline for construction of water quality treatment BMPs in coordination with the development projects in the BMP Strategy Area and their respective tenants.
Coordination with Outside Agencies	None identified.
Design Disciplines Involved	Civil, Landscape Architect, and others as needed depending on BMPs selected

Construction Considerations

Item	Description
Construction Components	Depends on BMPs selected.
Airport Operational Impacts	None identified.
Construction Challenges	Routing new gravity conveyance pipelines among project areas, BMPs, and existing stormwater conveyance may be challenging given conflicts with existing infrastructure and hydraulic needs.

Post-Construction Considerations

Item	Description
Post-Construction Coordination with Airport Operations	None identified.
Considerations for Operation and Maintenance (O&M) of the Solution	Depends on BMP selected. Refer to DSM Appendix O for guidance on O&M level of effort for various BMPs.

Potential Risks if Solution is Implemented / Risk Mitigation Strategies

Item	Description	Mitigation Strategy
Regulatory Compliance	Effectively tracking development project treatment needs and BMPs to which it is assigned	Develop BMP tracking tool.
Airport or Tenant Operations	None identified.	Not applicable.
Aircraft Safety	Risk of wildlife attraction	Selected BMP will not have exposed water surface to minimize wildlife attraction. Coordinate design features with Port Natural Resources staff.
Future Development Limitations	BMP footprint area will be unavailable for other development.	Coordinate siting with project planners to confirm location minimizes conflicts with future development.

Schedule Analysis

Item	Description
Critical Schedule Drivers	Coordinate the construction with the following project timeframes:[1] • Project #51: North Frontage Road (2020) • Project #71: Widen Airport Way Outbound East of 82nd (2017) • Project #72: Airport Way Braided Ramp Eastbound (2022) • Project #98: Portland International Center (PIC) Portland Development Commission (PDC) Lots Development (unknown timeframe) • SWM Solution 8-E: Provide Regional Water Quality Treatment for BMP SA-8.1
Target Construction Timeframe (2016-2020, 2021-2025, 2026-2035)	2021-2025 Timeframe selected because large majority of development area planned for 2020 and beyond. Assumed that BMP will be installed by end of timeframe.
Planning and Design Lead Time (<6 months, 6-12 months, 12-24 months)	6-12 months from beginning of development project design

Notes:
1. Project numbers and timeframes are from the Port's list of future development projects (Appendix A).

Cost Analysis

Item	Description
Opinion of Probable Capital Cost (2015 Dollars)	$160,000
Cost Estimate Class / Contingency (1-Bid received, 2-Construction, 3-Design, 4-Concept Design, 5- Screening/Planning)	5- Screening/Planning
Fixed Asset Modifications Excluded from Cost Estimate	None identified.
Cost Assumptions	• Includes 30% for hard cost contingency. • Includes 30% for soft cost contingency. • Other relevant assumptions provided in "BMP Sizing Basis" section in this fact sheet. • Assumes bioretention BMPs as representative for cost planning purposes, using unit costs from DSM Appendix N.
O&M Cost Considerations	Reference DSM Appendix O for information on O&M level of effort for BMPs.

SWM SOLUTION FACT SHEET 8-G

Stormwater Management Solution Tracking Information

SWM Solution ID	Solution Name	Capital Cost Summary	Anticipated Implementation Timeframe Summary	Author	Revision Date
8-G	Provide Project-based Water Quality Treatment for BMP Strategy Area (BMP SA)-8.3	$3,400,000	2026-2035	GS&P and Geosyntec	June 2015

Stormwater Management Needs Addressed by Solution

SWM Need ID	Need Name	Need Type		
		Address Ponding and Facilitate Drainage	Address Risk of Stormwater Asset Failure	Provide Required Stormwater Controls
0-1	Post-Construction Stormwater Pollutant and Runoff Control			X

Development projects planned by the Port will trigger stormwater quality treatment requirements of the MS4 permit as outlined in the Port of Portland Stormwater Design Standards Manual (DSM) and described in SWM Need Fact Sheet 0-1. The proposed solution addresses the need to provide treatment for future development projects in this BMP Strategy Area (BMP SA-8.3), as summarized in the table below. The subsequent table provides a summary of the BMP sizing requirements, as calculated based on DSM criteria.

Future Development Projects Treated by BMP

Project # [1]	Drainage Basin	Planned Development / Redevelopment Project Name	Acres Treated by BMP
98	8	Portland International Center (PIC) Portland Development Commission (PDC) Lots Development	5.8
33, 34, 75, 102 [2]	8	• 909 New Ready/Return Parking Spaces • New Rental Car Storage and Service Facilities • 310 New Ready/Return Parking Spaces • MP RAC Service Center Phase 3 (21 MAP)	82.9
Total Acres of Development Treated			88.7

Notes:
1. Project numbers correspond to future development areas displayed on Figure 1, and included in the Port's list of future development projects (Appendix A).
2. Project crosses into an adjacent BMP Strategy Area. Acreage reflects portion in this BMP Strategy Area.

Water Quality Treatment BMP Sizing Basis

Area to be Treated	Impervious Acres to be Treated	Annual Runoff Volume (ac-ft)	WQ Design Flow Rate (cfs)[1]	WQ Design Volume (ac-ft)[2]
Planned Development/Redevelopment Area Only	88.7	197.8	7.5	2.8
Entire BMP Strategy Area [3]	153.7	367.4	13.0	4.9

Notes:
1. Based on 0.1 in/hr design intensity, per DSM requirements for offline flow-based BMPs.
2. Based on 0.45 inch design depth, per DSM requirements for volume based BMPs with 24-hr drawdown time.
3. Provided for planning purposes only. BMP sizing and costs based on Planned Development / Redevelopment Area Only.

Solution Description

Solution Type	Summary Description
Future Planning Considerations	Select and construct BMPs, such as bioretention, infiltration trenches, vegetated swales, and/or pervious pavement as part of construction activities for development projects within BMP strategy area. This solution does not include use of a regional treatment facility.

Figure 1 depicts the BMP Strategy Area with the planned future development projects. Proposed BMP locations are omitted since the proposed BMPs can be either distributed controls or sub-regional facilities whose locations are dependent on the type of development and the location and distribution of pervious areas within the development. For building-based projects with roofs, parking lots, and landscaped areas, distributed stormwater controls such as planter box filters, bioretention facilities, infiltration trenches, vegetated swales, and/or other low impact development (LID) design elements can be used to reduce effective impervious areas and treat runoff. Alternatively, sub-regional facilities can be used to provide combined treatment for several projects and larger areas. The location and size of the proposed BMPs can be determined once the extents of the improvements are known. However, subregional BMPs would be best placed immediately upstream of any planned outfalls to the existing drainage channels ("PIC channels"). Larger areas may be treated, without the need for pumping stormwater by carefully considering how site grading and storm drain layout relate to BMP placement.

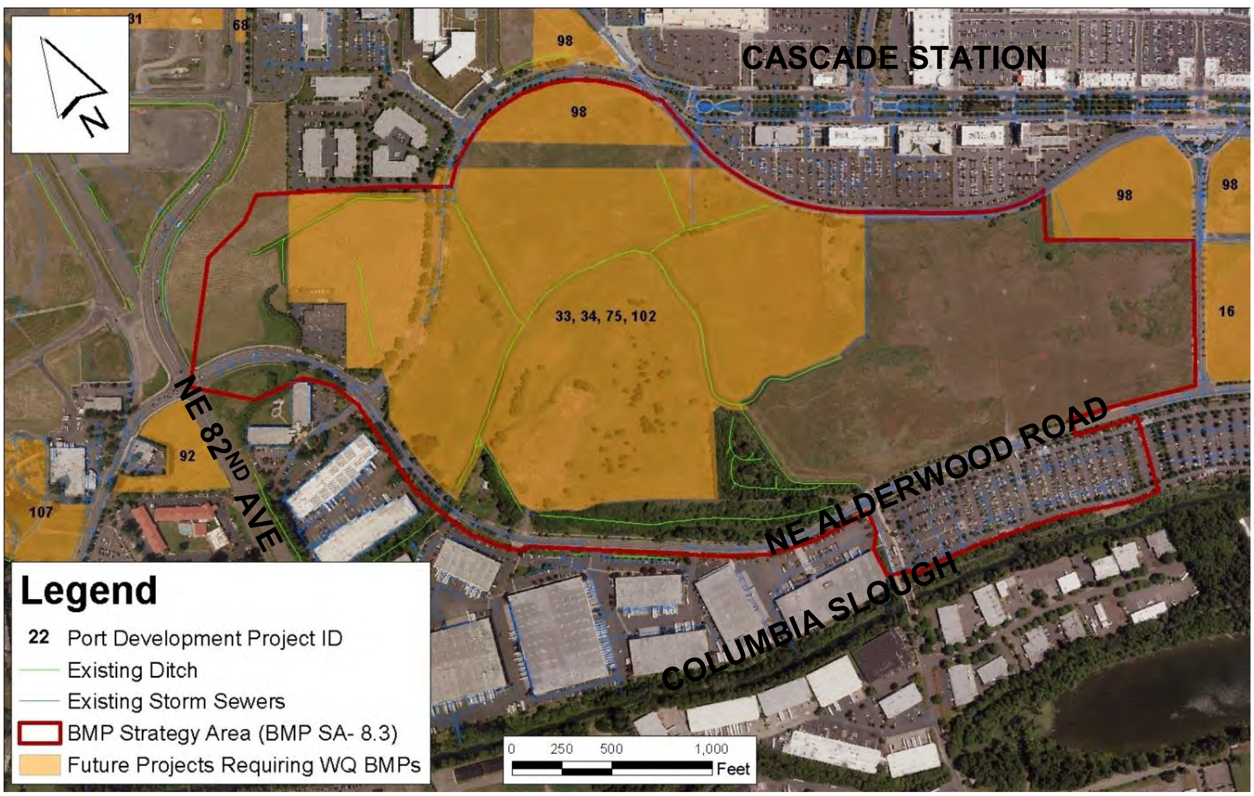


Figure 1: BMP SA-8.3 Vicinity

Implementation Considerations

The following tables provide recommended considerations as the project moves from planning concept to implemented solution. The tables below address implementation considerations for planning and design, construction, and post-construction.

Planning and Design Considerations

Item	Description
Field Data Collection	None identified.
Additional Technical Analysis	Individual BMP sizing needed once the type and location determined. Hydraulic analyses that considers influent flows, head losses, and tailwater conditions for the discharge.
Permitting	City of Portland, BES for Projects #98, #32, #33, #34, #75, and #102
Siting	During detailed design, review the development project extents and layout, with subsequent adjustment as needed to optimize land use, avoid utilities and meet setback requirements
Coordination with Elements of Other Projects	Post-construction BMPs must be installed to address the MS4 permit requirements following completion of the associated development/redevelopment projects.
Enabling Projects	None identified.
Related Solutions	None identified.
Coordination with Port Departments	• Planning and Development - Charter and Business Case Development • Engineering - pipe sizing, utility relocation, design coordination • Maintenance - change in catch basins and manholes requiring routine maintenance • Asset Management - removal of existing assets, addition of new assets • Wildlife Management - identify significance of potential risks
Coordination with Tenants	Port to determine the timeline for construction of water quality treatment BMPs in coordination with the development projects in the BMP Strategy Area and their respective tenants.
Coordination with Outside Agencies	None identified.
Design Disciplines Involved	Civil, Landscape Architect, and others as needed depending on BMPs selected

Construction Considerations

Item	Description
Construction Components	Depends on BMPs selected.
Airport Operational Impacts	None identified.
Construction Challenges	Routing new gravity conveyance pipelines among project areas, BMPs, and existing stormwater conveyance may be challenging given conflicts with existing infrastructure and hydraulic needs.

Post-Construction Considerations

Item	Description
Post-Construction Coordination with Airport Operations	None identified.
Considerations for Operation and Maintenance (O&M) of the Solution	Depends on BMP selected. Refer to DSM Appendix O for guidance on O&M level of effort for various BMPs.

Potential Risks if Solution is Implemented / Risk Mitigation Strategies

Item	Description	Mitigation Strategy
Regulatory Compliance	Effectively tracking development project treatment needs and BMPs to which it is assigned	Develop BMP tracking tool.
Airport or Tenant Operations	None identified.	Not applicable.
Aircraft Safety	Risk of wildlife attraction	Selected BMP will not have exposed water surface to minimize wildlife attraction. Coordinate design features with Port Natural Resources staff.
Future Development Limitations	BMP footprint area will be unavailable for other development.	Coordinate siting with project planners to confirm location minimizes conflicts with future development.

Schedule Analysis

Item	Description
Critical Schedule Drivers	Coordinate the construction with the following project timeframes:[1] • Project #33: 909 New Ready/Return Parking Spaces (2027) • Project #34: New Rental Car Storage and Service Facilities (2035) • Project #75: 310 New Ready/Return Parking Spaces (2035) • Project #98: Portland International Center (PIC) Portland Development Commission (PDC) Lots Development (unknown timeframe) • Project #102: MP RAC Service Center Phase 3 (21 MAP) (2022)
Target Construction Timeframe (2016-2020, 2021-2025, 2026-2035)	2026-2035 Timeframe selected to correspond with above development projects. Assumed that BMP will be installed by end of timeframe
Planning and Design Lead Time (<6 months, 6-12 months, 12-24 months)	6-12 months from beginning of development project design

Cost Analysis

Item	Description
Opinion of Probable Capital Cost (2015 Dollars)	$3,400,000
Cost Estimate Class / Contingency (1-Bid received, 2-Construction, 3-Design, 4-Concept Design, 5- Screening/Planning)	5- Screening/Planning
Fixed Asset Modifications Excluded from Cost Estimate	None identified.
Cost Assumptions	• Includes 30% for hard cost contingency. • Includes 30% for soft cost contingency. • Other relevant assumptions provided in “BMP Sizing Basis” section in this fact sheet. • Assumes bioretention BMPs as representative for cost planning purposes, using unit costs from DSM Appendix N.
O&M Cost Considerations	Reference DSM Appendix O for information on O&M level of effort for BMPs.

BASIN 9 STORMWATER MANAGEMENT FACT SHEETS

BASIN 9 STORMWATER MANAGEMENT FACT SHEETS

The SWM needs identified in Basin 9 are associated with ponding and water quality treatment requirement issues. SWM needs in Basin 9 are summarized in Table 21 below, and SWM solutions proposed to address these needs are described in Table 22. Both tables indicate how the SWM solutions align with each SWM need, and vice versa. Basin 9 SWM need and solution fact sheets immediately follow the tables.

The ponding need in Basin 9 is derived from potential impacts to future development as well as the potential for creating a hazardous wildlife attractant. The ponding need is generally associated with undersized drainage infrastructure. The solution for the ponding need includes coordinating development site grading, development drainage system tie-ins, and site layout with the objectives of minimizing risk of ponding of operational areas and buildings. The Basin 9 water quality BMP can either be distributed stormwater controls or sub-regional facilities whose locations are dependent upon the development type and layout

Table 21 – Basin 9 SWM Needs

SWM Need ID	Issue Type	Need Description	Corresponding SWM Solution ID
0-1	Stormwater Controls	Address Requirement for Post-Construction Stormwater Pollutant and Runoff Control	9-B
9-1	Ponding	Address Ponding in Development East of NE Mt St Helens Ave	9-A

Table 22 – Basin 9 SWM Solutions

SWM Solution ID	Solution Type	Solution Description	Corresponding SWM Need ID
9-A	Future Planning Considerations	Drainage Planning Recommendations for Development Along NE Mt St Helens Ave	9-1
9-B	Future Planning Considerations	Water Quality Planning Recommendations for BMP Strategy Area (BMP SA)-9.1	0-1

.

SWM NEED FACT SHEET 9-1

Stormwater Management Need Tracking Information

SWM Need ID	Need Name	Issue Type	Author	Revision Date
9-1	Address Ponding in Development East of NE Mt St Helens Avenue	Ponding	GS&P	June 2015

Stormwater Management Solutions Identified to Address Need

SWM Solution ID	Solution Name	Solution Type		
		New or Modified Infrastructure	Operational Change	Future Planning Considerations
9-A	Drainage Planning Recommendations for Development Along NE Mt St Helens Ave			X

Issue Characterization

Issue Type	Issue Description
Ponding	Stormwater hydraulic modeling of the Basin 9 drainage system under future (2035) development conditions reveals that the large increase in impervious area will create ponding within the proposed future development extents at Portland International Center during both the 10-year and 100-year, 24-hour storm events, as shown in Figure 1. This ponding could hinder the ability to develop and use a portion of the site.

Factors Potentially Contributing to Issue

Factor	Characterization Basis
Insufficient Drainage System Capacity	Assessments using the PDX stormwater hydraulic model indicate that ponding during the 10-year and 100-year storm events is created by insufficient drainage capacity in the Basin 9 storm sewer system.
Columbia Slough Water Levels	Influence of the tailwater from the Columbia Slough impacts the drainage system and may further reduce available drainage capacity.

Recommendations to Further Characterize Issue and Define Need

The following are actions recommended for further characterizing the issue before designing and implementing the identified solution(s).

Action	Description
Field Observations of Ponding	Site walks are recommended during both wet and dry weather conditions to determine if ponding is observed at this location. If ponding is observed, determine if the ponding is associated with storm events. If observed ponding is not associated with storm events, a field study is recommended to characterize depth to groundwater and potential influence of groundwater on ponding.
Additional Technical Analysis	Because this area is currently served by limited drainage infrastructure, the ponding extents shown in Figure 1 are highly conceptual and have been generated based on the existing site grade, existing drainage infrastructure and hydrologic conditions associated with future development. As site development plans and future drainage infrastructure are better defined, the stormwater hydraulic model should be updated to confirm that the proposed site drainage system meets the ponding criteria described in this fact sheet. For a list of the specific ponding criteria, refer to the section titled “Criteria to be Addressed by Stormwater Management Solutions.”

Figure 1: Plan View of Need

Regulatory Drivers for Stormwater Management Need

Driver	Description
FAA Hazardous Wildlife Attractant Criteria (FAA AC 150/5200-33)	Due to its proximity to PDX and location within the FAA 10,000 foot separation area, ponding at this location poses a risk for attracting wildlife into the runways' approach or departure airspace or into the Air Operations Area (AOA). According to FAA AC 150/5200-33, this poses a wildlife strike risk to aircraft.

Consequence of Not Mitigating Stormwater Management Need

Item	Description
Wildlife Hazard Management	Standing water in close proximity to the airport poses an increased risk of hazardous wildlife attraction and for wildlife strikes.
Planning and Development	The ponding overlaps with the future development extents of the following project: PIC – East of NE Mt. St. Helens Avenue (#16).[1] If the need is not met, new pavement or buildings associated with the future development are at risk of flooding during the 10 and 100-year storm events

Notes:

1. Project numbers were pulled from the Port's list of future development projects (Appendix A).

Criteria to be Addressed by Stormwater Management Solutions

Item	Description
Flooding of Existing/Future Pavement	Eliminate ponding onto the future development during the 10-year storm.
Flooding of Existing/Future Buildings	Eliminate risk of flooding future buildings during the 100-year storm.
Ponding in Unpaved Areas Identified as Critical for Ponding Reduction	Reduce the 10-year storm peak ponding elevation to the lowest known ground elevation.
Asset Management Criteria	Not applicable.
Water Quality Treatment Criteria	Not applicable.

SWM SOLUTION FACT SHEET 9-A

Stormwater Management Solution Tracking Information

SWM Solution ID	Solution Name	Capital Cost Summary	Anticipated Implementation Timeframe	Author	Revision Date
9-A	Drainage Planning Recommendations for Development Along NE Mt St Helens Avenue	Planning Guidance – No Costs Calculated	Development Driven	GS&P	June 2015

Stormwater Management Needs Addressed by Solution

SWM Need ID	Need Name	Need Type		
		Address Ponding and Facilitate Drainage	Address Risk of Stormwater Asset Failure	Provide Required Stormwater Controls
9-1	Address Ponding in Development East of NE Mt St Helens Avenue	X		

Solution Description

Solution Type	Summary Description
Future Planning Consideration	Consider recommendations for drainage system tie-ins and minimum grade while planning for future development along NE Mt St Helens Avenue. The recommended solution is in the form of a “future planning consideration” rather than a specific capital stormwater project because the ultimate development plans for the sites have a significant impact on the stormwater management solution details.

SWM Solution 9-A is associated with future development of the Port-owned properties along NE Mt St Helens Avenue. The Port is currently planning to develop properties on both the east and west side of Mt St Helens Avenue, as shown in Figure 1. However, at this time, the specifics of the development projects are unknown. The properties are currently open fields that drain to a 24-inch to 36-inch storm sewer that ties into the sump west of the MAX Light Rail and east of Mt St Helens. The sump also collects flows from the east side of Cascades Station and along Mt St Helens and conveys the water east through a 72-inch sewer which discharges to a second sump located along the Basin 9 storm sewer trunk line. The system is estimated to be insufficiently sized to convey increased flows from the development without resulting in on-site ponding in an existing low lying area.

To support future development along NE Mt St Helens Avenue, it is recommended that the drainage from the development areas be dispersed appropriately between the 42-inch to 54-inch sewer draining the east side of Cascades Station and NE Mt St Helens Avenue and the 24-inch to 36-inch sewer located within the development sites. Once more detailed information on the development is available, it is recommended that project designers coordinate minimum site grade with required drainage system pipe sizes and minimum depths of cover. It is recommended that the stormwater hydraulic model be updated with the more detailed information on the development. Stormwater drainage should be designed accordingly to minimize risk of ponding of operational areas and buildings.

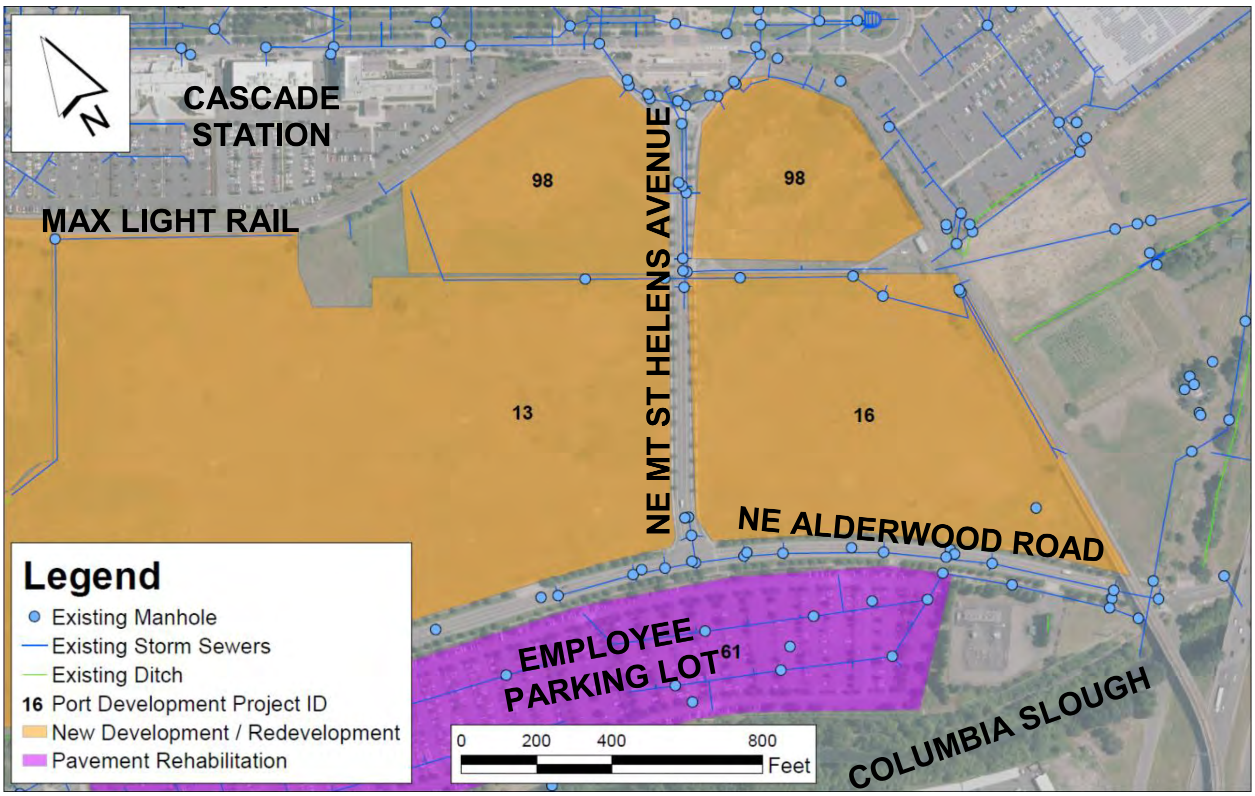


Figure 1: Plan View of Solution

Implementation Considerations

The following tables provide recommended considerations as the concepts for SWM Solution 9-A are further developed.

Planning and Design Considerations

Item	Description
Field Data Collection	• Underground utility location. • Confirmation of size and locations of potential tie-in points along the Mt St Helens Avenue storm sewers. • Geotechnical and hydrogeological studies may be needed to support detailed design. • Topographical surveying is recommended for the development sites (as part of development project design), to confirm grading requirements. • Condition inspection of any existing structures where new pipe connections will be made.
Additional Technical Analysis	Update the PDX stormwater hydraulic model to incorporate the proposed development and verify that the proposed grading and infrastructure are appropriate to address the risk of unacceptable ponding.
Permitting	City Storm Sewer Connection Permit for any new drainage infrastructure connecting to the City storm sewer system.
Siting	Consider siting drainage system to align with future development plans, align with planned stormwater control BMPs, and convey flows to the NE Mt St Helens Avenue storm sewers.

Coordination with Elements of Other Projects	• Coordinate solution with drainage infrastructure for the following planned development projects:
	  ○ Project #16: PIC East of NE Mt St Helens Avenue
	  ○ Project #98: Portland International Center (PIC) Portland Development Commission (PDC) Lots Development
	• Coordinate drainage system design for the development projects listed above with the planned water quality BMPs serving these development areas.

Enabling Projects	None identified.
Related Solutions	None identified.

Item	Description
Coordination with Port Departments	• Planning and Development - identification and timing of development projects • Properties – identification of tenant development needs • Engineering - pipe sizing, utility relocation, City storm sewer connection permit • Maintenance - new catch basins and manholes requiring routine maintenance • Asset Management - addition of new assets • Wildlife Management - change in future management techniques in area
Coordination with Tenants	Coordinate planning and design of drainage system with tenant development needs.
Coordination with Outside Agencies	None identified.
Design Disciplines Involved	Civil, and others as needed per development plans

Construction Considerations

Item	Description
Construction Components	Specific drainage system elements to be determined at a later date based on development plans and site surveys.
Airport Operational Impacts	None identified.
Construction Challenges	None identified.

Post-Construction Considerations

Item	Description
Post-Construction Coordination with Airport Operations	None identified.
Considerations for Operation and Maintenance (O&M) of the Solution	Increase in O&M for new drainage infrastructure.

Potential Risks if Solution is Implemented / Risk Mitigation Strategies

Item	Description	Mitigation Strategy
Regulatory Compliance	None identified.	Not applicable.
Airport or Tenant Operations	None identified.	Not applicable.
Aircraft Safety	None identified.	Not applicable.
Future Development Limitations	None identified.	Not applicable.

Schedule Analysis

Item	Description
Critical Schedule Drivers	Coordinate SWM Solution 9-A with the timeframes of the following development projects that are being served:[1] • Project #16: PIC East of NE Mt St Helens Avenue (unknown timeframe) • Project #98: Portland International Center (PIC) Portland Development Commission (PDC) Lots Development (unknown timeframe)
Target Construction Timeframe (2016-2020, 2021-2025, 2026-2035)	Timeframe will depend upon the development schedule for the site, which is currently unknown.
Planning and Design Lead Time (<6 months, 6-12 months, 12-24 months)	6-12 months from beginning of development project design

Notes:

1. Project numbers and timeframes are from the Port's list of future development projects (Appendix A).

Cost Analysis

Item	Description
Opinion of Probable Capital Cost (2015 Dollars)	Not evaluated at this time due to conceptual nature of development and undefined timeframe. It is assumed that drainage system costs will be incorporated into development project budgets.
Cost Estimate Class / Contingency (1-Bid received, 2-Construction, 3-Design, 4-Concept Design, 5- Screening/Planning)	Not applicable.
Fixed Asset Modifications Excluded from Cost Estimate	Not applicable.
Cost Assumptions	Not applicable.
O&M Cost Considerations	Not applicable.

SWM SOLUTION FACT SHEET 9-B

Stormwater Management Solution Tracking Information

SWM Solution ID	Solution Name	Capital Cost Summary	Anticipated Implementation Timeframe	Author	Revision Date
9-B	Water Quality Planning Recommendations for BMP Strategy Area (BMP SA)-9.1	$1,100,000	2026-2035	GS&P and Geosyntec	June 2015

Stormwater Management Needs Addressed by Solution

SWM Need ID	Need Name	Need Type		
		Address Ponding and Facilitate Drainage	Address Risk of Stormwater Asset Failure	Provide Required Stormwater Controls
0-1	Post-Construction Stormwater Pollutant and Runoff Control			X

Development projects planned by the Port will trigger stormwater quality treatment requirements of the MS4 permit as outlined in the Port of Portland Stormwater Design Standards Manual (DSM) and described in SWM Need Fact Sheet 0-1. The proposed solution addresses the need to provide treatment for future development projects in this BMP Strategy Area (BMP SA-9.1), as summarized in the table below. The subsequent table provides a summary of the BMP sizing requirements, as calculated based on DSM criteria. The future development projects in this BMP Strategy Area lie outside the current boundary of DSM applicability and may need to follow the City of Portland's Stormwater Management Manual.

Future Development Projects Treated by BMP

Project # [1]	Drainage Basin	Planned Development / Redevelopment Project Name	Acres Treated by BMP
16	9	PIC - East of NE Mt. St. Helens Ave.	15.1
98	9	Portland International Center (PIC) Portland Development Commission (PDC) Lots Development	12.1
Total Acres of Development Treated			27.2

Notes:
1. Project numbers correspond to future development areas displayed on Figure 1, and included in the Port's list of future development projects (Appendix A).

Water Quality Treatment BMP Sizing Basis

Area to be Treated	Impervious Acres to be Treated	Annual Runoff Volume (ac-ft)	WQ Design Flow Rate (cfs)[1]	WQ Design Volume (ac-ft)[2]
Planned Development/Redevelopment Area Only	27.1	64.5	2.3	0.9
Entire BMP Strategy Area [3]	88.3	212.3	7.5	2.8

Notes:
1. Based on 0.1 in/hr design intensity, per DSM requirements for offline flow-based BMPs.
2. Based on 0.45 inch design depth, per DSM requirements for volume based BMPs with 24-hr drawdown time.
3. Provided for planning purposes only. BMP sizing and costs based on Planned Development / Redevelopment Area Only.

Solution Description

Solution Type	Summary Description
Future Planning Considerations	Select and construct BMPs, such as planter boxes, bioretention, vegetated swales, and/or LID approaches, as part of construction activities for development projects within the BMP Strategy Area. Alternatively sub-regional BMP facilities can be used to address multiple projects. This solution does not include use of a regional treatment facility.

Figure 1 depicts the BMP Strategy Area with the planned future development projects. Proposed BMP locations are omitted since the proposed BMPs can be either distributed controls or sub-regional facilities whose locations are dependent on the type of development and the location and distribution of pervious areas within the development. For building-based projects with roofs, parking lots, and landscaped areas, distributed stormwater controls such as planter box filters, bioretention facilities, infiltration trenches, vegetated swales, and/or other low impact development (LID) design elements can be used to reduce effective impervious areas and treat runoff. Alternatively, sub-regional facilities can be used to provide combined treatment for several projects. The location and size of the proposed BMPs can be determined once the extents of the improvements are known. However, sub-regional BMPs would be best placed immediately upstream of any planned connects to the existing storm sewers. Larger areas may be treated, without the need for pumping stormwater, by carefully considering how site grading and storm drain layout relate to BMP placement.

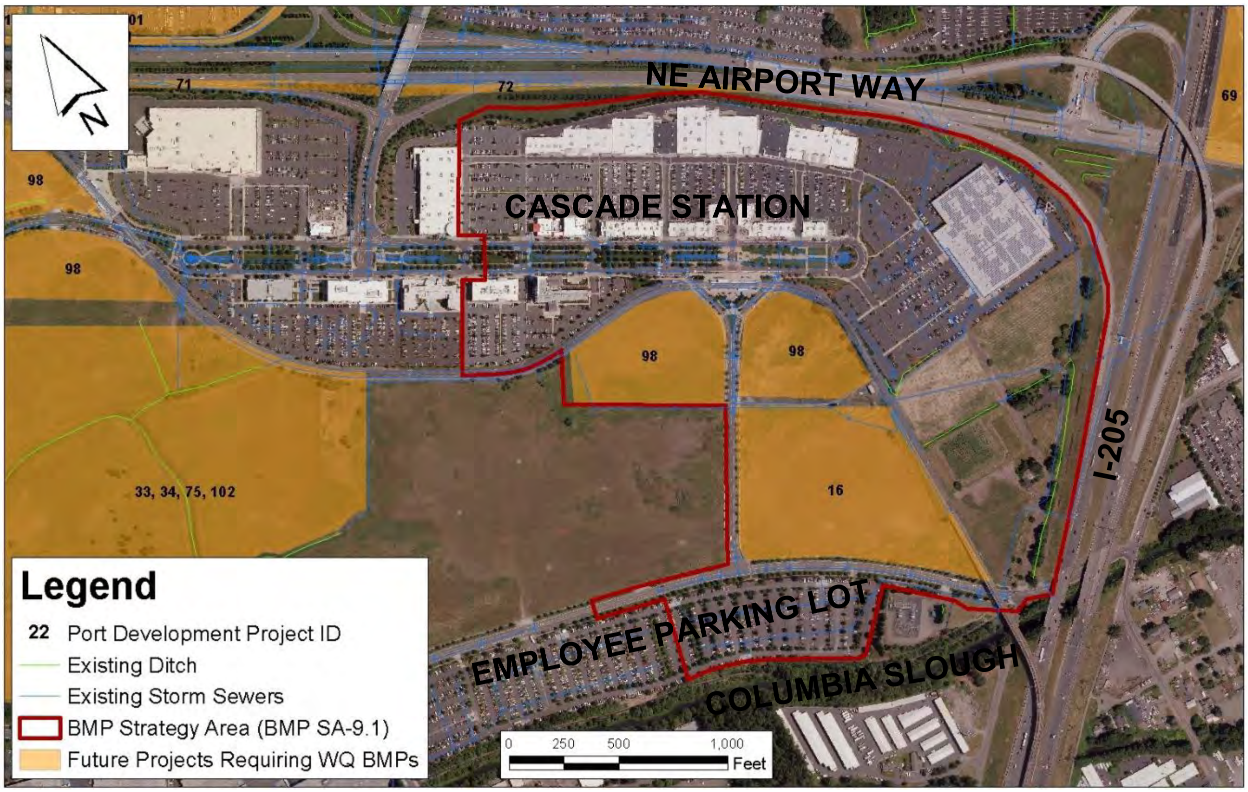


Figure 1: BMP SA-9.1 Vicinity

Implementation Considerations

The following tables provide recommended considerations as the project moves from planning concept to implemented solution. The tables below address implementation considerations for planning and design, construction, and post-construction.

Planning and Design Considerations

Item	Description
Field Data Collection	None identified.
Additional Technical Analysis	Individual BMP sizing needed once the type and location determined. Hydraulic analyses that considers influent flows, head losses, and tailwater conditions for the discharge.
Permitting	City of Portland, BES for Projects #98 and #16
Siting	During detailed design, review the development project extents and layout, with subsequent adjustment as needed to optimize land use, avoid utilities and meet setback requirements
Coordination with Elements of Other Projects	Post-construction BMPs must be installed to address the MS4 permit requirements following completion of the associated development/redevelopment projects.
Enabling Projects	None identified.
Related Solutions	None identified.
Coordination with Port Departments	• Planning and Development - Charter and Business Case Development • Engineering - pipe sizing, utility relocation, design coordination • Maintenance - change in catch basins and manholes requiring routine maintenance • Asset Management - removal of existing assets, addition of new assets • Wildlife Management - identify significance of potential risks
Coordination with Tenants	Port to determine the timeline for construction of water quality treatment BMPs in coordination with the development projects in the BMP Strategy Area and their respective tenants.
Coordination with Outside Agencies	None identified.
Design Disciplines Involved	Civil, Landscape Architect, and others as needed depending on BMPs selected

Construction Considerations

Item	Description
Construction Components	Depends on BMPs selected.
Airport Operational Impacts	None identified.
Construction Challenges	Connections to existing storm sewers may be needed at multiple locations if distributed BMPs are used and at fewer locations if sub-regional BMPs are used.

Post-Construction Considerations

Item	Description
Post-Construction Coordination with Airport Operations	None identified.
Considerations for Operation and Maintenance (O&M) of the Solution	Depends on BMP selected. Refer to DSM Appendix O for guidance on O&M level of effort for various BMPs.

Potential Risks if Solution is Implemented / Risk Mitigation Strategies

Item	Description	Mitigation Strategy
Regulatory Compliance	Effectively tracking development project treatment needs and BMPs to which it is assigned	Develop BMP tracking tool.
Airport or Tenant Operations	None identified.	Not applicable.
Aircraft Safety	Risk of wildlife attraction	Selected BMP will not have exposed water surface to minimize wildlife attraction. Coordinate design features with Port Natural Resources staff.
Future Development Limitations	BMP footprint area will be unavailable for other development.	Coordinate siting with project planners to confirm location minimizes conflicts with future development.

Schedule Analysis

Item	Description
Critical Schedule Drivers	Coordinate the construction with the following project timeframes:[1] • Project #16: PIC - East of NE Mt. St. Helens Avenue (unknown timeframe) • Project #98: Portland International Center (PIC) Portland Development Commission (PDC) Lots Development (unknown timeframe)
Target Construction Timeframe (2016-2020, 2021-2025, 2026-2035)	2026-2035 Timeframe selected due to unknown timeframes associated with above development projects. Assumed that BMP will be installed by end of timeframe.
Planning and Design Lead Time (<6 months, 6-12 months, 12-24 months)	6-12 months from beginning of development project design

Notes:
1. Project numbers and timeframes are from the Port's list of future development projects (Appendix A).

Cost Analysis

Item	Description
Opinion of Probable Capital Cost (2015 Dollars)	$1,100,000
Cost Estimate Class / Contingency (1-Bid received, 2-Construction, 3-Design, 4-Concept Design, 5- Screening/Planning)	5- Screening/Planning
Fixed Asset Modifications Excluded from Cost Estimate	None identified.
Cost Assumptions	• Includes 30% for hard cost contingency. • Includes 30% for soft cost contingency. • Other relevant assumptions provided in "BMP Sizing Basis" section in this fact sheet. • Assumes bioretention BMPs as representative for cost planning purposes, using unit costs from DSM Appendix N.
O&M Cost Considerations	Reference DSM Appendix O for information on O&M level of effort for BMPs.

APPENDIX A

LIST OF PLANNED DEVELOPMENT PROJECTS AT PDX THROUGH 2035

Appendix A: List of Planned Development Projects at PDX Through 2035

DEVELOPMENT PROJECT INFORMATION

Project No.[1]	Project Name[2]	Port Project No.[2]	Business Priority[2]	Project Description[2]	Anticipated Project Year[3]
1	Mt Hood Ave Ramps Rehab	100878	High	Reconstruct all access ramps leading to NE Mt Hood Avenue overpass. Asphalt will be replaced with concrete.	2014
2	Runway 3-21 & Twy M Rehab	100923	High	Rehabilitation of the Crosswinds Runway (3-21), a portion of Taxiway M and the regrading of the Runway 3-21 Safety Area (RSA) to improve drainage and prevent emergence of wetlands.	2021
3	TW E North Rehab	101053	High	Rehabilitate Taxiway E between Taxiway A and Runway 10R-28L. The proposed project will rehabilitate the asphalt pavement surface through pavement strengthening/resurfacing or reconstruction. The existing utilities infrastructure within the footprint of the project will be evaluated and repaired or replaced as required.	2015
4	Twy T Southwest Rehab	101211	High	The proposed Taxiway T rehabilitation project will focus on the region between Concourse Gates C11 and C22. Rehabilitation will include full reconstruction using either asphalt concrete or Portland cement concrete. The paved shoulders will be widened from 15 feet to 35 feet (where necessary) to meet FAA design standards. Centerline lighting will also be added. Infrastructure will be added, repaired or replaced when necessary.	2014
5	Pub Safety & Security Garage Exp	101586	High	The proposed project involves construction of a new building for storing Port Emergency Response Assets. The estimated building dimensions are 200' long by 72' deep. The building will have 11 vehicle bays, all with roll-up doors. The proposed building location is directly adjacent to the Port Fire Station. The existing ramp and driveway will likely be used for building access.	2015
6	Economy Red Lot Bus Route Rehab	101771	High	Economy Red Lot Bus Route will be rehabilitated. Asphalt will be removed and replaced with concrete. Drainage infrastructure will be inspected during the rehabilitation and replaced if necessary.	2015
7	Terminal Roadway Rehab	101772	High	Terminal Roadway will be rehabilitated. Drainage infrastructure will be inspected during the rehabilitation and replaced if necessary. Roadways will be replaced with asphalt or concrete as follows: - Upper Inner - Asphalt Concrete Pavement (Full Depth Recon) - Lower Outer - Portland Cement Concrete (Full Depth Recon) - Lower Inner - Asphalt Concrete Pavement (Mill & Inlay) - Taxi Exit - Asphalt Concrete Pavement (Mill & Inlay) - Outer Entry - Asphalt Concrete Pavement (Mill & Inlay) - Replace Expansion Joint (Upper Inner)	2014
8	Blue Lot Bus Route Rehab	101774	High	Blue Lot Bus Route will be rehabilitated. Asphalt will be removed and replaced with concrete. Drainage infrastructure will be inspected during the rehabilitation and replaced if necessary.	2015

RELATED SWM SOLUTIONS[4]

Project No.[1]	1-A	1-B	1-C	1-D	1-E	1-F	1-G	1-H	1-I	1-J	1-K	1-L	2-A	2-B	3-A	4-A	5-A	6-A	6-B	6-C	6-D	7-A	7-B	7-C	7-D	7-E	7-F	7-G	7-H	8-A	8-B	8-C	8-D	8-E	8-F	8-G	9-A	9-B
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Appendix A: List of Planned Development Projects at PDX Through 2035

DEVELOPMENT PROJECT INFORMATION						RELATED SWM SOLUTIONS[4]																																					
Project No.[1]	Project Name[2]	Port Project No.[2]	Business Priority[2]	Project Description[2]	Anticipated Project Year[3]	1-A	1-B	1-C	1-D	1-E	1-F	1-G	1-H	1-I	1-J	1-K	1-L	2-A	2-B	3-A	4-A	5-A	6-A	6-B	6-C	6-D	7-A	7-B	7-C	7-D	7-E	7-F	7-G	7-H	8-A	8-B	8-C	8-D	8-E	8-F	8-G	9-A	9-B
10	Airport Way Rehabilitation	101777	High	Airport Way will be reconstructed. Drainage infrastructure will be inspected during the rehabilitation and replaced if necessary.	2017																															X	X						
11	DD - PrimeView TW Y & Perm Rd	101931	Medium	Project will involve construction of the new Taxiway Y and relocation of the perimeter service road adjacent to PrimeView Redevelopment. The new taxiway will provide access to the proposed aircraft ramp. The perimeter service road will be relocated to allow for aircraft parking on the proposed ramp.	Unknown																										X							X	X				
12	ORANG Parcel C Modifications	101979	High	The proposed ORANG Parcel C modifications will be implemented after this property reverts to the Port. The modifications will repurpose the property, making it leasable for future tenants. The project includes: pavement improvements, utility separation (electrical, water, gas and telecommunications), select demolition, fencing and gate installation, expansion of Overend Drive, and pavement over demolished Building #370.	2015																		X		X	X																	
13	PDX Logistic Center	N/A	Unknown	Construction of Buildings One, Two and Three	2014																																						
14	Terminal Area Exit Lane (Link K)	101473	Medium	1 New Lane at Terminal Area Exit (Link K). Recommendation from Airport Futures. This project is driven by level of service.	2022																									X		X											
15	RAC QTA Expansion	101468	High	Construct a new QTA facility complete with wash racks, fueling stations and storage to accommodate 100% of the rental car industry at PDX.	2016																					X	X					X											
16	PIC - East of NE Mt. St. Helens Ave.	N/A	Medium	Development of area to warehousing/light industrial	Unknown																																					X	X
18	New Lane at NE Airport Way Westbound (Link A)	N/A	Medium	1 E38	2022																						X					X											
19	1 New Lane at Enplaning Level Approach (Link D)	N/A	Medium	1 New Lane at Enplaning Level Approach (Link D)	2022																										X												
20	P3 Garage	N/A	Medium	3,240 New Public Parking Spaces. May be a combination of surface lot parking and a parking structure. Construction of P3.	2027																											X											
21	ORANG Parcel D1 2030	N/A	Low	Give back of 12.974 acres. Redevelop as needed for Port use. Scope of redevelopment unknown.	2030																				X																		
22	North Fuel Island Recon	101207	Medium	Reconstruction of north fuel island concrete.	2018																										X												
23	1 New Lane at NE Airport Way, Eastbound (Link B)	N/A	Medium	1 New Lane at NE Airport Way, Eastbound (Link B)	2027																											X											
24	1 New Lane at Parking Entrance (Link C)	N/A	Medium	1 New Lane at Parking Entrance (Link C)	2027																											X											
25	1 New Lane at Enplaning Level Departure (Link F)	N/A	Medium	1 New Lane at Enplaning Level Departure (Link F)	2027																									X		X											
26	1 New Lane at Deplaning Level Departure (Link G)	N/A	Medium	1 New Lane at Deplaning Level Departure (Link G)	2027																									X		X											

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27	1 New Lane at Parking Exit (Link H)	N/A	Medium	1 New Lane at Parking Exit (Link H)	2027																									X		X											
28	1 New Lane at Terminal Exit (Link I)	N/A	Medium	1 New Lane at Terminal Exit (Link I)	2027																									X		X											
29	New Lane at Return-to-Terminal Road (Link J)	N/A	Medium	1 E89	2027																											X											
30	ORANG Parcel D2 2030	N/A	Low	Give back of 74.719 acres. Redevelop as needed for Port use. Scope of redevelopment unknown.	2030																		X	X																			
31	P4 Garage	N/A	Medium	4,030 New Public Parking Spaces. May be a combination of surface lot parking and a parking structure. Construction of P4.	2035																										X								X				
32	PIC Ditch Benching	101575	Medium	Bench the sides of ditches at PIC.	2018																														X								
33	909 New Ready/Return Parking Spaces	N/A	Medium	909 New Ready/Return Parking Spaces. Design and build a Consolidated RAC to accommodate additional spaces required.	2027																																				X		
34	New Rental Car Storage and Service Facilities	N/A	Medium	1.1 Acres for New Rental Car Storage and Service Facilities. Addition to Consolidated RAC.	2035																																				X		
35	Repair NE Elrod Road Ditch Crossings	101576	High	Remove three pavement covered culvert ditch crossings, and replace two of them with small pre-fabricated bridge structures. Work contained in area under MCDD management.	2015											X																											
36	Twy B Center & Exits Rehab	101215	High	Rehabilitation/replacement of the remaining asphaltic concrete portions of Taxiway B.	2018																					X		X		X													
37	Twy T SE Twy B East & CCA Apron 2	101250	High	Project scope includes surface and structural pavement rehabilitation where necessary. Pavement shoulders will be widened from 15' to 35' to meet airport design standards. Under drains will be installed. Electrical and storm drainage infrastructure will be repaired, replaced, or added as needed.	2021																					X				X													
38	MP RON Aircraft Parking Phs 1 (North Ramp Expansion)	101460	Low	Two-phased extension of existing apron into what is now Atlantic Aviaition's ramp. Purpose is to create additional RON parking for commercial aircraft.	2014																										X	X											
39	NW Ramp Relocation	101213	High	Project involves creation of new RON Parking ramp.	2017									X																													
40	Twy H Rehab	101210	Low	Modifications to that portion of Twy H necessary to optimize access to future RON ramp.	2017									X																													
41	Perimeter Road Rehabilitation	101994	Medium	Rehabilitation of large stretches of the PDX airfield perimeter road; the most affected portion of the road is on the north side of Runway 10L-28R.	2017	X							X	X	X		X	X	X												X												
42	Assumed Development (To Be Determined)	N/A	Unknown	Reconstruction of the SW Apron.	Unknown												X																										
43	North RWY Rehabilitation	101978	Medium	Likely a A/C mill and inlay life-extension project for the existing runway (last rehabilitated in 2009-2010).	2024																													X				X					

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DEVELOPMENT PROJECT INFORMATION

Project No.[1]	Project Name[2]	Port Project No.[2]	Business Priority[2]	Project Description[2]	Anticipated Project Year[3]
44	TWY A & Exits Rehab	102033	Medium	Likely a A/C mill and inlay life-extension project for the existing taxiway.	2023
45	TW T & K Centerline Lights	101195	High	Install taxiway centerline lighting infrastructure on Taxiway T/K between Taxiway E2 and Taxiway V. Directionally boring conduit between lighting can locations. At can locations, removing concrete, installing cans/lights, and replacing concrete.	2014
46	Snow Pad & Glycol Apron Rehab	101221	Low	Rehabilitation/replacement of existing asphalic concrete apron used to store deicing materials in aboveground tanks.	2026
47	SRWY AC Exits Only Rehab	102004	Medium	Reconstruction of existing A/C connecting taxiways (likely with PCC).	2025
48	Twy J Rehab	101212	High	Rehabilitation of existing taxiway.	2024
49	ARFF Bay asphalt apron	101918	Medium	Rehabilitate ARFF bay asphalt apron. Mill & Inlay/ replace like with like.	2021
50	Future Planning - ARFF Expansion	N/A	Medium	3.2 Acres for New ARFF Facilities	Unknown
51	North Frontage Rd	102180	High	Project will reconstruct North Frontage Road to include base and replace with asphalt.	2020
52	Fire Department Entry Rd Rehab	100756	High	Project will rehab the access road from NE Marine Drive to the PDX Fire Department ARFF Facility. Constuction will be a mill and inlay, replacing like with like.	2015
53	Future Planning - Fuel Farm Expansion	N/A	Medium	1 to 2 Acres for New Fuel Storage Facilities	Unknown
54	Future Planning - GA Expansion	N/A	Medium	10 to 20 Acres for New General Aviation Facilities	Unknown
55	MP Intersect Airtrans Cornfoot	101476	Low	Project will modify the intersection at NE Cornfoot & Airtrans Way to include signalization and turn lanes.	2022
56	Rehab Courier Ct	102183	High	Rehabilitate Courier Court - Mill & Inlay / replace like with like.	2016
57	Transport Way Rehab	100875	High	Project will reconstruct Transport Way. Project will include mill and inlay and upgraded stormwater sewers and catch basins.	2016
58	Rehab Airtrans Way	101944	High	Reconstruct Airtrans Way to include base and replace with asphalt.	2016
59	Rehab Aircraft Services Int Group Rd (ASIG)	102184	High	Rehabilitate ASIG Road - Mill & Inlay / replace like with like	2016
60	Maintenance Annex Parking	102182	High	Project will rehabilitate the Maintenance Annex Parking Lot, replacing like with like.	2018

RELATED SWM SOLUTIONS[4]

Project No.[1]	1-A	1-B	1-C	1-D	1-E	1-F	1-G	1-H	1-I	1-J	1-K	1-L	2-A	2-B	3-A	4-A	5-A	6-A	6-B	6-C	6-D	7-A	7-B	7-C	7-D	7-E	7-F	7-G	7-H	8-A	8-B	8-C	8-D	8-E	8-F	8-G	9-A	9-B
44																													X									
45																																						
46																							X		X													
47																																						
48																					X																	
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DEVELOPMENT PROJECT INFORMATION

Project No.[1]	Project Name[2]	Port Project No.[2]	Business Priority[2]	Project Description[2]	Anticipated Project Year[3]
61	Employee Parking Lot Bus Route	101942	High	Employee Parking Lot Bus Route will be rehabilitated. Asphalt will be removed and replaced with asphalt. Drainage infrastructure will be inspected during the rehabilitation and replaced if necessary.	2015
62	Parking Exit Plaza Expansion	101522	Low	Project will relocate the two exit lanes located north of the exit plaza to align with the six exit lanes south of the exit plaza building. The project will include a canopy, islands and drive lanes to match the existing six exit lanes.	2017
63	North Vendor Gate Access Road	101775	Medium	Rehabilitate North Vendor Gate Access Road. This will be a mill and inlay, replacing like with like.	2014
64	Economy Exit Plaza Rehab 14/15	101935	High	Project will demolish the current economy exit plaza building and constuct a new 800 SF building in a specified location close to the current exit plaza. Building will include all functions required to support a parking exit plaza facility.	2016
65	Long Term Parking Road Rehab	101524	High	Project will rehab the access road from NE Airport Way to the Long Term Parking (Surface) Lot. Constuction will be a mill and inlay, replacing like with like.	2014
66	Air Cargo Rd Rehab	101778	High	Project will reconstruct Air Cargo Rd to include removal of asphalt down to the base, repair base as required and pave with asphalt.	2016
67	Kliever Armory Compound Hardening	N/A	Unknown	The project will replace gravel and asphalt at the Kliever Armory Compound with new concrete pavement. Storm drainage improvements will also be included.	Unknown
68	MP Intersect NE 82nd AW	101474	Medium	Project will modify the intersection of NE 82nd Way & NE Airport way to include a grade separated roadway.	2020
70	Blue Economy Lot Parking	101946	High	Project will rehabilitate Blue Economy Lot Parking, replacing like with like.	2022
71	Widen APW Outbound East of 82nd	101228	Medium	Project will add an additional lane outbound on NE Airport Way between NE 82nd Way and the NE Mt Hood Avenue overpass.	2017
72	Airport Way Braided Ramp E Bound	101227	Low	Construct a braided ramp from NE Airport Way eastbound to the I-205 southbound on-ramp allowing traffic a more efficient way access to I-205 southbound.	2022
73	Central Apron E Reconstruction	101214	Medium	Project will involve reconstruction of concrete on the eastern portion of the central ramp.	2020
74	MP Elrod Road Upgrade (21 MAP)	101481	Low	Project would be development-driven, and the new projected need is not prior to 2035. This development would be undertaken in the event that the Southwest Quad were to be developed.	2035+
75	310 New Ready/Return Parking Spaces	N/A	Medium	310 New Ready/Return Parking Spaces. Expand Consolidated RAC to accommodate required spaces.	2035

RELATED SWM SOLUTIONS[4]

Project No.	1-A	1-B	1-C	1-D	1-E	1-F	1-G	1-H	1-I	1-J	1-K	1-L	2-A	2-B	3-A	4-A	5-A	6-A	6-B	6-C	6-D	7-A	7-B	7-C	7-D	7-E	7-F	7-G	7-H	8-A	8-B	8-C	8-D	8-E	8-F	8-G	9-A	9-B
61																														X								
62																											X											
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66																										X	X											
67																																						
68																										X								X				
70																																						
71																																		X	X			
72																																			X			
73														X							X																	
74																																						
75																																				X		

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76	Assumed Development (To Be Determined)	N/A	Unknown	Reconstruct a northwestern portion of the Air Trans Center ramp / taxi lane. Reconstruction area consists of two portions - ATC taxilane / ramp and narrow portion adjacent to the building.	Unknown														X		X																						
77	Assumed Development (To Be Determined)	N/A	Unknown	Reconstruct a south-central portion of the Air Trans Center ramp / taxi lane. Approximately 14.32 acre reconstruction area. Reconstruction area consists of three portions - large central ATC taxilane / ramp and two parallel narrow portions near buildings to the north and south (Buildings #5330 and #4635).	Unknown														X		X																						
78	TEIP / PDXNext Concourse E & Ramp Widening	101888	High	Construction of an approximately 10,000 sf extension onto Concourse E. Miscellaneous other improvements, including relocation of air carriers and associated airfield facility moves (GSE shops, MX shops, etc).	2015																										X												
79	MP SW Qd Prep & Rmp Ph 1 (21 MAP)	101480	Low	Project would be development-driven and due to ORANG lease completion. The new projected need is not prior to 2035. (Note: This is the same development area as Dredge Fill SW Quad - 100636)	2035+					X																																	
80	SE Apron Rehabilitation	100738	Low	Reconstruction of the SE Apron, dependent on future aircraft RON parking needs.	2023																							X		X	X												
81	GA Taxi Lane Rehab	101225	High	Mill and pave a section of the existing GA taxilane. The section is currently scoped at approximately 60' x 350'.	2020																						X		X		X			X									
82	Dredge Fill SW Quad	100636	Low	Add fill to meet grade of the runway prior to development. (Note: This is the same development area as MP SW Qd Prep & Rmp Ph 1 (21 MAP) - 101480)	2035+					X																																	
83	MP Airtrans Ramp Construction	101478	Low	Addition of potentially three development-driven ramp areas in the Air Trans Center area. All three parcels would be a combination of ramp, hangar, parking and prescribed landscaping requirements.	2022														X			X				X																	
84	McBride Slough Invest / Cleanup	820037	High	Investigation and cleanup of McBride Slough to comply with DEQ requirements. The investigation and feasibility study will establish the scope and scale of cleanup.	2016																																						
85	DD-GA West Redevelop Phase 1	102161	High	Demolition of 4 hangars (F, G, 8025, 8019) and infill with ramp.	2015																						X				X	X		X									
86	Ameri Flight Demolition	810039	High	Demolition of Ameriflight hangars in Southwest Quad area.	2016																																						
87	Buildings 5420 & 5380 Demo (formerly known as "Weather Bureau Demolition")	810053	Medium	Demolition of former Weather Building (Building #5420) and neighboring Building #5380.	2016																																						
88	DD-GA East Redevelopment	100973	High	Development-driven project that could demolish up to 4 buildings (#8855, #8975, #9009, #9137) and develop significant surrounding real estate. Includes ramp and taxiway development between Taxiway A and Frontage Road.	2017																																	X				

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89	SW Quad Drainage Improvements	102006	High	Prevent wetland reformation through improved drainage with pipes and culverts, as well as grading and seeding of the target area in the Southwest Quad.	2014																																						
90	GA Apron Central Rehab	101223	Medium	Geotech is required to know if the scope will include mill and inlay or reconstruction.	2020																						X					X											
91	DD-GA West Redevelopment Phase 2 (Atlantic Aviation)	102162	High	Redevelopment of the area that is currently occupied by the North Cargo Facility, Building #8119, Building #8121 and Building #8215 (former Gate Gourmet building). Project will likely demolish all 4 buildings and be the site of the future Business Aviation Terminal and related hangars.	2016																						X				X	X		X									
92	PDX Travel Center	N/A	High	Project will develop the area at the corner of NE 82nd Way & NE Alderwood Road into a gas station, convenience store, and cell phone waiting area.	2015																												X										
93	NE 33rd & Marine Drive Development - North	N/A	High	Development of area to warehousing/light industrial.	2015				X			X																															
94	NE 33rd & Marine Drive Development - South	N/A	Medium	Development of area to warehousing/light industrial.	Unknown				X			X																															
95	East side NE 33rd Development	N/A	Medium	Development of area to warehousing/light industrial.	Unknown					X		X			X																												
96	Ameriflight Redevelopment	N/A	Medium	Redevelopment of the area currently occupied by the Ameriflight Hangars (building demo project is #86) for airfield useage (hangars, ramp improvements, etc.).	Unknown												X																										
97	South of FedEx	N/A	Medium	Most likely develop into additional surface parking.	Unknown															X																							
98	PIC - PDC Lots	N/A	Medium	Commercial development	Unknown																																		X	X	X	X	X
99	Assumed Development (To Be Determined)	N/A	Unknown	Currently approximately 13 undeveloped acres are available for development.	Unknown				X			X																															
100	Concordia Athletic Expansion	N/A	Unknown	Currently approximately 7 undeveloped acres are available for development.	Unknown					X		X																															
101	Northside Service Center Redevelopment	N/A	Unknown	Redevelopment to occur north of NE Airport Way at the current (2014) rental car facility location.	Unknown																																	X	X				
102	MP RAC Srvc Cntr Ph 3 (21 MAP)	101470	Low	Expand RAC Service Center to increase capacity.	2022																																				X		
103	Terminal Apron PCC Joint Rehab	101695	High	Replace joints between concrete panels.	2014																																						
104	MP RON Aircraft Parking Phs 2 (DD RON NE Ramp Expansion)	101461	Low	Development of all-new ramp for RON parking on what is now mostly airfield turf.	2022									X																													
105	Assumed Development (To Be Determined)	N/A	Unknown	Scope of redevelopment unknown.	Unknown																		X																				

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106	SRWY Approach Wetlands Fill	102005	Medium	Fill wetlands on the west end of the South Runway which create a wildlife hazard.	2018																																						
107	Future Planning - New Airport Maintenance Facilities	N/A	Medium	2.2 Acres for New Airport Maintenance Facilities	Unknown																												X										
108	MP Air Cargo Site Prep Ph 2	101479	Medium	Development of site for Air Cargo	Unknown														X							X																	
109	Replace Access Control	101004	Unknown	Replace access card readers throughout airport including automatic gates. Rebuild mid-field checkpoints.	2016																										X												
110	PDX Cargo Center Ext Rehab	101982	High	Roof rehabilitation including gutter system, roll up door replacement & window replacement on the east building.	2015																																						
111	Levee Ditch Drainage	101616	High	Restore conveyance for the ditch that conveys drainage from the levee toe drains.	2018																																						
N/A	PDX Wetland Mitigation Develop	101176	High	Scope of project is unknown.	Unknown																																						
N/A	East Landside SW Enhancement Vault	102168	Unknown	Project is installation of a cartridge filter BMP to serve other development projects. Unclear if construction of BMP or associated facilities will trigger additional water quality requirements.	2015																																						
N/A	MX Covered Waste Mgmt Area	101578	High	Cover the waste management area at the maintenance facility. Exact project location is unknown, but the size will be approximately 300 sq ft. Project may be expanded to a centralized waste management area for all of PDX including tenants.	2017																																						
N/A	NW Airfield Water Line Replace	101494	Low	Development-driven installation of new water service in the NW quadrant of the airfield.	2017																																						

Notes:

1. See Figure 4-1 for project extents. Development projects with project numbers listed as "N/A" have unknown project extents and are not shown on Figure 4-1.
2. The list of projects was compiled from the following sources: Airport Futures Plan (Jacobs Engineering, 2010); Port Business Cases; List of 500+ projects for AVI Divisions through 2022 (July 2013); Port staff updates in August 2014
3. Listed project years represent the approximate start of construction, as confirmed by the Port in June 2015.
4. Stormwater Management (SWM) Solution IDs correspond to the SWM solution fact sheets located in the SWMP prior to the appendices. Locations of SWM solutions that involve new or modified infrastructure are illustrated on Figures 5-1 and 5-2. Please refer to the fact sheets for solution descriptions as well as guidance for coordination with the planned development projects indicated above.

APPENDIX B

OPINIONS OF PROBABLE COST FOR STORMWATER MANAGEMENT SOLUTIONS

APPENDIX B: OPINIONS OF PROBABLE COSTS FOR STORMWATER MANAGEMENT SOLUTIONS

The planning level opinion of probable costs are provided as part of the analysis of the stormwater management (SWM) solutions for the PDX Stormwater Master Plan (SWMP). The costs provided will support the decision-making process and the development of project charters. This opinion of cost is intended to be used as a conceptual budget for determining the order of magnitude cost for executing the entire scope of the solution, which will be determined in greater detail at a later date. The approach to defining the line items included in the opinion of costs tables involved identifying the major infrastructure components of the SWM solution (e.g., pipes, structures, pumps, etc.) and the general supporting construction methods (e.g., width of trench to determine disturbance to pavement, dewatering, demolishing existing pipes and structures, abandoning existing pipes, etc.) to the extent possible at this stage of planning.

Quantities were developed based upon the planning level layout of the SWM solutions with an understanding that approximately 10% - 15% of the project has been defined at this time. The quantities provided are solely to support the opinion of costs and planning level definition of the solutions. The proposed solution is based upon planned future development extents as provided by the Port in August 2014 and may need to be refined as development plans evolve. The provided costs and current planning level layout of solutions do not include any costs for detailed stormwater drainage system needs within the planned future development projects.

The general sources for the costs include bid tabs from the Oregon Department of Transportation, Washington State Department of Transportation, Port of Vancouver Washington, past project experience, and vendor quotes. Values presented are subject to change based on regional availability of materials, general contractor workloads, project timelines and competing projects of similar scope. Additionally, the opinion of cost presented here may not accurately capture other costs including, but not limited to, unforeseen site conditions, unanticipated means of construction, etc.

In addition to the costs associated with constructing the solution (hard costs), Port soft costs were included as 40% of the hard costs. Contingencies were factored based upon hard and soft costs and were incorporated into the total opinion of costs. Contingencies provide planning level buffers to the costs and ranged from 30-100%. Contingencies are significantly higher when there are a greater amount of unknowns or a higher level of complexity in the solution (e.g. SWM Solution 7-A and SWM Solution 6-D).

The specific assumptions that went into each solution are provided at the bottom of each opinion of cost table (starting on page 3 of this appendix). Cost assumptions that are common among solutions are listed on the following page.

Common Cost Assumptions:

- Construction to take place during the dry season.
- Depth to groundwater does not require significant design changes to address buoyancy.
- No contaminated soils.
- Shoring is needed for trenching in paved open cut areas.
- Trenches with shoring are 10 foot width average.
- No extra excavation or trench stabilization for unstable soils.
- Pipe cost includes excavation, material furnish, installation, bedding, backfill, and testing.
- Dewatering on all excavations due to high water table and dewatering costs approximately 20% of installed pipe cost.
- 10% for contractor general conditions, including mobilization and demobilization.
- Reuse of trenching spoils on-site, requiring no off-site hauling.
- Includes contractor overhead, profit, and bond.
- Includes Port soft costs calculated at 40% of the hard costs.
- An existing Port access gate can be used for construction contractor access to site.
- Logistics for site access not fully vetted at this planning level.
- Pavement demolition and replacement for portions of solutions within planned development projects will be performed as part of associated development projects.
- Final grading and seeding for portions of solutions within planned development projects will be performed as part of associated development projects.
- Does not include haul road for access or stock pile area preparation.
- Manholes are included at all locations where pipelines change direction, where major lateral connections occur, and in accordance with the maximum distance between manholes required by the Port of Portland Stormwater Design Standards Manual for the specified diameter of pipe.
- Trench and manhole depths are approximately 10-12 feet, based on average PDX site conditions.
- Costs to tie in perforated underdrains are not included.
- Pipes are not required to be water tight.
- Utility relocation costs not included.

Opinion of Cost Table	Appendix B Page Number	Grand Total Per SWM Solution
SWM Solution 1-A: Replace Portion of Basin 1 North Trunk Line	B-4	$2,200,000
SWM Solution 1-B: Replace Portion of Basin 1 South Trunk Line	B-5	$3,200,000
SWM Solution 1-C: Replace Pipe Serving South Runway (10R-28L) in Basin 1 South	B-6	$720,000
SWM Solution 1-I: Provide Regional Water Quality Treatment for BMP Strategy Area (BMP SA)-1.3	B-7	$1,400,000
SWM Solution 1-L: Provide Regional Water Quality Treatment for BMP Strategy Area (BMP SA)-1.6	B-8	$2,900,000
SWM Solution 2-A: Replace Basin 2 Outfall Pipe and Portion of Basin 2 Trunk Line	B-9	$1,400,000
SWM Solution 2-B: Provide Regional Water Quality Treatment for BMP Strategy Area (BMP SA)-2.1	B-10	$1,400,000
SWM Solution 4-A: Provide Regional Water Quality Treatment for BMP Strategy Area (BMP SA)-4.1	B-11	$1,100,000
SWM Solution 5-A: Provide Regional Water Quality Treatment for BMP Strategy Area (BMP SA)-5.1	B-12	$1,100,000
SWM Solution 6-D: Provide Regional Water Quality Treatment for BMP Strategy Area (BMP SA)-6.4	B-13	$1,300,000
SWM Solution 7-A: Provide Pump Station to Address Basin 7 Capacity Limitations	B-14	$15,500,000
SWM Solution 7-B: Replace and Extend Pipe Across Southeast Ramp to Post Office	B-16	$1,500,000
SWM Solution 7-C: Replace Lateral North of North Ramp	B-17	$4,100,000
SWM Solution 7-D: Provide Regional Water Quality Treatment for BMP Strategy Area (BMP SA)-7.1	B-18	$1,000,000
SWM Solution 7-E: Provide Regional Water Quality Treatment for BMP Strategy Area (BMP SA)-7.2	B-19	$3,300,000
SWM Solution 7-F: Provide Regional Water Quality Treatment for BMP Strategy Area (BMP SA)-7.3	B-20	$390,000
SWM Solution 7-H: Improve Basin 7 Trunk Line to Address Risk of Asset Failure	B-21	$4,200,000
SWM Solution 8-A: Replace Basin 8 Outfall Pipe	B-22	$1,000,000
SWM Solution 8-B: Replace Portion of Eastern Basin 8 Trunk Line Along Airport Way	B-23	$810,000
SWM Solution 8-C: Replace Pipe Along NE Airport Way Frontage Road in Northwest Basin 8	B-24	$110,000
SWM Solution 8-D: Add Fill and Pipe Storage Southeast of North Runway (10L-28R)	B-25	$330,000
SWM Solution 8-E: Provide Regional Water Quality Treatment for BMP Strategy Area (BMP SA)-8.1	B-26	$4,400,000
	Total Opinion of Cost For Proposed Infrastructure:	**$53,400,000**

Engineer's Opinion of Probable Cost
SWM Solution 1-A: Replace Portion of Basin 1 North Trunk Line

Item	Quantity	Units	Unit Price	Total
72" Reinforced Concrete Pipe	2,130	LF	$301	$641,130
Install 108" Aircraft Rated Manhole	8	EA	$17,250	$138,000
Pavement Removal - Standard Section	111	SY	$4	$444
Pavement Removal - Airport PCC	200	SY	$8	$1,600
Pavement Restoration - Airport PCC	200	SY	$204	$40,800
Remove Existing Pipe	2,130	LF	$16	$34,080
Remove Manhole	6	EA	$400	$2,400
Connect Existing Pipe to Structure	15	EA	$880	$13,200
Open Cut Shoring	25,490	SF	$2	$50,980
Inlet Protection	15	EA	$82	$1,230
High Visibility Fence	2,000	LF	$3	$5,000
Stabilized Construction Entrance	1	EA	$1,200	$1,200
Seeding and Mulching	1	ACRE	$2,000	$1,000
Temporary Stormwater Management	2,130	LF	$4	$8,520
Subtotal				**$940,000**
Airfield Coordination Premium (15%)				$141,000
Contractor General Conditions (10%)				$94,000
Total - Construction Hard Costs				**$1,175,000**
Port Soft Costs (40% of Hard Costs)				$470,000.00
Hard Cost Contingency (35% of Hard Costs)				$412,000.00
Soft Cost Contingency (30% of Port Soft Costs)				$141,000.00
Grand Total				**$2,200,000**

Cost Assumptions:
1. Assumptions common to all solutions are listed in the front section of Appendix B.
2. Assume open cut of the perimeter road and Taxiway C1.
3. Assume no significant construction impact to existing drainage tile.

Engineer's Opinion of Probable Cost

SWM Solution 1-B: Replace Portion of Basin 1 South Trunk Line

Item	Quantity	Units	Unit Price	Total
48" Reinforced Concrete Pipe	4,010	LF	$180	$721,800
Install 72" Aircraft Rated Manhole	11	EA	$7,500	$82,500
Remove Manhole	3	EA	$400	$1,200
Trenchless Crossing - 72" Casing	240	LF	$1,300	$312,000
Fill Abandoned Pipe with CDF	583	CY	$70	$40,810
Pavement Removal - Airport HMAC	900	SY	$8	$7,200
Connect Existing Pipe to Structure	20	EA	$880	$17,600
Connection Piping 10"	200	LF	$50	$10,000
Open Cut Shoring	48,040	SF	$2	$96,080
Inlet Protection	27	EA	$82	$2,214
High Visibility Fence	3,750	LF	$3	$9,375
Stabilized Construction Entrance	1	EA	$1,200	$1,200
Seeding and Mulching	1	ACRE	$2,000	$2,000
Subtotal				**$1,304,000**
Airfield Coordination Premium (15%)				$195,600
Contractor General Conditions (10%)				$130,400
Total - Construction Hard Costs				**$1,630,000**
Port Soft Costs (40% of Hard Costs)				$652,000.00
Hard Cost Contingency (40% of Hard Costs)				$652,000.00
Soft Cost Contingency (30% of Port Soft Costs)				$196,000.00
Grand Total				**$3,200,000**

Cost Assumptions:

1. Assumptions common to all solutions are listed in the front section of Appendix B.
2. Assume open cut of Taxiway C, Taxiway G, and Runway 3-21.
3. Trenchless crossing of Runway 10R-28L (South Runway).
4. Assume no significant construction impact to existing drainage tile.
5. Assume no traffic control needed on the perimeter road.

Engineer's Opinion of Probable Cost

SWM Solution 1-C: Replace Pipe Serving South Runway (10R-28L) in Basin 1 South

Item	Quantity	Units	Unit Price	Total
48" Reinforced Concrete Pipe	340	LF	$180	$61,200
30" Reinforced Concrete Pipe	840	LF	$164	$137,760
Remove Existing Pipe	380	LF	$8	$3,040
Fill Abandoned Pipe with CDF	94	CY	$70	$6,580
Install 72" Aircraft Rated Manhole	4	EA	$11,250	$45,000
Remove Manhole	4	EA	$400	$1,600
Connect Existing Pipe to Structure	8	EA	$880	$7,040
Open Cut Shoring	14,160	SF	$2	$28,320
Inlet Protection	4	EA	$82	$328
High Visibility Fence	1,120	LF	$3	$2,800
Stabilized Construction Entrance	1	EA	$1,200	$1,200
Seeding and Mulching	0	ACRE	$2,000	$500
Temporary Stormwater Management	380	LF	$4	$1,520
Subtotal				**$297,000**
Airfield Coordination Premium (15%)				$44,550
Contractor General Conditions (10%)				$29,700
Total - Construction Hard Costs				**$372,000**
Port Soft Costs (40% of Hard Costs)				$149,000.00
Hard Cost Contingency (40% of Hard Costs)				$149,000.00
Soft Cost Contingency (30% of Port Soft Costs)				$45,000.00
Grand Total				**$720,000**

Cost Assumptions:

1. Assumptions common to all solutions are listed in the front section of Appendix B.

Engineer's Opinion of Probable Cost

SWM Solution 1-I: Provide Regional Water Quality Treatment for BMP Strategy Area (BMP SA)-1.3

Item	Quantity	Units	Unit Price	Total
Temporary Stormwater Bypass	10	DAY	$320	$3,200
Remove Manhole	1	EA	$750	$750
24" Reinforced Concrete Pipe, Complete	140	LF	$106	$14,840
8" Ductile Iron Pipe, Complete	50	LF	$80	$4,000
Open Cut Shoring	2,280	SF	$2	$4,560
60" Diversion Manhole	1	EA	$9,000	$9,000
60" Return Manhole	1	EA	$7,500	$7,500
Lift Station (<1,000 GPM) - 2 Flyght 5HP Pumps & Controls	1	LS	$51,600	$51,600
Lift Station (<1,000 GPM) - Oldcastle RC509 Precast Structure	1	LS	$75,450	$75,450
Lift Station (<1,000 GPM) - Installation & Start Up	15	DAY	$2,250	$33,750
Contech Stormfilter (36 Cartridges) & Vault (8ft x 16ft)	1	LS	$129,740	$129,740
Contech Stormfilter & Vault Installation	5	DAY	$2,250	$11,250
SSFW - Excavation	4,840	CY	$9	$43,560
SSFW - Geomembrane	2,904	SY	$14	$40,656
SSFW - Geotextile	2,904	SY	$3	$8,712
SSFW - Drainage Aggregate	2,904	CY	$30	$87,120
SSFW - Appurtenances	1	LS	5%	$9,100
Hydroseeding	0.6	ACRE	$2,000	$1,200
Inlet Protection & Erosion Control	1	LS	$3,000	$3,000
High Visibility Fence	650	LF	$3	$1,625
Stabilized Construction Entrance	1	EA	$1,200	$1,200
Subtotal				**$542,000**
Airfield Coordination Premium (15%)				$81,300
Contractor General Conditions (10%)				$54,200
Total - Construction Hard Costs				**$678,000**
Port Soft Costs (40% of Hard Costs)				$272,000
Hard Cost Contingency (40% of Hard Costs)				$272,000
Soft Cost Contingency (30% of Port Soft Costs)				$82,000
Grand Total				**$1,400,000**

Cost Assumptions:

1. Assumptions common to all solutions are listed in the front section of Appendix B.

Engineer's Opinion of Probable Cost

SWM Solution 1-L: Provide Regional Water Quality Treatment for BMP Strategy Area (BMP SA)-1.6

Item	Quantity	Units	Unit Price	Total
Temporary Stormwater Bypass	10	DAY	$320	$3,200
Remove Manhole	2	EA	$750	$1,500
24" Reinforced Concrete Pipe, Complete	150	LF	$106	$15,900
6" Ductile Iron Pipe, Complete	300	LF	$60	$18,000
Open Cut Shoring	5,400	SF	$2	$10,800
60" Diversion Manhole	2	EA	$9,000	$18,000
60" Return Manhole	1	EA	$7,500	$7,500
Lift Station (>1,000 GPM) - 2 Flyght 5HP Pumps & Controls	1	LS	$51,600	$51,600
Lift Station (~2,000 GPM) - 2 Flyght 20HP Pumps & Controls	1	LS	$100,600	$100,600
Lift Station (>1,000 GPM) - Oldcastle RC611 Precast Structure	2	LS	$99,000	$198,000
Lift Station (>1,000 GPM) - Installation & Start Up	30	DAY	$2,250	$67,500
Contech Stormfilter (36 Cartridges) & Vault (8ft x 16ft)	1	LS	$129,740	$129,740
Contech Stormfilter (50 Cartridges) & Vault (11ft x 16ft)	1	LS	$182,000	$182,000
Contech Stormfilter & Vault Installation	10	DAY	$2,250	$22,500
SSFW - Excavation	8,809	CY	$9	$79,281
SSFW - Geomembrane	4,404	SY	$14	$61,656
SSFW - Geotextile	4,044	SY	$3	$12,132
SSFW - Drainage Aggregate	5,873	CY	$30	$176,190
SSFW - Appurtenances	1	LS	5%	$16,500
Hydroseeding	0.9	ACRE	$2,000	$1,800
Inlet Protection & Erosion Control	1	LS	$3,000	$3,000
High Visibility Fence	650	LF	$3	$1,625
Stabilized Construction Entrance	1	EA	$1,200	$1,200
Subtotal				**$1,181,000**
Airfield Coordination Premium (15%)				$177,150
Contractor General Conditions (10%)				$118,100
Total - Construction Hard Costs				**$1,477,000**
Port Soft Costs (40% of Hard Costs)				$591,000
Hard Cost Contingency (40% of Hard Costs)				$591,000
Soft Cost Contingency (30% of Port Soft Costs)				$178,000
Grand Total				**$2,900,000**

Cost Assumptions:

1. Assumptions common to all solutions are listed in the front section of Appendix B.

Engineer's Opinion of Probable Cost

SWM Solution 2-A: Replace Basin 2 Outfall Pipe and Portion of Basin 2 Trunk Line

Item	Quantity	Units	Unit Price	Total
2 ft x 6 ft Rectangular Pipe	290	LF	$707	$204,908
2 ft x 4 ft Rectangular Pipe	590	LF	$340	$200,541
Rectangular Pipe - Excavation & Backfill	880	LF	$58	$50,758
Pavement Removal - Standard Section	60	SY	$4	$247
Remove Existing Pipe	874	LF	$8	$7,202
Remove Manhole	3	EA	$258	$773
Install Aircraft Rated Manhole Riser	3	EA	$7,725	$23,175
Install Manhole Riser	1	EA	$5,150	$5,150
Install 2 ft x 4 ft Rectangular Pipe Cap	2	EA	$1,648	$3,296
Adjust Catch Basin	1	EA	$515	$515
Connect Existing Pipe to Structure	7	EA	$906	$6,345
Headwall Structure	1	EA	$30,900	$30,900
Access Staircase	1	LS	$9,900	$9,900
Headwall Structure - Excavation and Backfill	200	CY	$24	$4,738
Class 700 riprap	20	CY	$77	$1,545
Open Cut Shoring	6,000	SF	$2	$12,360
Inlet Protection	7	EA	$84	$591
High Visibility Fence	750	LF	$3	$2,318
Remove and install AOA fence	1	LS	$2,800	$2,800
Seeding and Mulching	0.25	ACRE	$2,060	$515
Stabilized Construction Entrance	1	EA	$1,200	$1,200
Turbidity Curtain	1	LS	$1,600	$1,600
Temporary Stormwater Management	880	LF	$4	$3,626
Subtotal				**$576,000**
Airfield Coordination Premium (15%)				$86,400
Contractor General Conditions (10%)				$57,600
Total - Construction Hard Costs				**$720,000**
Port Soft Costs (40% of Hard Costs)				$288,000.00
Hard Cost Contingency (40% of Hard Costs)				$288,000.00
Soft Cost Contingency (30% of Port Soft Costs)				$87,000.00
Grand Total				**$1,400,000**

Cost Assumptions:

1. Assumptions common to all solutions are listed in the front section of Appendix B.
2. Trenching depth approximately 6 feet, based on average site conditions.
3. Assume open cut of the perimeter road.
4. Assume no traffic control needed for the perimeter road.
5. Assume additional erosion control materials & labor for work near open waterways.
6. Assumes permitting costs are captured within the Port soft costs given the planning level understanding. Permitting will need to be further defined before design and construction.

Engineer's Opinion of Probable Cost

SWM Solution 2-B: Provide Regional Water Quality Treatment for BMP Strategy Area (BMP SA)-2.1

Item	Quantity	Units	Unit Price	Total
Temporary Stormwater Bypass	30	DAY	$320	$9,600
Remove Manhole	1	EA	$750	$750
Remove Existing Pipe	400	LF	$16	$6,400
24" Reinforced Concrete Pipe, Complete	40	LF	$106	$4,240
Open Cut Shoring	480	SF	$2	$960
60" Return Manhole	1	EA	$7,500	$7,500
Basin - Excavation	8,712	CY	$9	$78,408
Basin - Geomembrane	8,712	SY	$14	$121,968
Basin - Drainage Aggregate	8,712	CY	$30	$261,360
Basin - Underdrain	2,000	LF	$22	$44,000
Basin - Appurtenances	1	LS	5%	$25,300
Inlet Protection & Erosion Control	1	LS	$3,000	$3,000
High Visibility Fence	1,150	LF	$3	$2,875
Stabilized Construction Entrance	1	EA	$1,200	$1,200
Subtotal				**$568,000**
Airfield Coordination Premium (15%)				$85,200
Contractor General Conditions (10%)				$56,800
Total - Construction Hard Costs				**$710,000**
Port Soft Costs (40% of Hard Costs)				$284,000
Hard Cost Contingency (40% of Hard Costs)				$284,000
Soft Cost Contingency (30% of Port Soft Costs)				$86,000
Grand Total				**$1,400,000**

Cost Assumptions:

1. Assumptions common to all solutions are listed in the front section of Appendix B.

Engineer's Opinion of Probable Cost

SWM Solution 4-A: Provide Regional Water Quality Treatment for BMP Strategy Area (BMP SA)-4.1

Item	Quantity	Units	Unit Price	Total
Temporary Stormwater Bypass	10	DAY	$320	$3,200
24" Reinforced Concrete Pipe, Complete	30	LF	$106	$3,180
60" Return Manhole	1	EA	$7,500	$7,500
Oil Water Separator	1	EA	$265,500	$265,500
Contech Stormfilter (36 Cartridges) & Vault (8ft x 16ft)	1	LS	$129,740	$129,740
Contech Stormfilter & Vault Installation	5	DAY	$2,250	$11,250
Basin - Backfill	3,320	CY	$9	$29,880
Inlet Protection & Erosion Control	1	LS	$3,000	$3,000
High Visibility Fence	650	LF	$3	$1,625
Stabilized Construction Entrance	1	EA	$1,200	$1,200
Subtotal				**$457,000**
Airfield Coordination Premium (15%)				$68,550
Contractor General Conditions (10%)				$45,700
Total - Construction Hard Costs				**$572,000**
Port Soft Costs (40% of Hard Costs)				$229,000
Hard Cost Contingency (40% of Hard Costs)				$229,000
Soft Cost Contingency (30% of Port Soft Costs)				$69,000
Grand Total				**$1,100,000**

Cost Assumptions:

1. Assumptions common to all solutions are listed in the front section of Appendix B.
2. Fill volume assumed to be 75% of existing Central Quiescent Basin (CQB) volume.

Engineer's Opinion of Probable Cost

SWM Solution 5-A: Provide Regional Water Quality Treatment for BMP Strategy Area (BMP SA)-5.1

Item	Quantity	Units	Unit Price	Total
Temporary Stormwater Bypass	10	DAY	$320	$3,200
Remove Manhole	1	EA	$750	$750
24" Reinforced Concrete Pipe, Complete	70	LF	$106	$7,420
6" Ductile Iron Pipe, Complete	50	LF	$60	$3,000
Open Cut Shoring	1,440	SF	$2	$2,880
60" Diversion Manhole	1	EA	$9,000	$9,000
60" Return Manhole	1	EA	$7,500	$7,500
Lift Station (>1,000 GPM) - 2 Flyght 5HP Pumps & Controls	1	LS	$51,600	$51,600
Lift Station (>1,000 GPM) - Oldcastle RC611 Precast Structure	1	LS	$99,000	$99,000
Lift Station (>1,000 GPM) - Installation & Start Up	15	DAY	$2,250	$33,750
Biofiltration - Excavation	2,581	CY	$9	$23,229
Biofiltration - Geomembrane	1,936	SY	$14	$27,104
Biofiltration - Filter Blanket	350	CY	$45	$15,750
Biofiltration - Bioretention Media	1,291	CY	$70	$90,370
Biofiltration - Mulch Layer	1	LS	$1,500	$1,500
Biofiltration - Underdrain	530	LF	$18	$9,540
Biofiltration - Granular Backfill for Underdrain	700	CY	$23	$16,100
Biofiltration - 3" Pea Gravel	161	CY	$51	$8,211
Biofiltration - Appurtenances	1	LS	5%	$9,600
Hydroseeding	0.4	ACRE	$2,000	$800
Inlet Protection & Erosion Control	1	LS	$3,000	$3,000
High Visibility Fence	550	LF	$3	$1,375
Stabilized Construction Entrance	1	EA	$1,200	$1,200
Subtotal				**$426,000**
Airfield Coordination Premium (15%)				$63,900
Contractor General Conditions (10%)				$42,600
Total - Construction Hard Costs				**$533,000**
Port Soft Costs (40% of Hard Costs)				$214,000
Hard Cost Contingency (40% of Hard Costs)				$214,000
Soft Cost Contingency (30% of Port Soft Costs)				$65,000
Grand Total				**$1,100,000**

Cost Assumptions:

1. Assumptions common to all solutions are listed in the front section of Appendix B.

Engineer's Opinion of Probable Cost

SWM Solution 6-D: Provide Regional Water Quality Treatment for BMP Strategy Area (BMP SA)-6.4

Item	Quantity	Units	Unit Price	Total
Temporary Stormwater Bypass	30	DAY	$320	$9,600
24" PVC, Complete	40	LF	$85	$3,400
Clearing & Grubbing (Site Preparation)	4.6	ACRE	$950	$4,370
Treatment Basin - Excavation	180	CY	$9	$1,620
Treatment Basin - Finish Grading	6,944	CY	$9	$62,496
Treatment Basin - Ballast Rock Stockpile & Embankment	6,670	CY	$16	$106,720
Treatment Basin - Trench Filter Gravel	180	CY	$30	$5,400
Treatment Basin - Underdrain	400	LF	$18	$7,200
Treatment Basin - Filter Berm Media	230	CY	$70	$16,100
Treatment Basin - Real-Time Control & Actuated Valve	1	LS	$55,000	$55,000
Treatment Basin - 8" Faircloth Skimmer	1	EA	$5,000	$5,000
Treatment Basin - Geomembrane Liner	6,944	SY	$14	$97,216
Inlet Protection & Erosion Control	1	LS	$3,000	$3,000
High Visibility Fence	1,000	LF	$3	$3,000
Stabilized Construction Entrance	1	EA	$1,200	$1,200
Subtotal				**$382,000**
Airfield Coordination Premium (15%)				$57,300
Contractor General Conditions (10%)				$38,200
Total - Construction Hard Costs				**$478,000**
Port Soft Costs (40% of Hard Costs)				$192,000
Hard Cost Contingency (100% of Hard Costs)				$478,000
Soft Cost Contingency (30% of Port Soft Costs)				$58,000
Grand Total				**$1,300,000**

Cost Assumptions:

1. Assumptions common to all solutions are listed in the front section of Appendix B.
2. Hard cost contingency reflects preliminary nature of solution.

Engineer's Opinion of Probable Cost

SWM Solution 7-A: Provide Pump Station to Address Basin 7 Capacity Limitations

Item	Quantity	Units	Unit Price	Total
Temporary Protection of Traffic	1	LS	$8,000	$8,000
Install Temporary AOA Fence and Replacement of AOA Fence	1	LS	$24,000	$24,000
Pavement Demolition and Resurfacing	1	LS	$458,000	$458,000
Remove Existing Pipe	590	LF	$8	$4,720
Lateral Connections	17	EA	$1,030	$17,510
Disconnecting or Abandoning Existing Pipes	130	CY	$72	$9,373
18" Reinforced Concrete Pipe	400	LF	$58	$23,124
24" Reinforced Concrete Pipe	470	LF	$80	$37,577
36" Reinforced Concrete Pipe	610	LF	$173	$105,792
42" Reinforced Concrete Pipe	120	LF	$203	$24,354
48" Reinforced Concrete Pipe	790	LF	$241	$190,453
Trenchless Crossing - 42" Steel Pipe	50	LF	$615	$30,750
24" Internal Diameter Ductile Iron Force Main (Open Cut)	800	LF	$191	$152,520
24" Internal Diameter Ductile Iron Force Main (Horizontal Directional Drill)	2,370	LF	$554	$1,311,795
Install 48" Aircraft Rated Manhole	2	EA	$5,408	$10,815
Install 60" Aircraft Rated Manhole	1	EA	$7,725	$7,725
Install 72" Aircraft Rated Manhole	2	EA	$11,588	$23,175
Install 84" Aircraft Rated Manhole	1	EA	$16,223	$16,223
Install 96" Aircraft Rated Manhole	1	EA	$18,540	$18,540
Install 48" Manhole	2	EA	$3,605	$7,210
Install 72" Manhole	1	EA	$7,725	$7,725
Install 84" Manhole	1	EA	$10,815	$10,815
Install 96" Manhole	1	EA	$12,360	$12,360
24" River Outfall	1	LS	$1,133,000	$1,133,000
Pump Station Junction Structure	1	LS	$129,000	$129,000
Pump Station Wet Well	1	LS	$384,000	$384,000
Pump Station Valve Vault	1	LS	$74,000	$74,000
Pump Station Meter Vault	1	LS	$38,000	$38,000
Pump Station Mechanical Equipment	2	LS	$257,500	$515,000
Pump Station Valves in Structures	1	LS	$56,000	$56,000
24" Ductile Iron Pipe	150	LF	$157	$23,484
Air Valves	1	LS	$4,000	$4,000
Concrete Block Building	1	LS	$43,000	$43,000
Local Control Panels	1	LS	$186,000	$186,000
Control Utility	2,250	LF	$46	$104,288
Power Utility, 480V, 1500 kVA	1,000	LF	$77	$77,250
Standby Generator, 1250 kVA	1	LS	$387,000	$387,000
PLC Programming	1	LS	$31,000	$31,000
Total Organic Carbon (TOC) Monitoring Instrument	1	LS	$103,000	$103,000
Open Cut Shoring	32,680	SF	$2	$65,360
Inlet Protection	17	EA	$82	$1,394
High Visibility Fence	3,750	LF	$3	$9,375
Stabilized Construction Entrance	1	EA	$1,200	$1,200
Temporary Stormwater Management	2,440	LF	$4	$9,760
Subtotal				**$5,888,000**

Engineer's Opinion of Probable Cost

SWM Solution 7-A: Provide Pump Station to Address Basin 7 Capacity Limitations

Item	Quantity	Units	Unit Price	Total
Airfield Coordination Premium (15%)				$883,200
Contractor General Conditions (10%)				$588,800
Total - Construction Hard Costs				**$7,360,000**
Port Soft Costs (40% of Hard Costs)				$2,944,000.00
Hard Cost Contingency (50% of Hard Costs)				$3,680,000.00
Soft Cost Contingency (50% of Port Soft Costs)				$1,472,000.00
Grand Total				**$15,500,000**

Cost Assumptions:

1. Assumptions common to all solutions are listed in the front section of Appendix B.
2. Assumes that building demolition will be coordinated outside of this project.
3. Quantities associated with directional drill are subject to change based on drill depth and final outfall location.
4. Costs do not include the spill control measure depicted in the diagram in the 7-A fact sheet.
5. Costs do no include the recommended overflow connection to the Basin 7 trunk line as mentioned within the 7-A fact sheet.
6. Assumes permitting costs are captured within the Port soft costs given the planning level understanding. Permitting will need to be further defined before design and construction.

Engineer's Opinion of Probable Cost

SWM Solution 7-B: Replace and Extend Pipe Across Southeast Ramp to Post Office

Item	Quantity	Units	Unit Price	Total
Pavement Demolition and Resurfacing	1	LS	$38,000	$38,000
Remove Existing Pipe	1,090	LF	$8	$8,720
Lateral Connections	9	EA	$1,230	$11,070
Disconnecting or Abandoning Existing Pipes	70	CY	$72	$5,047
24" Reinforced Concrete Pipe	420	LF	$80	$33,579
48" Reinforced Concrete Pipe	1,470	LF	$241	$354,388
Install 84" Aircraft Rated Manhole	3	EA	$16,223	$48,668
Install 48" Manhole	1	EA	$3,605	$3,605
Install 60" Manhole	1	EA	$5,150	$5,150
Install 84" Manhole	1	EA	$10,815	$10,815
Install 120" Manhole	1	EA	$25,750	$25,750
Open Cut Shoring	22,680	SF	$2	$45,360
Inlet Protection	9	EA	$82	$738
High Visibility Fence	2,000	LF	$3	$5,000
Stabilized Construction Entrance	1	EA	$1,200	$1,200
Seeding and Mulching	0.25	ACRE	$2,000	$500
Temporary Stormwater Management	1,890	LF	$4	$7,560
Subtotal				**$606,000**
Airfield Coordination Premium (15%)				$90,900
Contractor General Conditions (10%)				$60,600
Total - Construction Hard Costs				**$758,000**
Port Soft Costs (40% of Hard Costs)				$304,000.00
Hard Cost Contingency (35% of Hard Costs)				$266,000.00
Soft Cost Contingency (30% of Port Soft Costs)				$92,000.00
Grand Total				**$1,500,000**

Cost Assumptions:

1. Assumptions common to all solutions are listed in the front section of Appendix B.
2. Depth of trenching and structures range from 5-14 feet, without including sumps for structures.
3. The 120" manhole is assumed to have a depth of 14 feet without a sump and is assumed to be cast in place. Assuming cost of structure, but there could be potential to tie into the existing structure along the trunk line.

Engineer's Opinion of Probable Cost

SWM Solution 7-C: Replace Lateral North of North Ramp

Item	Quantity	Units	Unit Price	Total
48" Reinforced Concrete Pipe	4,790	LF	$180	$862,200
Install 84" Aircraft Rated Manhole	15	EA	$12,750	$191,250
Remove Existing Pipe	4,790	LF	$8	$38,320
Remove Manhole	12	EA	$250	$3,000
Pavement Removal - Standard Section	1,190	SY	$4	$4,760
Pavement Removal - Airport HMAC	2,340	SY	$8	$18,720
Pavement Restoration - Standard Section	1,190	SY	$64	$76,160
Pavement Restoration - Airport HMAC	2,340	SY	$126	$294,840
Open Cut Shoring	57,460	SF	$2	$114,920
Connect Existing Pipe to Structure	33	EA	$880	$29,040
Inlet Protection	38	EA	$82	$3,116
High Visibility Fence	5,000	LF	$3	$12,500
Stabilized Construction Entrance	1	EA	$1,200	$1,200
Seeding and Mulching	1	ACRE	$2,000	$2,000
Temporary Stormwater Management	4,790	LF	$4	$19,160
Subtotal				**$1,672,000**
Airfield Coordination Premium (15%)				$250,800
Contractor General Conditions (10%)				$167,200
Total - Construction Hard Costs				**$2,090,000**
Port Soft Costs (40% of Hard Costs)				$836,000.00
Hard Cost Contingency (40% of Hard Costs)				$836,000.00
Soft Cost Contingency (35% of Port Soft Costs)				$293,000.00
Grand Total				**$4,100,000**

Cost Assumptions:

1. Common cost assumptions across the solutions have been included in the front of this appendix.

Engineer's Opinion of Probable Cost

SWM Solution 7-D: Provide Regional Water Quality Treatment for BMP Strategy Area (BMP SA)-7.1

Item	Quantity	Units	Unit Price	Total
Temporary Stormwater Bypass	10	DAY	$320	$3,200
Remove Manhole	1	EA	$750	$750
24" Reinforced Concrete Pipe, Complete	180	LF	$106	$19,080
6" Ductile Iron Pipe, Complete	150	LF	$60	$9,000
Open Cut Shoring	3,960	SF	$2	$7,920
60" Diversion Manhole	1	EA	$9,000	$9,000
60" Return Manhole	1	EA	$7,500	$7,500
Lift Station (<1,000 GPM) - 2 Flyght 5HP Pumps & Controls	1	LS	$51,600	$51,600
Lift Station (<1,000 GPM) - Oldcastle RC509 Precast Structure	1	LS	$75,450	$75,450
Lift Station (<1,000 GPM) - Installation & Start Up	15	DAY	$2,250	$33,750
Contech Stormfilter (23 Cartridges) & Vault (8ft x 11ft)	1	LS	$85,930	$85,930
Contech Stormfilter & Vault Installation	5	DAY	$2,250	$11,250
SSFW - Excavation	2,420	CY	$9	$21,780
SSFW - Geomembrane	1,452	SY	$14	$20,328
SSFW - Geotextile	1,452	SY	$3	$4,356
SSFW - Drainage Aggregate	1,452	CY	$30	$43,560
SSFW - Appurtenances	1	LS	5%	$4,600
Hydroseeding	0.3	ACRE	$2,000	$600
Inlet Protection & Erosion Control	1	LS	$3,000	$3,000
High Visibility Fence	450	LF	$3	$1,125
Stabilized Construction Entrance	1	EA	$1,200	$1,200
Subtotal				**$415,000**
Airfield Coordination Premium (15%)				$62,250
Contractor General Conditions (10%)				$41,500
Total - Construction Hard Costs				**$519,000**
Port Soft Costs (40% of Hard Costs)				$208,000
Hard Cost Contingency (40% of Hard Costs)				$208,000
Soft Cost Contingency (30% of Port Soft Costs)				$63,000
Grand Total				**$1,000,000**

Cost Assumptions:

1. Assumptions common to all solutions are listed in the front section of Appendix B.

Engineer's Opinion of Probable Cost
SWM Solution 7-E: Provide Regional Water Quality Treatment for BMP Strategy Area (BMP SA)-7.2

Item	Quantity	Units	Unit Price	Total
Temporary Stormwater Bypass	10	DAY	$320	$3,200
Remove Manhole	1	EA	$750	$750
24" Reinforced Concrete Pipe, Complete	80	LF	$106	$8,480
6" Ductile Iron Pipe, Complete	50	LF	$60	$3,000
Open Cut Shoring	1,560	SF	$2	$3,120
60" Diversion Manhole	1	EA	$9,000	$9,000
60" Return Manhole	1	EA	$7,500	$7,500
Lift Station (~2,000 GPM) - 2 Flyght 20HP Pumps & Controls	1	LS	$100,600	$100,600
Lift Station (~2,000 GPM) - Oldcastle RC611 Precast Structure	1	LS	$99,000	$99,000
Lift Station (~2,000 GPM) - Installation & Start Up	20	DAY	$2,250	$45,000
Contech Stormfilter (43 Cartridges) & Vault (11ft x 16ft)	1	LS	$162,500	$162,500
Contech Stormfilter & Vault Installation	10	DAY	$2,250	$22,500
Detention - Excavation	3,227	CY	$9	$29,043
Detention - Geotextile	1,936	SY	$3	$5,808
Detention - 48" DuroMaxx HDPE, Access Risers, Installation	2,800	LF	$296	$828,800
Detention - Aggregate Base	350	CY	$25	$8,750
Detention - Appurtenances	1	LS	5%	$43,700
Hydroseeding	0.4	ACRE	$2,000	$800
Inlet Protection & Erosion Control	1	LS	$3,000	$3,000
High Visibility Fence	550	LF	$3	$1,375
Stabilized Construction Entrance	1	EA	$1,200	$1,200
Subtotal				**$1,388,000**
Airfield Coordination Premium (15%)				$208,200
Contractor General Conditions (10%)				$138,800
Total - Construction Hard Costs				**$1,735,000**
Port Soft Costs (40% of Hard Costs)				$694,000
Hard Cost Contingency (40% of Hard Costs)				$694,000
Soft Cost Contingency (30% of Port Soft Costs)				$209,000
Grand Total				**$3,300,000**

Cost Assumptions:

1. Assumptions common to all solutions are listed in the front section of Appendix B.

Engineer's Opinion of Probable Cost

SWM Solution 7-F: Provide Regional Water Quality Treatment for BMP Strategy Area (BMP SA)-7.3

Item	Quantity	Units	Unit Price	Total
60" Diversion Manhole	1	EA	$9,000	$9,000
60" Return Manhole	1	EA	$7,500	$7,500
Contech Stormfilter (36 Cartridges) & Vault (8ft x 16ft)	1	LS	$129,740	$129,740
Contech Stormfilter & Vault Installation	5	DAY	$2,250	$11,250
Subtotal				**$158,000**
Airfield Coordination Premium (15%)				$23,700
Contractor General Conditions (10%)				$15,800
Total - Construction Hard Costs				**$198,000**
Port Soft Costs (40% of Hard Costs)				$80,000
Hard Cost Contingency (40% of Hard Costs)				$80,000
Soft Cost Contingency (30% of Port Soft Costs)				$24,000
Grand Total				**$390,000**

Cost Assumptions:

1. Assumptions common to all solutions are listed in the front section of Appendix B.

Engineer's Opinion of Probable Cost

SWM Solution 7-H: Improve Basin 7 Trunk Line to Address Risk of Asset Failure

Item	Quantity	Units	Unit Price	Total
78" Reinforced Concrete Pipe	90	LF	$301	$27,090
60" Reinforced Concrete Pipe	1,250	LF	$246	$307,500
42" Reinforced Concrete Pipe	280	LF	$180	$50,400
21" Reinforced Concrete Pipe	280	LF	$84	$23,520
60" CIPP Liner	740	LF	$1,300	$962,000
Remove Existing Pipe	1,900	LF	$10	$19,000
Install 120" Aircraft Rated Manhole	7	EA	$19,500	$136,500
Install 120" Manhole	4	EA	$13,000	$52,000
Remove Manhole	8	EA	$400	$3,200
Connect Existing Pipe to Structure	19	EA	$880	$16,720
Pavement Removal - Standard Section	1,033	SY	$4	$4,132
Pavement Removal - Airport HMAC	300	SY	$8	$2,400
Pavement Restoration - Standard Section	555	SY	$64	$35,520
Pavement Restoration - Airport HMAC	133	SY	$126	$16,758
Open Cut Shoring	21,490	SF	$2	$42,980
Inlet Protection	23	EA	$82	$1,886
Seeding and Mulching	0.25	ACRE	$2,000	$500
Stabilized Construction Entrance	2	EA	$1,200	$2,400
High Visibility Fence	1,000	LF	$3	$2,500
Temporary Stormwater Management	2,630	LF	$4	$10,520
Subtotal				**$1,718,000**
Airfield Coordination Premium (15%)				$257,700
Contractor General Conditions (10%)				$171,800
Total - Construction Hard Costs				**$2,148,000**
Port Soft Costs (40% of Hard Costs)				$860,000.00
Hard Cost Contingency (40% of Hard Costs)				$860,000.00
Soft Cost Contingency (30% of Port Soft Costs)				$258,000.00
Grand Total				**$4,200,000**

Cost Assumptions:

1. Common cost assumptions across the solutions have been included in the front of this appendix.
2. Assume no traffic control needed for work adjacent to roadway.

Engineer's Opinion of Probable Cost
SWM Solution 8-A: Replace Basin 8 Outfall Pipe

Item	Quantity	Units	Unit Price	Total
84" Reinforced Concrete Pipe	690	LF	$301	$207,690
Fill Abandoned Pipe with CDF	320	CY	$70	$22,400
Clearing and grubbing	0.25	AC	$1,800	$450
Connect Existing Pipe to Structure	7	EA	$880	$6,160
Install 108" Manhole	4	EA	$11,500	$46,000
Pavement Removal - Standard Section	489	SY	$4	$1,956
Pavement Restoration - Standard Section	489	SY	$64	$31,296
Headwall Structure	2	EA	$17,500	$35,000
Access Staircase	2	LS	$9,900	$19,800
Headwall Structure - Excavation and Backfill	400	CY	$23	$9,200
Remove and install fence	1	LS	$2,700	$2,700
Class 700 riprap	25	CY	$75	$1,875
Traffic Control	1	LS	$25,000	$25,000
Open Cut Shoring	8,200	SF	$2	$16,400
Inlet Protection	7	EA	$82	$574
Seeding and Mulching	0.25	ACRE	$2,000	$500
High Visibility Fence	1,200	LF	$3	$3,000
Stabilized Construction Entrance	2	EA	$1,200	$2,400
Coffer Dam	1	LS	$19,200	$19,200
Turbidity Curtain	1	LS	$1,600	$1,600
Subtotal				**$454,000**
Contractor General Conditions (10%)				$45,400
Total - Construction Hard Costs				**$500,000**
Port Soft Costs (40% of Hard Costs)				$200,000.00
Hard Cost Contingency (40% of Hard Costs)				$200,000.00
Soft Cost Contingency (30% of Port Soft Costs)				$60,000.00
Grand Total				**$1,000,000**

Cost Assumptions:

1. Common cost assumptions across the solutions have been included in the front of this appendix.
2. Assume open cut of Alderwood Road.
3. Assume additional erosion control materials & labor for work near open waterways.
4. Assume paved trench restoration of parking lot.
5. Assumes permitting costs are captured within the Port soft costs given the planning level understanding. Permitting will need to be further defined before design and construction.

Engineer's Opinion of Probable Cost
SWM Solution 8-B: Replace Portion of Eastern Basin 8 Trunk Line Along Airport Way

Item	Quantity	Units	Unit Price	Total
60" Reinforced Concrete Pipe	740	LF	$246	$182,040
Remove Existing Pipe	620	LF	$10	$6,200
Install 120" Manhole	7	EA	$13,000	$91,000
Pavement Removal - Standard Section	244	SY	$4	$976
Pavement Restoration - Standard Section	244	SY	$64	$15,616
Open Cut Shoring	8,820	SF	$2	$17,640
Connect Existing Pipe to Structure	14	EA	$880	$12,320
Traffic Control	1	LS	$50,000	$50,000
Inlet Protection	5	EA	$82	$410
High Visibility Fence	700	LF	$3	$1,750
Seeding and Mulching	0.1	ACRE	$2,000	$200
Stabilized Construction Entrance	1	EA	$1,200	$1,200
Temporary Stormwater Management	620	LF	$4	$2,480
Subtotal				**$382,000**
Contractor General Conditions (10%)				$38,200
Total - Construction Hard Costs				**$421,000**
Port Soft Costs (40% of Hard Costs)				$169,000.00
Hard Cost Contingency (40% of Hard Costs)				$169,000.00
Soft Cost Contingency (30% of Port Soft Costs)				$51,000.00
Grand Total				**$810,000**

Cost Assumptions:
1. Common cost assumptions across the solutions have been included in the front of this appendix.
2. Pipeline realignment necessary to avoid conflict with bridge pier structure.
3. Assume pavement restoration necessary for immediate roadway service.

Engineer's Opinion of Probable Cost

SWM Solution 8-C: Replace Pipe Along NE Airport Way Frontage Road in Northwest Basin 8

Item	Quantity	Units	Unit Price	Total
18" Reinforced Concrete Pipe	230	LF	$75	$17,250
Remove Existing Pipe	230	LF	$8	$1,840
Open Cut Shoring	2,680	SF	$2	$5,360
Sidewalk Restoration	50	SF	$13	$625
Install 48" Manhole	3	EA	$5,500	$16,500
Remove Manhole	2	EA	$400	$800
Connect Existing Pipe to Structure	4	EA	$880	$3,520
Inlet Protection	5	EA	$82	$410
High Visibility Fence	700	LF	$3	$1,750
Seeding and Mulching	0.2	ACRE	$2,000	$400
Stabilized Construction Entrance	1	EA	$1,200	$1,200
Temporary Stormwater Management	230	LF	$4	$920
Subtotal				**$51,000**
Contractor General Conditions (10%)				$5,100
Total - Construction Hard Costs				**$57,000**
Port Soft Costs (40% of Hard Costs)				$23,000.00
Hard Cost Contingency (40% of Hard Costs)				$23,000.00
Soft Cost Contingency (30% of Port Soft Costs)				$7,000.00
Grand Total				**$110,000**

Cost Assumptions:

1. Common cost assumptions across the solutions have been included in the front of this appendix.
2. Assume no traffic control needed for work adjacent to roadway.

Engineer's Opinion of Probable Cost
SWM Solution 8-D: Add Fill and Pipe Storage Southeast of North Runway (10L-28R)

Item	Quantity	Units	Unit Price	Total
24" Reinforced Concrete Pipe	340	LF	$84	$28,560
Remove Existing Pipe	340	LF	$8	$2,720
Open Cut Shoring	4,060	SF	$2	$8,120
Pavement Removal - Standard Section	50	SY	$4	$200
Pavement Restoration - Standard Section	50	SY	$64	$3,200
Install Catch Basin	1	EA	$1,200	$1,200
Adjust Manhole Rims	2	EA	$750	$1,500
Adjust Catch Basin	5	EA	$500	$2,500
Excavate and Haul Fill	100	CY	$8	$800
Place & Compact Fill	3,600	CY	$18	$64,800
Connect Existing Pipe to Structure	13	EA	$880	$11,440
Inlet Protection	25	EA	$82	$2,050
High Visibility Fence	2,000	LF	$3	$5,000
Stabilized Construction Entrance	1	EA	$1,200	$1,200
Seeding and Mulching	0.5	ACRE	$2,000	$1,000
Subtotal				**$135,000**
Airfield Coordination Premium (15%)				$20,250
Contractor General Conditions (10%)				$13,500
Total - Construction Hard Costs				**$169,000**
Port Soft Costs (40% of Hard Costs)				$68,000.00
Hard Cost Contingency (40% of Hard Costs)				$68,000.00
Soft Cost Contingency (30% of Port Soft Costs)				$21,000.00
Grand Total				**$330,000**

Cost Assumptions:
1. Common cost assumptions across the solutions have been included in the front of this appendix.
2. Assume open cut of roadway, no significant traffic control costs incurred.

Engineer's Opinion of Probable Cost

SWM Solution 8-E: Provide Regional Water Quality Treatment for BMP Strategy Area (BMP SA)-8.1

Item	Quantity	Units	Unit Price	Total
Temporary Stormwater Bypass	10	DAY	$320	$3,200
Remove Manhole	1	EA	$750	$750
24" Reinforced Concrete Pipe, Complete	280	LF	$106	$29,680
6" Ductile Iron Pipe, Complete	50	LF	$60	$3,000
Open Cut Shoring	3,960	SF	$2	$7,920
60" Diversion Manhole	2	EA	$9,000	$18,000
60" Return Manhole	1	EA	$7,500	$7,500
Lift Station (~2,000 GPM) - 2 Flyght 20HP Pumps & Controls	1	LS	$100,600	$100,600
Lift Station (~2,000 GPM) - Oldcastle RC611 Precast Structure	1	LS	$99,000	$99,000
Lift Station (~2,000 GPM) - Installation & Start Up	20	DAY	$2,250	$45,000
Contech Stormfilter (67 Cartridges) & Vault (11ft x 30ft)	1	LS	$257,400	$257,400
Contech Stormfilter & Vault Installation	10	DAY	$2,250	$22,500
Detention - Excavation	3,227	CY	$9	$29,043
Detention - Geotextile	1,936	SY	$3	$5,808
Detention - 48" DuroMaxx HDPE, Access Risers, Installation	4,560	LF	$296	$1,349,760
Detention - Aggregate Base	350	CY	$25	$8,750
Detention - Hydroseeding	0.4	ACRE	$2,000	$800
Detention - Appurtenances	1	LS	5%	$69,800
Inlet Protection & Erosion Control	1	LS	$3,000	$3,000
High Visibility Fence	550	LF	$3	$1,375
Stabilized Construction Entrance	1	EA	$1,200	$1,200
Subtotal				**$2,064,086**
Contractor General Conditions (10%)				$206,500
Total - Construction Hard Costs				**$2,271,000**
Port Soft Costs (40% of Hard Costs)				$909,000.00
Hard Cost Contingency (40% of Hard Costs)				$909,000.00
Soft Cost Contingency (30% of Port Soft Costs)				$273,000.00
Grand Total				**$4,400,000**

Cost Assumptions:

1. Assumptions common to all solutions are listed in the front section of Appendix B.

APPENDIX C

LIST OF DELIVERABLES RELATED TO SWMP ANALYSES

APPENDIX C: LIST OF DELIVERABLES RELATED TO SWMP ANALYSES

The following table presents relevant reports and memos developed by the GS&P Team that were previously submitted to the Port and provide additional information related to PDX SWMP analyses and content. The listed files include deliverables that were part of the *Port of Portland Integrated Stormwater Master Planning* project (2013-2015), as well as documentation of related tasks that were performed prior to or simultaneously with the SWMP project.

Table 1 List of Associated SWMP Deliverables

Deliverable Title	**Date Delivered**	**Brief Description**
Basin 7 Spill Control	To be delivered shortly after the *Stormwater Master Plan*	Summary of recommendations for spill control measures within the PDX Drainage Basin 7.
Summary of Deicing System Analysis for PDX Stormwater Master Plan	Jun-2015	Summary of the analysis performed to understand potential impacts to the deicing system from the planned future development and the proposed stormwater management solutions as identified within the *Stormwater Master Plan*. This analysis supported findings and recommendations for stormwater management solutions.
Stormwater BMP Retrofit Plan	Oct-2014	Plan to retrofit targeted underserved areas with stormwater BMPs to improve water quality discharges over time in accordance with the MS4 Permit.
Port MS4 Permit Required Water Quality Assessment	Oct-2014	Documentation of the assessments related to receiving waters to which the Port's MS4 discharges, including 303(d) Listed Pollutant Evaluation; Wasteload Allocation Attainment Assessment; and Total Maximum Daily Load (TMDL) Pollutant Load Reduction Evaluation.
Hydromodification Assessment	Oct-2014	Documentation of the assessment of potential hydromodification impacts related to MS4 discharges required by the Port's MS4 permit
Taxiway E North Stormwater Pipe Sizing Analysis and Drainage Basin 1 South Flood Mitigation Improvements	Sep-2014	Summary of the potential stormwater infrastructure improvements to address the pavement ponding along Taxiway T (SWM Need 1-2 of the SWMP). Included coordination with the Taxiway E North Rehabilitation stormwater design as well as the SWMP. SWM Solution 1-B incorporates the findings of this analysis outside of the Taxiway E North Rehabilitation stormwater sewers.

Deliverable Title	Date Delivered	Brief Description
Basin 7 Flood Management Infrastructure Pump to River Option Memo and Project Charter	Aug-2014	Initial write up for the proposed stormwater management (SWM) solution that includes a new pump that discharges to the Columbia River in Drainage Basin 7 (SWM Solution 7-A) to support the Project Charter. The *Stormwater Master Plan* fact sheet for SWM Solution 7-A is the most recent understanding of the proposed solution. Additionally, development projects surrounding the proposed pump are evolving and coordination on routing of flows and collection area will need to occur.
Stormwater Asset Management Assessment Report	Jul-2014	Summary of the evaluation of the existing state of the selected stormwater infrastructure at PDX, Terminal 2, Terminal 4, Terminal 5, and Terminal 6. Includes findings on material, age, useful life remaining, and past field inspections. Provides recommendations for collection of additional data, prioritization of locations for inspection of pipe condition, and recommendations for pipe inspection, defect coding, and data management processes.
Colwood Pipe Information	Jun-2014	Summary of the proposed stormwater sewer that is to be installed to mitigate the risk of flooding of upstream drainage basins (7a, 7b, 7c, and 7d) should the "Straw" pipe fail.
Port of Portland Stormwater Design Standards Manual	May-2014	The Design Standards Manual (DSM) is the central component of the Port's Post-Construction Stormwater Pollutant and Runoff Control Program. Any development / redevelopment project that meets the threshold of applicability must comply with the DSM requirements.
Ameriflight Stormwater Analysis	Mar-2014	Summary of the results of a stormwater analysis for the Ameriflight Hangar Relocation project, including stormwater quantity and quality management.
PDX Water Quality Assessment	Jan-2014	Documentation providing stormwater modeling results and assessment of existing water quality conditions at PDX in support of the Port's Stormwater Master Plan
Review of Multnomah County Drainage District (MCDD) Model	Nov-2013	Summary of the review of the MCDD hydrologic and hydraulic model, including model comparison and model data differences.
PDX GlyCAST™ Updates	Oct-2013	Summarizes the baseline conditions for the PDX deicing system model, which include the representation of existing conditions development (2013) and the deicing system characteristics following the 2012-2013 deicing season (deicing treatment facility in operation). Additionally the memo summarizes sensitivity of various parameters included within the deicing system model.

Deliverable Title	Date Delivered	Brief Description
Pollutant Fact Sheets	Aug-2013	Fact sheets describing the following pollutants and the potential interaction at Port facilities within the Portland Urban Services Boundary: Aldrin-Dieldrin, Chlordane, Cyanide, Dioxin, Hexachlorobenzene, Iron, Lead, Mercury, PAHs, PCB, PCP, Phosphorus.
Data Gap Analysis	Jun-2013	Summary of the assessment performed on the data provided by the Port of Portland on whether or not the data is sufficient to meet the model inputs and standard technical assumptions necessary to complete the *Stormwater Master Plan* assessments. Values and percentages based upon the GIS data are likely out of date due to updates performed regularly to the GIS data.
PDX Existing Conditions Report	May-2013	Summary of the findings up to May 2013, including those found within the December 2012 *Stormwater Assessment – Existing Conditions, Portland International Airport, Gresham, Smith and Partners* and January 2013 *Existing Pollutant Loads at Outfalls of the Portland International Airport – Draft Final Report,* Geosyntec. The report documents the baseline data for the development of the SWMP. Additional data was collected after this report to provide detail where needed to support analyses (e.g. survey of channel cross sections, survey of prioritized ponded areas, etc.).
Summary of Existing Port BMPs	May-2013	Summary of the types of best management practices implemented at the Port facilities and the information collected on the BMPs during the data collection period of the *Port of Portland Integrated Stormwater Master Planning* project.
Summary of potential future water quality regulations	Apr-2013	Summary and evaluation of potential future water quality requirements which may affect the pollutants of concern, effluent limitations, or other regulatory requirements for the Port
Summary of Existing Water Quality Regulations	Mar-2013	Summary and interpretation of existing water quality regulations that are relevant to the Port, primarily arising from the Port's MS4 permit, the 1200-COLS industrial permit, and 1200-Z industrial permit.
Existing Pollutant Loads at Outfalls of the Portland International Airport – Draft Final Report, Geosyntec	Jan-2013	Summarizes the development and results of the existing conditions pollutant load model for PDX. The conclusions of this report are superseded by the *Stormwater Master Plan* findings and recommendations.

Deliverable Title	Date Delivered	Brief Description
Stormwater Assessment – Existing Conditions, Portland International Airport, Gresham, Smith and Partners	Dec-2012	Summary of the characterization of stormwater issues in existing conditions along with modeling methodology. Additionally this report describes the process and sources used to develop the stormwater management hydraulic and hydrologic models. The conclusions of this report are superseded by the *Stormwater Master Plan* findings and recommendations.
SW Quad Hydraulic Analysis Technical Memorandum with Addendum	May-2010	Summary of the initial analysis of future conditions for the Southwest (SW) Quad and means to reduce the 100-year floodplain. The conclusions of this memo are superseded by the recommendations within the SWMP due to data collection and model updates that have occurred since 2010.
PDX Integrated Stormwater Infrastructure Database (Developed during Stormwater Master Plan Phase 1)	Apr-2009	Data compilation and correlation of Portland International Airport GIS and paper Maintenance Records. This information is superseded by the most up to date PDX GIS files.
PDX Draft Storm Water Master Plan - Phase 1 (Gap Analysis and Recommendations for Future Storm Water Master Plan Phases)	Apr-2009	Summary of the evaluation of the existing stormwater system infrastructure at PDX, including an analyses of gaps in records. The findings are superseded by the *Data Gap Analysis* performed under the *Port of Portland Integrated Stormwater Master Planning* project.

APPENDIX D

GENERAL ASSUMPTIONS USED FOR SWMP ANALYSES

APPENDIX D: GENERAL ASSUMPTIONS USED FOR SWMP ANALYSES

A variety of analyses were performed to support the PDX Stormwater Master Plan. Key assumptions associated with the analyses fall into the following categories and are documented in this appendix.

- Planned Development Assumptions
- Stormwater Hydraulic Modeling Assumptions
- Ponding Assumptions
- Water Quality / Stormwater Control Evaluation Assumptions
- Asset Management Assumptions

Planned Development Assumptions

The following general assumptions were used to characterize planned development at PDX, for incorporation into the stormwater hydraulic modeling as well as stormwater control analyses:

- Planned development project information and extents were compiled into a project list (Appendix A) and figure (Figure 4-1) based on information from the sources listed below, which were received from the Port in 2014. Some additional development projects and project locations/descriptions were added or updated based on coordination with Port staff in 2014-2015.

    - Airport Futures Plan (Jacobs Consultancy, 2010)
    - Port Project Charter and Business Case documents
    - Standalone drawings of various planned development projects
    - Drawings of airport-wide planned development
    - List of 500+ projects for AVI Divisions through 2022 (July 2013)

- The nature of each development project (as shown in Figure 4-1) was determined based on the project description (refer to Appendix A) as well as indications of each project's anticipated impacts on pavement and buildings, as provided by Port staff. In cases where the exact nature of a planned development project was unknown, the project was assumed to involve new construction / reconstruction, which triggers the need for stormwater control planning.

- All planned development that was categorized as new construction or reconstruction of pavement or buildings was assumed to be 100% impervious for purposes of stormwater control sizing and hydraulic modeling.

- To characterize 2035 development conditions for stormwater hydraulic modeling purposes, the planned development and redevelopment project extents were overlaid on and combined with assumed existing conditions impervious areas. Existing impervious areas were assumed to remain impervious through the 2035 planning horizon.

- Development at the Southwest Quad (including the associated Elrod Road Upgrade) was not assumed to occur within the 2035 planning horizon. However, due to the significant extents of the planned development, the hydraulic impacts of this development were evaluated as described in SWM Need 1-8 and the corresponding SWM Solution 1-E.

Stormwater Hydraulic Modeling Assumptions

The following general assumptions relate to the stormwater hydraulic modeling analyses performed to characterize PDX drainage system performance, identify ponding issues and develop drainage infrastructure solutions:

- The technical basis for analysis of the existing PDX storm sewer system was a simulation model developed using Autodesk Storm and Sanitary AnalysisTM (SSA) software. SSATM is an enhanced version of the U.S. EPA Stormwater Management Model (SWMM) software.
- The PDX stormwater hydraulic models were initially developed in 2012 based on data from the Port's GIS. This data was supplemented by select drawings from the Port's Technical Reference Center (TRC) and "pdx-features.dwg" and "pdx-utilities.dwg" CAD drawings. A variety of assumptions based on typical sewer design principles were also incorporated to fill data gaps.
- Modeled storm sewer capacities are as-installed (based on the sources indicated above), and do not reflect restrictions in capacity based on potential maintenance or condition issues that may be present in the field (e.g., pipe deflections, sedimentation or debris deposits, groundwater inflow and infiltration through pipe joints).
- The modeled stormwater infrastructure was generally limited to storm sewer pipes with diameters greater than or equal to 24 inches, except where necessary to capture critical areas served by smaller pipes.
- Base flow assumptions for the stormwater hydraulic models were developed based on an evaluation of seven years of flow data from the PDX SCADA system and rainfall data from the USGS.
- The 2012 stormwater hydraulic models were calibrated to field measured flow rates from four calibration events in 2010-2012. The data were typically collected by flow monitoring devices located along storm sewer trunk lines or at other downstream locations.
- Updates were performed within the existing conditions models between 2013 and 2015 in support of the SWMP, in select portions of the models where additional detail was needed to adequately characterize ponding issues. Updated (2014) versions of the "pdx-features.dwg" and "pdx-utilities.dwg" CAD drawings, as well as select drawings from the Port's TRC were referenced to incorporate any significant changes to the PDX hydraulic system, but the model was not fully updated to reflect 2015 conditions. Additional data from the City of Portland's online GIS were also referenced to fill significant data gaps, where applicable. Survey and site visit data (topographic and infrastructure) was collected in select areas where necessary to address significant data gaps or inconsistencies. Re-calibration of the models was outside the scope of the PDX Stormwater Master Plan Project.
- The Columbia Slough tailwater elevation was assumed to be variable and equal to the tailwater curve used in MCDD's SWMM model for the 100-year, 24-hour storm. The variable tailwater curve assumed for the 10-year, 24-hour storm event was based on MCDD's tailwater

curve for the 100-year event but was adjusted based on the proportional difference in flows between the two events.

- Pump station on/off settings at Broadmoor Pump Station and MCDD Pump Station #2 were assumed to match the "Pre-Storm" settings provided by MCDD in 2014.
- Surface ponding allowances were determined based on the Port's 2005 LiDAR 2' contours. This data was supplemented by more detailed topographic data (e.g. Port survey data, design surfaces from recent Port projects) where available.
- Per the Port of Portland Stormwater Design Standards Manual (DSM), gravel lots were considered impervious.
- Modeling assumptions for the downstream portion of Basin 1 were based on the SWMM model for this region, as created by Crawford Engineering for MCDD.
- Future conditions drainage infrastructure was assumed to be the same as under existing conditions, except where infrastructure was added or modified as part of proposed SWM solutions.
- In redevelopment areas, future conditions drainage patterns and subbasin boundaries were generally assumed to be the same as under existing conditions, except where necessary to subdivide areas to implement proposed SWM solutions. In new development areas, future conditions drainage patterns and boundaries where generally defined based on project extents or anticipated tie-in locations to the existing storm sewer system.

Ponding Assumptions

The following general assumptions were used to estimate design storm ponding extents reflected in the PDX Stormwater Master Plan:

- Simulation results from the PDX stormwater hydraulic models reflecting planned development through the 2035 planning horizon were used to determine the extents of ponding at each ponding need location identified in the PDX Stormwater Master Plan (shown in Figure 4-2).
- The elevations of ponding during the 10-year and 100-year, 24-hour storm events, as simulated in the stormwater hydraulic models, were converted to ponding extents using the Port's 2005 LiDAR 2' contours. In some locations, more detailed topographic data was available to the GS&P Team (e.g. Port survey data, design surfaces from recent Port projects); this data was used to develop ponding extents, where available.

Water Quality / Stormwater Control Evaluation Assumptions

The following general assumptions were used to characterize stormwater control needs and solutions:

- Stormwater controls or best management practices (BMPs) were assumed to be required for all planned development projects categorized as new development or redevelopment, in accordance with the requirements of the MS4 permit and DSM.

- Required capacities of BMPs were determined based on the sizing criteria and equations defined in the DSM, and applicable projects were assumed to be 100% impervious within the project extents defined in Figure 4-1.

- Conceptual BMP footprints were estimated using engineering judgement based on required BMP capacities.

- BMP types were selected from BMP options defined in the DSM, as appropriate based on BMP location and site characteristics. Where possible, a treatment train was recommended. Although not currently required to meet the MS4 permit or DSM requirements, the intent is to preserve the area to address potentially more stringent water quality requirements in the future.

- New BMPs were assumed to be configured off-line, using a lift station to divert flows to the BMP and overcome hydraulic drop limitations.

- All BMPs were assumed to be compatible with dilute deicer stormwater if located in line with the deicing system.

Asset Management Assumptions

The following general assumptions were used in the evaluation of stormwater assets:

- Asset management analyses performed in support of the SWMP focused on pipes with diameters greater than or equal to 18 inches. Pipes on this size range are generally more critical to drainage and are likely to have an increased consequence of failure. Additionally, the datasets referenced for the relevant analyses were considerably more complete for pipes greater than or equal to 18 inches.

- Storm sewer pipe materials and diameters used in the asset management analyses (e.g. useful life analysis) are from the Port's 2012 GIS. Some data gaps were filled by the GS&P Team based on a review of drawings from the Port's TRC, particularly for pipes near ORANG, where there were significant data gaps in the GIS. In select locations (e.g. along storm sewer trunk lines and main lateral lines), pipe materials were assumed based on a review of materials for other nearby pipes.

- Storm sewer pipe installation years used in the asset management analyses (e.g. useful life analysis) are from an internal Port assessment utilizing the TRC. Some data gaps were filled by the GS&P Team based on a review of additional drawings from the Port's TRC, particularly for pipes near ORANG. In select locations (e.g. along storm sewer trunk lines and main lateral lines), missing installation years were assumed based on a review of installation years for other nearby pipes.

- Pipe inspection findings mentioned in the PDX Stormwater Master Plan are from various pipe inspection reports provided to the GS&P Team. For some inspections, particularly the Basin 7 trunk line inspection performed by the Port in 2014, a report was not reviewed by the GS&P Team, and references to the inspection findings are based solely on anecdotal evidence from Port staff.

- Useful life estimates of pipe materials were compiled from the following sources:

    - Oregon Department of Transportation. Hydraulics Manual. 2005.
    - U.S. Army Corps of Engineers (COE). Engineering and Design Manual – Conduits, Culverts, and Pipes, Manual EM-1110-2-2902. 1998.
    - City of Portland Bureau of Environmental Services. Sewer and Drainage Facilities Design Manual. 2006.
    - City of Olympia. Storm and Surface Water Plan. Appendix J: Pipe Evaluation and Replacement Options and Costs. 2003.
    - American Concrete Pipe Association (ACPA). Concrete Pipe Design Manual. 2011.
    - American Iron and Steel Institute (AISI). Welded Steel Pipe Design Manual - Merits, Design Standards, Technical Data and References. 2007.
    - Plastics Pipe Institute (PPI). Corrugated Polyethylene Pipe Design Manual and Installation Guide: Chapter 7- Durability and Service Life. http://plasticpipe.org/drainage/design_manual.html

APPENDIX E

STORMWATER MASTER PLAN IMPLEMENTATION TASKS RACI (RESPONSIBLE, ACCOUNTABLE, CONSULT, INFORM) CHART

Appendix E: Stormwater Master Plan Implementation Tasks
RACI (Responsible, Accountable, Consult, Inform) Chart

Task	Responsible	Accountable	Consult	Inform	Comments
Stormwater master plan sponsor	Planning and development department	Planning and development department	Engineering, construction, maintenance, environmental; Stormwater AMP Team	Business line manager	The Stormwater master plan consists of documents and tools which will require periodic updating. This plan identifies the processess, tools and documents associated with implementation of the Stormwater Master Plan and identifies via a RACI Chart format who is responsible, accountable, etc. for each task. These ongoing tasks can be coordinated by the Stormwater Asset Management Planning (AMP) Team, uner the sponsorship of the Planning and Development Manager, although the actual work will be performed by the responsible/accountable entity.
Stormwater Asset Management Planning (AMP) Team	Planning and development department	Planning and development department	Engineering, construction, maintenance, environmental	Business line manager	Purpose of team is to provide technical input and recommendations regarding storm system infrastructure modifications (capacity, condition, treatment) associated with development and redevelopment projects. Team would also be a technical resource for operating projects with storm system impacts, charter & business case development, project prioritization and sequencing recommendations, project conformance to the Port's Design Standard Manual (DSM), future revisions to the DSM. and tracking/documentation of decisions.
Port Capital Projects - Initiation					
Charter Development					
Develop Charters for Stormwater master plan projects	Development Manager	Development Manager	Civil PE, Lead Engr; Asset management; AMP Team; Env Planner; Stormwater AMP Team	PPO; Business Line Manager	Charters for storm system infrastructure projects will be based on recommendations and information to be provided by the stormwater Master Plan project. Years 1-5 – Actual projects (e.g., straw pipe redevelopment); Years 6-10 – ideas (e.g. Basin 7 stormwater System Improvements); Years 11-20+ -- “master plan” areas (e.g. SW Quad stormwater Program). Some projects will be standalone and some will be combined with capital projects.
All Projects: During Charter development, review potential stormwater impacts and requirements	Development Manager	Development Manager	Civil PE, Lead Engr; Asset management; Env Planner; Stormwater AMP Team	PPO; Business Line Manager	All project Charters are reviewed by the Environmental Planner and potential media impacts (including water quality, NEPA, etc.) are identified. Decisions about hydraulics, asset managemens and treatment may need input from the Stormwater AMP Team. The Development Manager then incorporates information into scope, schedule & budget as appropriate.
Incorporate projects into CIP (ProSight)	Finance; PPO	Development Manager	Sponsor	Business Line Manager	Incorporate Charter/Project Setup information into ProSight
Business Case Development					
Develop Business Cases for stormwater master plan projects	Development Manager	Development Manager or Sponsor; Business Line Manager	Civil PE, Lead Engr; AMP Axis Team; Engineering PM; Stormwater AMP Team	PPO	The stormwater master plan will identify recommended storm system infrastructure projects and will provide a charter level of detail for each project. When projects enter into years 1-5 of the CIP, the development manager will develop the Business Case , including any additional research or study required, for inclusion in the capital projects portfolio (Business Cases are due in September of the year before the FY which the project will start).
All Projects: During Business Case development, review stormwater impacts and requirements	Development Manager	Development Manager or Sponsor; Business Line Manager	Environmental Planner; Civil PE; PM; Stormwater AMP Team	PPO	When projects enter into years 1-5 of the CIP, begin Business Case development. Business Cases are reviewed by the Environmental Planner and an Environmental Checklist is generated identifying impacts to media areas, including water quality (and NEPA, etc.). BC should include any additional research or study required (e.g., infrastructure in the area and condition). Decisions about hydraulics, asset management and treatment may need input from the stormwater AMP Team. Evaluate and include any additional scope and schedule/budget impacts into the project. Business Cases are due in September of the year before the FY which the project will start to be considered for inclusion into the capital portfolio.
Project prioritization	PMT	Business line manager; PPO	Development Manager; asset management; Civil PE; Stormwater AMP Team	Sequencing Team	BLMs initially score projects in their Business Lines and PMT approves the overall prioritization of the portfolios. Stormwater Master Plan will inform prioritization of stormwater projects and stormwater improvements.
Project sequencing	Sequencing Team	Project Manager	Development Manager	Sponsor; Business Line Manager	If projects are approved for inclusion in the capital portfolio, the Sequencing team will sequence the project start date and assign the Project Manager.

Appendix E: Stormwater Master Plan Implementation Tasks
RACI (Responsible, Accountable, Consult, Inform) Chart

Task	Responsible	Accountable	Consult	Inform	Comments
Port Capital Projects - Design					
Design capital project in conformance with Design Standard Manual (DSM)	Designer	Project Manager	Civil PE Lead Engr	Sponsor	Individual project responsible for design consistent with DSM including stormwater treatment and hydraulics; includes evaluation of LID/GI opportunities.
Review/approve project conformance with DSM	Project Engineer	Project Manager	Civil PE Lead Engr; Stormwater AMP Team	Sponsor	Project PE must review & approve calculations, modeling reports, hydrogeologic analyses, O&M plan,and support drawings to ensure project design conforms to DSM. This step includes an assessment of local versus regional controls and/or a decision whether to request a variance from stormwater treatment requirements.
Perform hydraulic analysis using the Port's hydraulic model	Project Engineer; consultant design engineer	Project Manager	Civil PE Lead Engr	Sponsor	Each project must assess impacts to drainage system and flooding using model. Impacts from project may extend outside project boundaries. At a minimum, projects cannot make existing flooding worse. A decision may be necessary regarding infrastructure to fix flooding or surcharging or address an asset management issue particularly if infrastructure is outside project boundaries.
Approve/disapprove variance request	Civil PE, Lead Engr	Project Engineer; Project Manager	Stormwater AMP Team	Sponsor	Notify project development group of treatment requirement. Work with Civil PE Lead and Project Engineer to determine if a local or regional treatment structure is appropriate. If a regional structure is the preferred alternative, variance will be approved and business case/charter needs to be developed to reflect mandatory nature of regional project within specified timeframe. See Port Capital Projects - Initiation for roles/responsibilities regarding charter and business case development.
Port Capital Projects - Close Out					
Update hydraulic model and document stormwater treatment	Project Engineer	Project Engineer; Project Manager	Maintenance; asset management	Development Manager	After review and approval of record drawings, Civil PE ensures hydraulic model is updated with record drawing information, and Project Development group is notified if a charter or business case needs to be developmed for regional treatment structure. Asset management database needs to be updated.
Transition to operations/implementation	Project Manager; Construction Manager	Project Manager; Construction Manager; Project Engineer; Facilities Engineer	Maintenance	Sponsor	Transition needs to ensure the following are completed or addressed: O&Ms, training, preventative maintenance, and warranty
Maintain Tools and Documents					
Design Standard Manual	Civil PE, Lead Engr	Civil PE, Lead Engr	Environmental; Stormwater AMP Team		DSM will require periodic updating to address changing permit requirements, changing boundary, stakeholder input, and lessons learned
Hydraulic model	Project Engineer	Civil PE, Lead Engr			The base hydraulic model will need to be kept updated.
Pollutant load model	Environmental	Environmental	Civil PE, Lead Engr		There may not be an ongoing application for the pollutant loading model associated with capital projects except for five years intervals when MS4 analyses are due.
Stormwater treatment tracking tool	Civil PE, Lead Engr	Project Engineer; Project Manager	Environmental, Planning and Development; Stormwater AMP Team	Sponsor; Business Line Manager	A tracking tool will be developed by the Stormwater Master Plan project. Treatment decisions and variances must be tracked so that regional treatment structure capacity keeps pace with projects. The tracking system must be consistently maintained to ensure it will satisfy an EPA audit.
Intergovernmental Agreement with City of Portland for Stormwater Design Standards	Environmental	Environmental	Engineering; Legal	Government Affairs Manager	1st IGA to be developed by stormwater master plan team but future updates will need to be managed by the assigned entity.

Appendix E: Stormwater Master Plan Implementation Tasks
RACI (Responsible, Accountable, Consult, Inform) Chart

Task	Responsible	Accountable	Consult	Inform	Comments
Operations					
Pipe condition investigations	Asset management	Asset management	Business line, Engineering	Site specific stakeholders	Asset management responsible for obtaining resources, determining prioritization and incorporating results into asset management program. Maintenance will take the lead on investigation, e.g. basin 7 trunk line inspection.
Storm system field modifications	Maintenance	Maintenance	Engineering, construction, environmental; Stormwater AMP Team	Business Line Manager	There is not a formal process to document and track ad-hoc/operations-driven changes to storm system infrastructure (and other utilities). A formal process needs to be established to track changes to storm system infrastructure by maintenance due to failed infrastructure, sinkholes or other issues and the base hydraulic model needs to be udated.
Storm system asset management data	Asset Program Manager	Asset Program Manager	Engineering, construction, maintenance, environmental	Planning and Development Manager	Storm system infrastructure information (condition) is generated by construction and maintenance inspections. In addition, the storm waster master plan project will make recommendations for asset condition field work based on data gaps identified during the project. This information will need to be incorporated into the asset management database that is used to track the storm system. AMP Team has lead role (see under charters - consult).
Stormwater analyses for operating projects	Business Line Manager; Sponsor	Project Manager	Civil PE, Lead Engr; Stormwater AMP Team		Funds must be allocated by the BLM for stormwater analyses for operating projects that will modify storm system infrastructure.
O&M of regional stormwater structures	Maintenance	Business Unit Manager	Environmental	Operations	The O&M costs for regional structures need to be allocated to the responsible business unit and business unit managers must budget the funds. Each treatment structure will have a different cost allocation depending upon which projects/areas are served by the structure.
Tenant Processes					
BATS	Project Engineer responsible for reviewing BATS	Property Manager	Property manager; Stormwater AMP Team	Business Line Manager	These decisions can effect the cost of a development deal. Engineering is the lead to identify storm system infrastructure issues for property transactions: hydraulics and stormwater treatment. There needs to be a discussion with the Property Manager on the path forward.
Tenant construction (PDX projects only)	Project Engineer responsible for reviewing tenant permits	Tenant permit coordinator; property manager	Property manager; Stormwater AMP Team	Business Line Manager	Engineering is the lead to identify storm system infrastructure issues for tenant development: hydraulics and stormwater treatment. This information is communicated to the tenant permit coordinator who communicates it to the tenant.
Financial					
Stormwater facility charges (SWFC)	Finance	Finance	Civil PE, Lead Engr; Property Managers; Stormwater AMP Team	Project managers; property managers	The Stormwater Master Plan Project will provide technical information to finance to facilitate rate setting based on actual projected costs. In addition to initially setting the rate, Stormwater facility charges will require periodic review and updating. The rate structure can impact development deals, so property managers should be consulted for tenant rates.
Financial bank for regional stormwater treatment structures	Finance	Project Manager	PPO		Future opportunity - How will SWFCs be managed in the context of capital projects? Capital projects will need a line item in budget for stormwater treatment. PM is responsible for change management to move money to bank. Finance must create structure so funds can be banked and used at a later date for construction of regional infrastructure.
FAA CIP funding for regional structures	Project development group	Project development group	Finance; Stormwater AMP Team		Future opportunity: Determine if FAA will allow the use of CIP funds to design/construct regional stormwater treatment structure in advance of requirement (i.e.will FAA fund creation of a stormwater bank).

APPENDIX F
REGULATORY SUMMARY

APPENDIX F: REGULATORY SUMMARY

This appendix summarizes key stormwater management regulatory requirements pertaining to the PDX Stormwater Master Plan (SWMP). As described in Section 4 of the SWMP, the need to address stormwater management issues identified at PDX (i.e., ponding, stormwater asset failure, and stormwater controls) is largely driven by regulatory requirements and compliance risks, in addition to potential risks of impacts to airport safety, infrastructure, operations, and development. Additionally, it is critical that stormwater management solutions selected to be implemented do not negatively impact the ability to comply with existing permits and regulatory criteria. In particular, this appendix focuses on state and local requirements driving stormwater management at PDX, as well as FAA criteria applicable to airport design and safety.

The implementation of stormwater management solutions may trigger compliance with additional regulatory processes and criteria, including Sections 401 and 404 of the Clean Water Act, National Marine Fisheries Service consultation, National Environmental Policy Act (NEPA), floodplain regulations, City of Portland environmental zones, and a variety of other requirements. Those broader regulatory considerations are not summarized here, as many have already been summarized in previous SWMP deliverables (see Appendix C).

MS4 Permit

The Port of Portland (Port) and City of Portland (City) each own and operate separate Municipal Separate Storm Sewer Systems (MS4s) within the City Urban Services Boundary (USB). Stormwater discharges from both jurisdictions are regulated under a shared MS4 permit as part of the State of Oregon National Pollutant Discharge Elimination System (NPDES) permit program. The MS4 permit (Permit No. 101314) was most recently renewed by the Oregon Department of Environmental Quality (DEQ) in 2011, but was initially issued as part of the Phase I MS4 individual permit program in 2004. Although the Port and City MS4s are generally distinct, the drainage systems are connected in select areas around the outskirts of the facility, and at locations where property transitions between Port ownership and public or non-Port private facilities. The Port is responsible for implementing the requirements of the MS4 permit within the Port MS4 permit area, which includes all Port-owned property within the City USB (Port 2011).

The Port's requirements for post-construction stormwater management design, review, and approval have been incorporated into the Port's Stormwater Design Standards Manual (DSM), as described in Section 2 of the SWMP. Portions of PDX not implementing the DSM are currently required to comply with the stormwater management requirements in the City of Portland *Storm Water Management Manual*. Both of these stormwater manuals have specific requirements for managing stormwater from development or redevelopment projects (as discussed later in this appendix).

In addition to the post-construction stormwater requirements, the MS4 Permit requires the Port to develop and maintain a stormwater management program which contains overarching goals and additional requirements. These programmatic criteria are not described in this document because they are not drivers for the SWMP.

NPDES Permits for Industrial Activities

1200-COLS General NPDES Permit for Industrial Activities

Although the primary services provided at PDX are related to passenger airline and cargo carrier operations, the facility also encompasses operations ranging from car rental and other airport support services to light industrial business parks and retail. Airport stormwater discharges to the Columbia Slough are permitted under the 1200-COLS general NPDES permit, which is applicable to stormwater discharges from industrial activities other than deicing. The Port maintains a Stormwater Pollution Control Plan (SWPCP) that details industrial activities and stormwater best management practices at PDX. Specific industrial activities that take place at PDX include:

- Fueling
- Aircraft, equipment, vehicle, and building Maintenance
- Aircraft and pavement deicing
- Airport maintenance and operations
- Material storage and handling
- Food services
- Garbage and recycling storage
- Fire station operations and training
- Aircraft, vehicle, and equipment washing
- Rental car fueling, maintenance, and washing
- Aircraft and ground services equipment painting
- Vehicle and equipment storage

Individual NPDES Waste Discharge Permit for Deicing Activities

The Port and associated co-permittees hold an individual industrial NPDES permit (#101647) for stormwater discharges to the Columbia Slough and Columbia River associated with aircraft and pavement deicing activities and the deicing system at PDX. The permit sets daily limitations for BOD mass loading. The permit defines a total maximum BOD mass load (pounds per day) to the river that is dependent on the month. The allowable BOD discharges to the Columbia River are applicable only to the deicing system outfall. The BOD daily mass load allocations for the Columbia Slough are based on flow rate in the Columbia Slough. The BOD daily mass loading allocations to the Columbia Slough are for the Port discharges and Oregon Air National Guard discharges combined. The permit currently allows stormwater discharges to the Columbia Slough year-round and to the Columbia River during the winter months (November through May).

BES Pretreatment Permit for Sanitary Sewer Discharges

The Port holds a Pretreatment Permit from the City of Portland Bureau of Environmental Services (BES) that authorizes the discharge of deicer-impacted stormwater to the sanitary sewer. The permit has limits for the maximum flow rate and maximum daily BOD load that can be discharged to the sanitary sewer.

FAA Criteria for Drainage and Stormwater Management

The Federal Aviation Administration (FAA) provides guidance related to stormwater management at airports in the form of advisory circulars (ACs). Critical stormwater criteria relevant to the SWMP are primarily covered by three ACs:

- FAA Advisory Circular 150/5320-5: "Airport Drainage Design"
- FAA Advisory Circular 150/5300-13: "Airport Design"
- FAA Advisory Circular 150/5200-33: "Hazardous Wildlife Attractants On or Near Airports"

Airport Drainage Design

The Airport Drainage Design AC provides criteria for the design of airport stormwater drainage infrastructure, as well as grading to efficiently drain airport runoff to the drainage system. This AC establishes objectives for airport drainage systems, including the following:

- "The objective of storm drainage design is to provide for safe passage of vehicles or operation of the facility during the design storm event…. Rapid removal of storm water from the pavement minimizes the conditions which can result in the hazards of hydroplaning."
- "The objective of storm water conveyance systems (e.g., storm drain piping, ditches and channels, pumps) is to provide an efficient mechanism for conveying design flows from inlet locations to the discharge point without surcharging inlets or otherwise causing surface flooding."

Key airport drainage system design and performance criteria established by this AC that are pertinent to the SWMP include the following:

- Conveyance systems shall be designed to convey the 5-year storm, without flooding runway and taxiway pavements.
- Infield areas along taxiways and runways may be used to provide storage for storm events larger than the 5-year storm.
- Ponding areas resulting from a 10-year storm shall not cover an area exceeding 50% of the width of any runway or taxiway pavement.
- Requires that airport drainage systems "provide for safe … operation of the facility"

Airport Design

The Airport Design AC provides design standards and guidance for a wide variety of airport features, with consideration for aircraft and vehicle safety, operations, and other critical FAA objectives. In addition to echoing the drainage objectives and goals described in the Airport Drainage Design AC, this AC provides the following additional criteria affecting airport stormwater management:

- The Runway Safety Area (RSA) must be "drained by grading or storm sewers to prevent water accumulation."
- Additionally, the RSA must be "capable, under dry conditions, of supporting snow removal equipment, Aircraft Rescue and Fire Fighting (ARFF) equipment, and the occasional passage of aircraft without causing damage to the aircraft."

Hazardous Wildlife Attractants

AC 150/5200-33 discourages hazardous wildlife attractants, including stormwater impoundments with open water surfaces, within 10,000 feet of an airport's Air Operations Area (AOA), due to the aircraft strike risk. Recurring ponding on an airfield may act as a hazardous wildlife attractant and may warrant mitigation to minimize the wildlife risk.

The PDX Wildlife Hazard Management Plan, which was developed in accordance with FAA criteria, establishes specific criteria and strategies for managing stormwater-related wildlife attractants within multiple wildlife management zones extending outward from the airfield, including the Primary, Intermediate, Secondary, and Five-Mile Zones. In addition to hazing and other operational measures to deter wildlife, strategies to reduce wildlife risk include modifying or eliminating potential wildlife attractants to reduce their attractiveness based wildlife-deterrent characteristics, including the following:

- Complete drainage within 48 hours after a storm event and remain dry between storms
- Steep side slopes with linear edges
- Wildlife-resistant or deterrent vegetation

GRESHAM SMITH AND PARTNERS

155 East Broad Street, Suite 900
Columbus, OH 43215
614.221.0678

www.gspnet.com

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