Low Impact Development Guideline

Seattle-Tacoma International Airport

Effective December 2016, Revised August 2018
Port of Seattle Aviation Environmental Programs

Port of Seattle

RKI planning engineering

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Acknowledgements

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Acronyms and Abbreviations

AA	Apron Area
ACN	Advisory Circular Number
ASDM	*Aviation Stormwater Design Manual (WSDOT 2008)*
AOA	Airport Operations Area
BMP	Best Management Practice
BOD	Biochemical Oxygen Demand
CAVFS	Compost-amended Vegetated Filter Strip
CFR	*Code of Federal Regulations*
DAF	Dissolved Air Flotation
Ecology	Washington State Department of Ecology
FAA	Federal Aviation Administration
FOD	Foreign Object Debris
GSI	Green Stormwater Infrastructure
Guideline	*Low Impact Development Guideline*
IWS	Industrial Waste System
IWTP	Industrial Wastewater Treatment Plant
LID	Low Impact Development
MS4	Municipal Separate Storm Sewer System
NFPA	National Fire Protection Act
NPDES	National Pollutant Discharge Elimination System
PA	Protected Airspace
Permit	*STIA NPDES Individual Permit No. WA-002465-1*
Port	Port of Seattle Aviation
Port SWMM	*Stormwater Management Manual for Port Aviation Division Property (Anchor 2017)*
ROFA	Runway Object Free Area
RPZ	Runway Protection Zone
RSA	Runway Safety Area
SDS	Stormwater Drainage System
SSP	Stormwater Site Plan
STIA	Seattle Tacoma International Airport
SWMMWW	*Stormwater Management Manual for Western Washington (2014 amended)*
SWPPP	Stormwater Pollution Prevention Plan
TOFA	Taxiway Object Free Area
TSA	Taxiway Safety Area
WHA	Wildlife Hazard Area
WHMP	*Wildlife Hazard Management Plan, Seattle-Tacoma International Airport* (Port of Seattle and USDA 2004)
WSDOT	Washington State Department of Transportation

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1 Introduction

This Port of Seattle Aviation (Port) Low Impact Development (LID) Guideline (Guideline) provides guidance for assessing the requirements, applicability, and technical feasibility of implementing LID at Seattle-Tacoma International Airport (STIA). Developed under the Port's LID Program, this Guideline is consistent with the requirements of the STIA National Pollutant Discharge Elimination System (NPDES) Individual Permit No. WA-002465-1 (Permit), Federal Aviation Administration (FAA) requirements for commercial airport operations with regularly scheduled air-carrier service, and Port policies and strategic goals.

The LID Best Management Practices (BMPs) provided in this Guideline comply with applicable FAA regulations. BMP design modifications are provided as needed for alignment with those regulations, particularly for airfield compaction, elimination of standing water, and minimizing wildlife attractants that help maintain passenger and aircraft safety.

1.1 Purpose and Applicability of this Guideline

The Guideline applies to new and redevelopment projects located within the Permit-coverage area that are tributary to the Stormwater Drainage System (SDS). This Guideline does not apply to new or redevelopment projects that are tributary to the Industrial Waste System (IWS) at STIA. See Figure 1-1 for the STIA SDS and IWS drainage basin boundaries.

Refer to the *Stormwater Management Manual for Port Aviation Division Property* (Port SWMM, Anchor 2017) for requirements and standards to be used for projects that are tributary to the IWS. For projects on Port properties located outside of the Permit coverage area, the Guideline shall be used in conjunction with other applicable local jurisdiction codes and requirements.

1.2 Background

This section provides background information on the working definition of LID, STIA's LID program goals and objectives, regulatory requirements and guidance for implementing LID at STIA, and the relationship of this Guideline to other standards, guidance, and tools.

1.2.1 Definition of Low Impact Development

The "Definitions and Acronyms" section of *Western WA Phase II Municipal Separate Storm Sewer System (MS4) Permit, Effective 2013* defines LID as a "…stormwater and land use management strategy that strives to mimic pre-disturbance hydrologic processes of infiltration, filtration, storage, evaporation and transpiration by emphasizing conservation, use of on-site natural features, site planning, and distributed stormwater management practices that are integrated into a project design". For purposes of this Guideline, the terms LID and Green Stormwater Infrastructure (GSI) are used interchangeably, since both practices use similar processes of infiltration, filtration, storage, evaporation and transpiration to manage stormwater runoff naturalistically and in an integrated manner.

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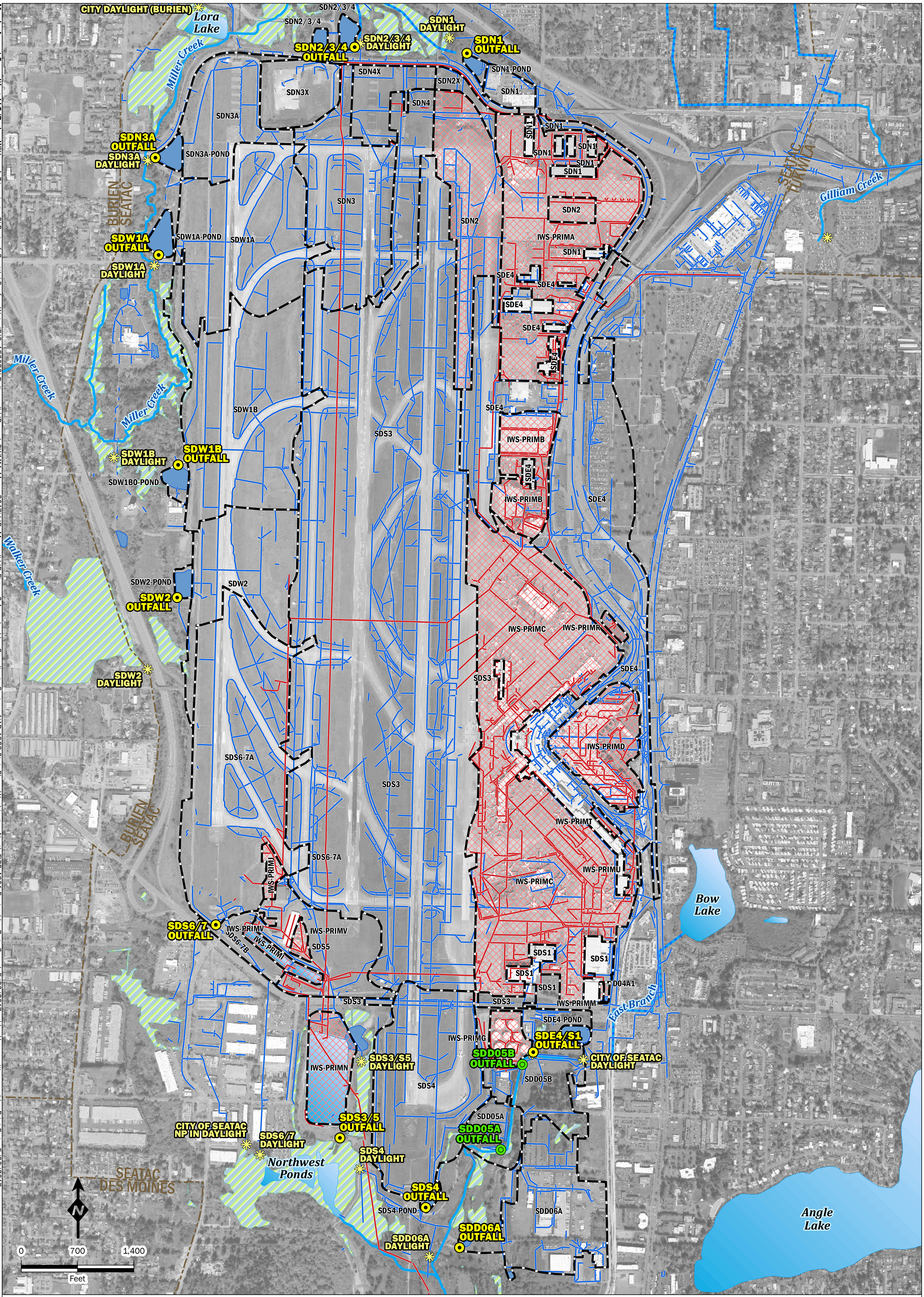

Existing Outfall
Future Outfall
SDS Pipe Daylight
Storm Drainage Subbasin
IWS Conveyance Pipe
SDS Conveyance Pipe
Industrial Waste System (IWS) Area
Surface Waterbody
Conveyance
Stream
City Limit
Wetlands (ESA Consulting 2016)*
Stormwater Pond or Lagoon

*Some wetlands are no longer regulatorily valid and may have changed since they were last delineated. The shapes can be used for site assessment and planning but cannot be used as a basis for future natural resource permitting without a new valid delineation and Corps verification.

FIGURE 1-1

STIA SDS and IWS Drainage Systems, Basins, and Receiving Waters

STIA LID Guideline

MAP BY: Aspect CONSULTING | RKI planning engineering | Port of Seattle

Map by Aspect Consulting, LLC (Parker Wittman): T:\projects_8\Port_of_Seattle\SurfaceWaterDIQ_150050\Delivered\LID_and_SWMM_Maps_2017\LID_Manual\LID Figure 2-1.mxd || Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet || Date Saved: 5/30/2017 || User: pwittman || Print Date: 5/30/2017

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1.2.2 STIA LID Program Goals and Objectives

The Port of Seattle Commission has developed a series of goals, objectives, and guiding strategies within its Century Agenda, which includes a goal to "be the greenest and most energy efficient port in North America" with a commitment to "meet or exceed agency requirements for stormwater leaving facilities owned or operated by the Port". The Port's 2016 Long Range Plan identifies the development of LID and rainwater capture as an action needed to meet this Century Agenda goal and objective.

In addition to these Port-wide goals and objectives, STIA-specific sustainability objectives have been developed. The use of LID BMPs at STIA is included in the 2020 *Airport Sustainability Initiative for Water Quality*: "Contribute to the restoration of Puget Sound and local receiving waters by providing water quality treatment, flow control and infiltration (where feasible) to airport industrial stormwater."

The STIA LID Program supports these environmental goals, objectives, and strategies by:

- Helping to restore Puget Sound and local receiving waters through the programmatic use of LID;
- Using FAA-acceptable LID BMPs that meet or exceed minimum requirements for stormwater discharging from Port-owned or -operated facilities;
- Integrating LID into on-going flow control, water quality treatment, and runoff capture and reuse practices, designed in a manner consistent with FAA-regulated passenger and aircraft safety and operational standards and the STIA wildlife hazard management plan;
- Maintaining planning and operations consistent with the Port stormwater facilities certification as Salmon-Safe under those stormwater management guidelines (Salmon-Safe 2016); and
- Contributing leadership to the United States Airport Industry in environmental innovation, while minimizing STIA's environmental impacts.

1.3 Regulatory Requirements and Guidance

Regulatory requirements and guidelines from the Permit and the federal code pertaining to planning, design, construction, and maintenance of stormwater management facilities at STIA are summarized below.

<u>Permit</u>

Part 2 of the Permit covers stormwater discharges from the approximately 1,200 acres of SDS basin area (Figure 1-1). Stormwater runoff in the SDS is generally from roads, runways, taxiways, airfield, rooftops, cargo operation areas, flight kitchens, and other areas associated with airport industrial activities. Stormwater runoff from these surfaces is treated via existing ponds, grass swales, and other passive stormwater treatment methods in accordance with Special Condition 2S6 - Stormwater Pollution Prevention Plan (SWPPP).

Special Condition 2S6.A.3 requires the Port to adopt a STIA-specific LID implementation guideline effective December 31, 2016. This Guideline was prepared in accordance with that Permit requirement.

FAA Regulations and Guidance

Applicable FAA regulations are summarized in *MEMORANDUM: FAA Limitations and Exclusions to Applying LID Standards at STIA* (HNTB 2016), provided in Appendix A. The primary FAA regulations that apply to STIA operations and certification are contained in Title 14 CFR Part 139, Certification of Airports, Subpart C (Airport Certification Manual) and Subpart D (Operations).

STIA must be maintained and operated in a condition that meets all requirements deriving out of CFR Part 139. Modification from the standards without FAA approval is not permitted. Annual inspections are required to maintain FAA certification under these regulations. The FAA guiding documents that derive from CFR Part 139 affecting airport design and operations are listed below:

- ***FAA Advisory Circular Number (ACN) 150/5300-13A, Airport Design*** - Prescribes airfield layout standards to maintain passenger and aircraft safety around operational surfaces in the various FAA regulated airport zones.
- ***FAA ACN 150/5200-33B, Hazardous Wildlife Attractants On or Near Airports*** - Provides design limitations on certain land uses that have the potential to attract hazardous wildlife on or near public-use airports.
- ***FAA ACN 150/5370-10G, Standards for Specifying Construction of Airports*** - Prescribes the material requirements and methods used for the construction of airport operating surfaces and subgrades including site drainage.
- ***FAA ACN 150/5210-24, Airport Foreign Object Debris (FOD) Management*** - Provides required management practices to reduce the risk of FOD damage within the Airport Operations Area (AOA).
- ***FAA ACN 150/5380-6, Guidelines and Procedures for Maintenance of Airport Pavements*** - Describes methods for maintaining airport pavements used by aircraft.
- ***FAA ACN 150/5320-6E, Airport Pavement Design and Evaluation*** - Describes required methods for design and evaluation of airport structural and shoulder pavements used by aircraft.
- ***FAA ACN 150/5320-5D, Airport Drainage*** - Describes requirements for the design and construction of airport surface and subsurface storm drainage systems for paved runways, taxiways, and aprons.
- ***Seattle-Tacoma International Airport Certification* Manual** – Requires that STIA be certified by the FAA every 3 years. Section 309 – Runway Safety Areas (RSAs) describes the required condition of safety areas, as influenced by site drainage conditions.

1.4 Relationship to Other Standards, Guidance, and Tools

Several other requirements, standards, and guidance by the State of Washington, the Port, and local jurisdictions may affect how LID is implemented at STIA. A summary of related stormwater management manuals and guidance documents, local jurisdiction codes and standards, and available tools is provided below:

Stormwater Manuals and Guidance Documents

- ***Stormwater Management Manual for Port Aviation Division* Property (Port SWMM; Port of Seattle 2017)** – Provides standards for implementing the Stormwater Management Manual for Western Washington (2014 amended, SWMMWW) on Port properties. This Guideline is used in conjunction with the Port SWMM.
- ***Wildlife Hazard Management Plan, Seattle-Tacoma International Airport* (WHMP; Port of Seattle and USDA 2004)** – The guiding document used for wildlife management at STIA. The manual echoes the FAA advisory circulars requirements and expands upon them to include a Landscape Exclusion Zone Map as well as a list of approved plant species for each landscape area.
- ***LID Technical Guidance Manual for Puget Sound* (WSU Extension and Puget Sound Partnership 2012)** – Provides guidance on LID principles, such as site assessment, site planning and layout, vegetation and soil protection, site preparation and construction/inspection; and guidance on design, construction, inspection, and maintenance of LID BMPs.
- ***Aviation Stormwater Design Manual: Managing Wildlife Hazards Near Airports* (ASDM) M3041.00, (WSDOT 2008)** – Developed in partnership by the FAA and WSDOT to provide guidance on minimizing hazardous attraction of wildlife in stormwater facility design.

Local Codes and Standards

- ***Municipal codes for cities of SeaTac, Burien, Des Moines*** - These municipal codes apply to development on STIA property outside of the Permit boundary and within those jurisdictions. As required by the NPDES Phase II MS4 Permit, these municipalities updated their 2016 codes, standards, ordinances, and other enforceable documents to make LID the preferred and commonly used approach to new and redevelopment.
- ***King County Surface Water Design Manual* (King County 2016)** - The Cities of SeaTac, Burien, and Des Moines have adopted this manual, or a locally modified equivalent version. This manual has been identified as equivalent to the SWMMWW through Appendix 10 of the Ecology NPDES Phase 1 MS4 Permit.
- ***Interlocal Agreement with the City of SeaTac*** - The Port has an inter-local agreement with the City of SeaTac which guides design review and specific project requirements, inclusive of LID application.

Implementation Tools

- ***Infiltration Feasibility Assessment, Seattle-Tacoma International Airport, SeaTac, Washington (Aspect 2016)*** - Provides planning-level guidance for identifying infiltration opportunities based on STIA geology, hydrogeology, and expected surficial geology/soils permeability characteristics, while also considering runway embankment fills and associated retaining walls, steep slopes, and other sensitive and critical area limitations to infiltration. It provides figures that summarize the key assessment findings including an overview assessment of shallow and deep infiltration potential and feasibility for Port properties within and beyond the NPDES Permit boundary.
- ***Infiltration Infeasibility Map (Aspect 2018)*** – Provides a map of areas pre-determined to be infeasible for infiltration based on the infeasibility criteria provided in the SWMMWW. This map is used as the first step in assessing project site infiltration

feasibility for selecting appropriate LID BMPs for on-site stormwater management, runoff treatment, and flow control. Refer to Figure 3-3 for instructions on how to use this map and Figure 3-4 for the map itself. Appendix B provides the technical report that documents the background assumptions and methods used for developing this map (Aspect 2018).

- ***Model Stormwater Management Guidelines for Infrastructure New Development and Redevelopment (Salmon-Safe 2016)*** - Provides guidelines for achieving Salmon-Safe Certification goals and objectives related to implementing technically feasible LID practices for new development and redevelopment that address runoff retention and discharge water quantity/quality control needs.

2 Existing Systems and LID BMPs

Stormwater runoff is collected by one of two STIA drainage systems — the SDS or the IWS — with collective tributary drainage basin areas of approximately 1,575 acres (Port of Seattle 2015). Figure 1-1 shows those drainage systems and the current STIA basin areas that drain to each system and receiving water.

The following sections briefly describe each system and provide the general rules for determining where STIA site improvements must drain. Refer to the STIA SWPPP (Port of Seattle 2015) for more specifics. Under some circumstances, the Port may also require the stormwater runoff from a site to drain to the sanitary system. The project proponent is required to contact the Port's Environmental Program Manager to confirm which system is appropriate for use for their project.

2.1 Stormwater Drainage System

Part 2 of the Permit covers stormwater associated with the SDS, serving approximately 1,200 acres (Port of Seattle 2015) of the stormwater drainage system. Stormwater runoff is from roads, runways, taxiways, airfield, rooftops, cargo operations, flight kitchens, and other areas associated with airport industrial activities. Runoff from nearly half of that area emanates from impervious (hard) surfaces.

Stormwater runoff is controlled and treated prior to discharge to outfalls using detention ponds, compost-amended filter strips, biofiltration and bioretention swales and cells, and other passive stormwater treatment methods. Treated stormwater discharges to freshwater streams, wetlands, and lakes around the airport. Lake Reba and Miller Creek receive runoff from approximately 25% of SDS area, the Northwest Ponds and Des Moines Creek receive runoff from approximately 71% of the SDS area, and Walker Creek and Gilliam Creek receive runoff from the remaining drainage areas (Figure 1-1; Port of Seattle 2015).

The STIA SDS underwent significant recent modifications with stormwater retrofits in response to Permit conditions and requirements of a Section 401 Water Quality Certification issued in association with the 1997 Master Plan Update. A number of studies and planning documents were completed to enable these modifications. The final stormwater improvements for retrofit of the SDS under the Permit were completed in 2011 (Port of Seattle 2015). The outcome of these stormwater retrofits has been a highly functional SDS that has maintained compliance with the Permit water quality discharge effluent limits at the eleven designated SDS outfalls.

2.2 Industrial Waste System

The IWS consists of a collection and conveyance system, a high and low strength biochemical oxygen demand (BOD) waste stream segregation system, three storage lagoons, an industrial wastewater treatment plant (IWTP) that includes dissolved air flotation (DAF), a direct discharge to Puget Sound through the Midway Sewer District's outfall, and an alternate discharge to King County's Renton Treatment Plant for the high strength BOD waste stream.

IWS flows consist of runoff collected from the North and South Service Basins, totaling approximately 375 acres (Port of Seattle 2015), which mainly consists of stormwater runoff from terminal, air cargo, deicing areas, hangars, and maintenance areas. The parking structure and surrounding ground-level parking and toll booth area also discharge to the IWS up to the water quality design storm, with a high flow bypass diverting overflows to the SDS.

Due to the nature of activities in these areas, the water collected has variable levels of spilled fuel, deicing and anti-icing chemicals, wash water, and other minor process water sources. These combined stormwater and intermittent process flows (collectively defined by Ecology as process flows) are collected in the IWS drainage system and are conveyed to the storage lagoons for subsequent treatment in the IWTP.

The STIA LID Program does not apply to the projects within the airport ramp or other IWS service areas because of the industrial activities that occur, elevated level of runoff contaminants, and presence of known subsurface contamination.

2.3 Stormwater Drainage Systems Outside Airport NPDES Limits

The Port owns property and, in some cases, operates facilities beyond the AOA limits that are not covered under the Permit. Stormwater requirements for new and redevelopment occurring outside the Permit coverage area are in accordance with the local jurisdiction (Cities of SeaTac, Burien, and Des Moines) NPDES Phase II MS4 General Permit.

The Port has an inter-local agreement with the City of SeaTac as the basis for coordinating design review and specific project requirements, inclusive of LID application within the City's jurisdiction. This Guideline may be used to determine appropriate LID implementation requirements, including limitations in BMP selection and design applicable to the operation and maintenance of STIA in accordance with FAA regulations.

2.4 LID and Treatment Facilities

The Port has installed numerous LID and water quality treatment facilities that meet competing needs (Section 3.2) and site constraint criteria, including (Figure 2-1):

- Construction of Runway 16R (Third Runway) filter strips with length extension beyond that required and with compost amendment;
- Reconstruction of Runway 16L/34R and 16C/34C filter strips with shoulder widening improvements, inclusive of compost amendment and extension in filter strip length;

- Installation of a media filter drain system along the east embankment of the north-bound expressway exiting the airport;
- Construction of bioretention cell to serve the cell phone parking lot;
- Construction of bioretention swales SDS1 and SDN1;
- Use of a solar powered pump system at the SDN1 pond, operated to promote infiltration of wet pool volume during the summer months;
- Retrofit of the South Employee Parking Lot grass swale with bioretention to treat discharges from SD05B; and
- Temporary closure of selected stormwater detention pond outlet control valves during summer periods to promote infiltration under shallow ponding depths.

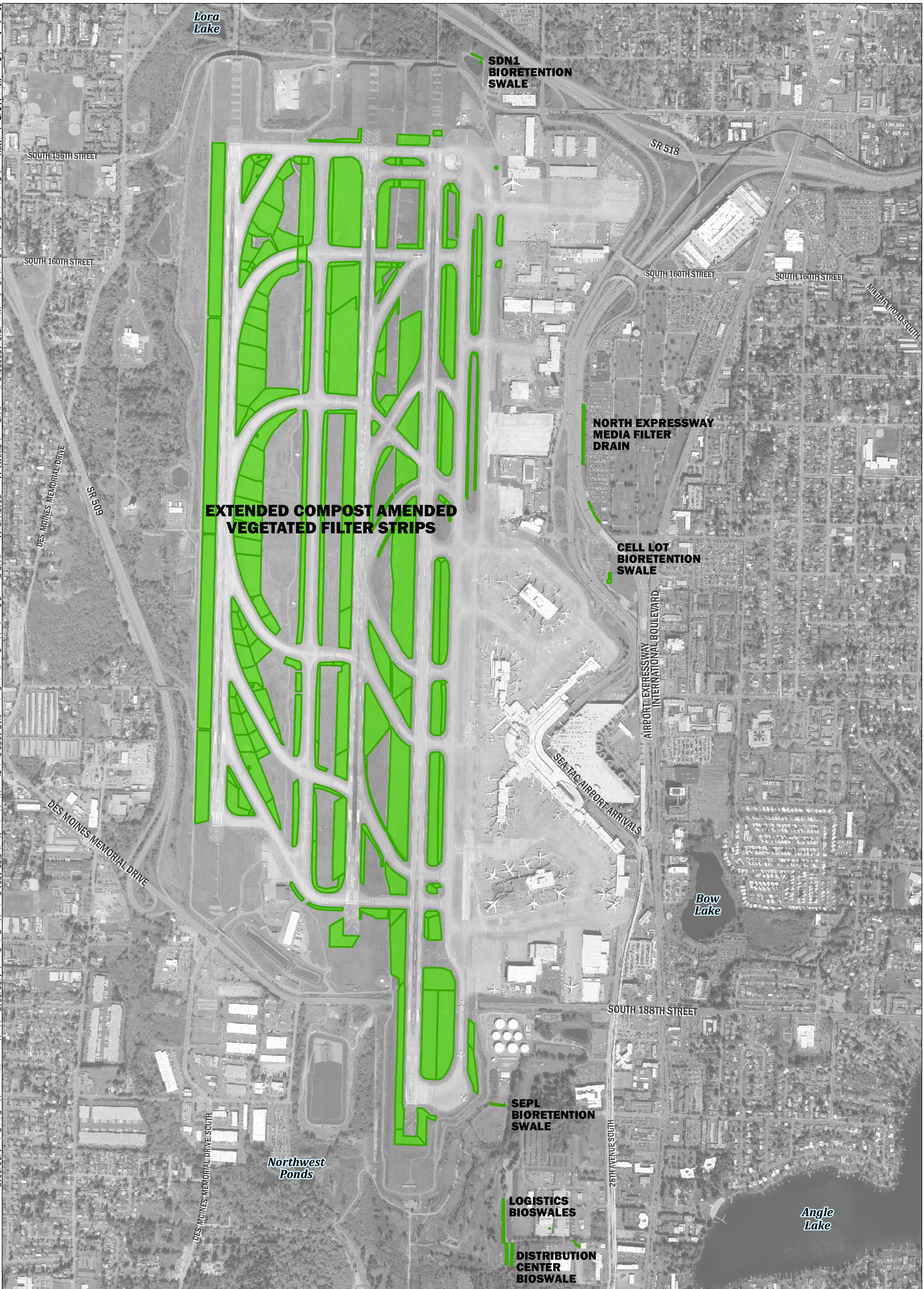
Modifications to the airfield filter strips' design from the SWMMWW compost-amended vegetated filter strips (CAVFS; BMP T7.40) criteria were made to provide compatibility with Runway Safety Area (RSA) and Runway Object Free Area (ROFA) aircraft operation limitations under FAA regulation in those zones. The Third Runway and Runways 16L/34R and 16C/34C reconstructed CAVFS designs were based on recommendations included in the soil amendments analysis conducted as part of the Port's Stormwater Engineering Report (R W Beck 2006).

The analysis concluded that amending the upper 4 inches of soil with compost produces a soil layer with greater water storage capacity and increased infiltration and evaporation characteristics, while still meeting FAA airfield compaction requirements to support aircraft and emergency vehicles. Specifically, 2 inches of compost were incorporated into the upper 4 inches of soil disturbed during construction activities to achieve a composite topsoil with a minimum organic matter content of 10% (by weight). Runway filter strip lengths were also maximized from the runway shoulder to catch basin inlets (typically to 100 feet or greater). This is three to four times the typical required CAVFS length based on the SWMMWW BMP design criteria. This STIA-modified airfield filter strip BMP is referred to as Extended CAVFS.

Other STIA bioretention swale/cell design modifications have included the following:

- Retrofitting biofiltration swales with mixed filter media;
- Limiting intermittent ponding to a maximum of 4 inches in depth for durations up to a maximum of 48 hours;
- Use of underdrains with outlet shutoff valves to minimize ponding effects under possible long-term subgrade infiltration degradation; and
- Specifying grass or a carefully-selected native plant palette for the bioretention cell/swale vegetative cover instead of the SWMMWW-recommended plant species (i.e., cell phone parking lot bioretention BMP criteria) (Otak 2014). These modifications reduce ponding and plant species diversity, making the bioretention swales less attractive to wildlife.

These STIA BMP modifications help achieve on-site stormwater management, flow control, and water quality treatment objectives to the extent feasible while reducing or avoiding impacts to airport operations.



LID Bioretention and Infiltration

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Feet

FIGURE 2-1
Existing STIA LID and Treatment Facilities Providing LID Functions

Seattle Tacoma International Airport Stormwater Low Impact Development Guideline

MAP BY: Aspect CONSULTING | RKI planning engineering | Port of Seattle

Map by Aspect Consulting, LLC (Parker Wittman): T:\projects_8\Port_of_Seattle\SurfaceWaterDIG_150050\Delivered\LID_and_SWMM_Maps_2017\LID_Manual\LID Figure 2-2.mxd || Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet || Date Saved: 4/26/2017 || User: pwittman || Print Date: 4/26/2017

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3 Implementing LID for New and Redevelopment Projects

Implementing LID for new and redevelopment projects at STIA entails the following 7 steps.

- ***Step 1*: Determine Minimum Requirements Applicability
- ***Step 2*: Evaluate Competing Needs
- ***Step 3*: Assess Dispersion Feasibility
- ***Step 4*: Assess Infiltration Feasibility
- ***Step 5*: Select LID BMPs
- ***Step 6*: Design and Construct LID BMPs
- ***Step 7*: Conduct long-term Operation and Maintenance

Figure 3-1 presents a flow chart illustrating how to follow these steps to determine if LID BMPs are required and, if so, how to assess technical feasibility, select, and design LID BMPs. Each step is discussed below.

3.1 Step 1: Determine Minimum Requirements Applicability

The Port SWMM defines a total of 10 minimum requirements for new and redevelopment projects. Refer to Volume I, Chapter 2, Section 2.4 of the Port SWMM for the procedures to be used to determine the applicability of all 10 minimum requirements, including the flow charts provided in Figure 2.4.1 for new development (e.g., sites with less than 35% existing impervious coverage) and Figure 2.4.2 for redevelopment projects. The majority of STIA is located within a single parcel (KC 2823049016) that has greater than 35% impervious coverage. All projects within this area are classified as redevelopment.

In addition to Minimum Requirement (MR) #5 – On-site Stormwater Management, MR #6 – Runoff Treatment and/or MR #7 – Flow Control may also apply if the project adds more than 5,000 square feet of new or replaced hard surfaces or converts 3/4-acre or more of vegetation to lawn or landscape (refer to the Port SWMM for complete requirements). For projects that trigger MR #6 and/or MR #7, water quality treatment and flow control BMPs are evaluated and applied in addition to the evaluation and application of LID BMPs in accordance with this Guideline. Therefore, LID BMPs may be stand-alone on some smaller projects or may work in concert with flow control and treatment BMPs on larger projects.

Projects that trigger MR #5 shall evaluate and use LID BMPs in accordance with the thresholds, standards, and criteria provided in the SWMMWW, Volume I, Section 2.5.5 to infiltrate, disperse, and retain stormwater runoff on-site to the extent feasible without causing flooding or erosion impacts. Regulatory competing needs (Section 3.2 of this Guideline), including requirements to minimize hazardous attraction of wildlife, shall also be assessed when selecting LID BMPs and required design modifications (Section 3.6 of this Guideline) shall be incorporated into LID BMP designs.

Under the Salmon-Safe certification program, the threshold for application of those stormwater management guidelines and associated LID provisions is a project footprint exceeding 5,000 square feet.

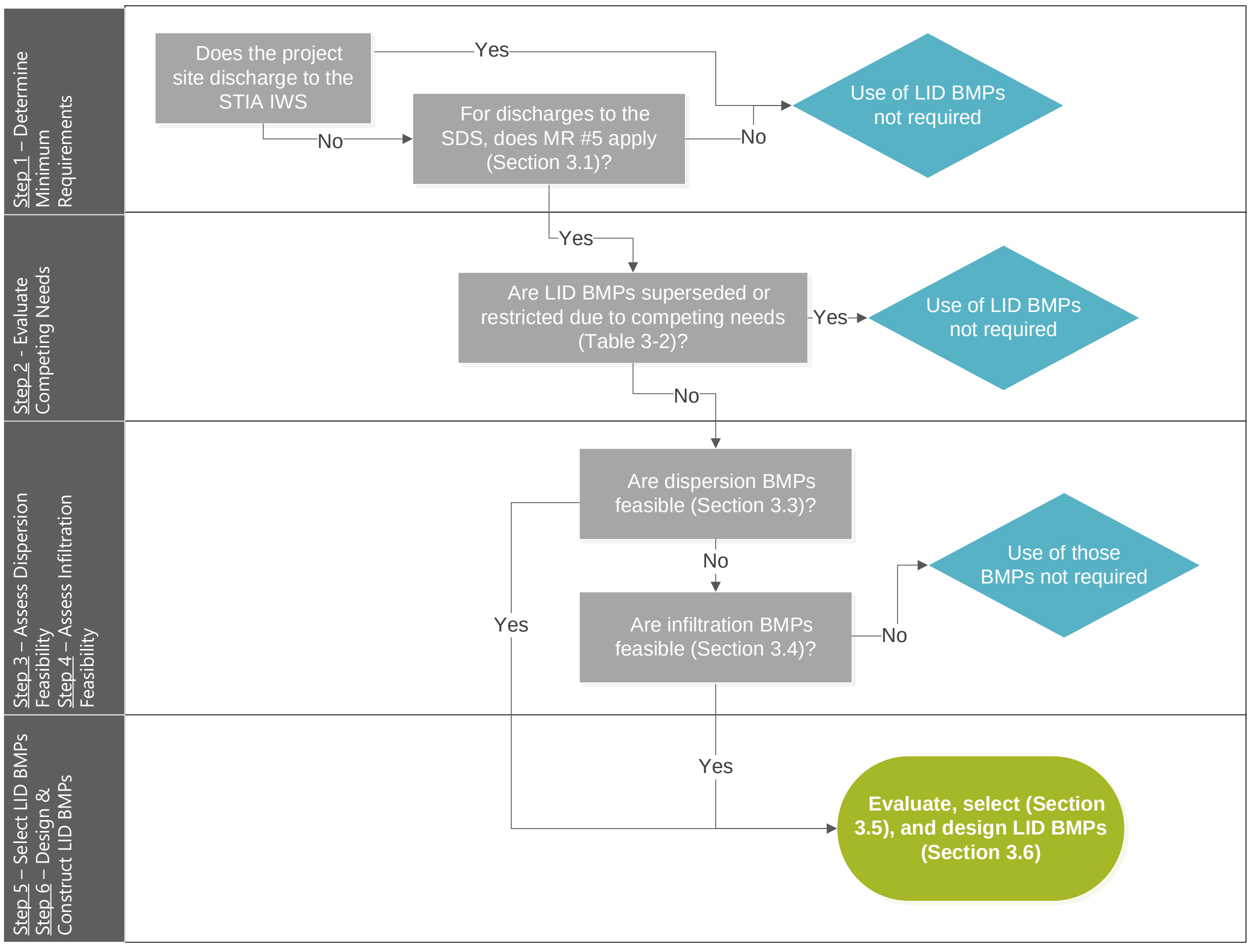

Figure 3-1
STIA LID BMP Applicability and Evaluation Flow Chart (Steps 1-6)

Abbreviations:

BMP	Best Management Practice	MR	Minimum Requirement
LID	Low Impact Development	SDS	Stormwater Drainage System

3.1.1 New Development

The following new development shall comply with MR #5 – On-site Stormwater Management for the new and replaced hard surfaces and the land disturbed:

- Results in 2,000 square feet or more of new, replaced, or new plus replaced hard surface area (e.g., impervious surfaces, permeable pavement, and vegetated roofs); or
- Disturbs 7,000 square feet or more of land.

MR #5 shall also apply to the new and replaced hard surfaces and the converted vegetation areas for new development that:

- Results in 5,000 square feet, or greater, of new plus replaced hard surface area; or
- Converts ¾ acres or more of vegetation to lawn or landscaped areas; or
- Converts 2.5 acres or more of native vegetation to pasture.

3.1.2 Redevelopment

The following redevelopment shall comply with MR #5 – On-site Stormwater Management for the new and replaced hard surfaces and the land disturbed:

- Results in 2,000 square feet or more of new, replaced, or new plus replaced hard surface area (e.g., impervious surfaces, permeable pavement, and vegetated roofs); or
- Disturbs 7,000 square feet or more of land.

MR #5 shall also apply to the new hard surfaces and converted pervious areas for redevelopment that:

- Adds 5,000 square feet or more of new hard surface; or
- Converts ¾ acres or more of vegetation to lawn or landscaped areas; or
- Converts 2.5 acres or more of native vegetation to pasture.

3.2 Step 2: Evaluate Competing Needs

If the project triggers MR #5 (Section 3.1), competing needs must be evaluated in this step to determine whether use of LID BMPs is superseded or restricted by regulatory requirements. From Volume V, Section 5.3.1 of the SWMMWW, competing needs applicable to STIA operations include the following:

- FAA standards and requirements for airports;
- Transportation regulations to maintain the option for future expansion or multi-modal use of transportation facilities and public rights-of-way; and
- Public health and safety standards.

This section identifies STIA's operation zones and key FAA regulatory requirements affecting LID implementation in each zone. The regulatory requirements discussed in this section are summarized from *MEMORANDUM: Federal Aviation Administration Limitations and Exclusions* *to Applying LID Standards at Seattle-Tacoma International Airport* (HNTB 2016), provided in Appendix A.

3.2.1 Map Operation Zones

The FAA defines several operation zones with specific requirements for siting and design of stormwater facilities, including LID BMPs. These zones are described briefly below and are mapped in Figure 3-2. Refer to Appendix A for additional detail:

- **Airport Operations Area (AOA)** – The area of an airport used or intended for use for landings, takeoffs, or surface maneuvering of aircraft. The AOA is the area where aircraft can operate, either under their own power or while in tow. At STIA, the AOA is defined physically by the airport perimeter fence and includes all areas with restricted access and located outside the airport terminal buildings, including runways, taxiways, aprons, ramps, hardstands, safety areas, perimeter roads, and cargo areas.

- **Runway Safety Area (RSA)** – The defined ground space surface that includes and surrounds the runway and is prepared for the express purpose of reducing catastrophic loss of life and damage to aircraft in the event of an undershoot, overshoot, or excursion from the runway surface. At STIA, the RSA for air-carrier operations of Group V aircraft is 500 feet wide, centered on the runway, and extends 1,000 feet beyond the runway ends.

- **Runway Object Free Area (ROFA)** – The defined area centered on the runway enhances the safety of aircraft operations by remaining completely clear of objects, including terrain variations, that protrude above the elevation of the nearest point of the RSA surface. At STIA, the ROFA is 800-feet wide, centered on the runway, and extends 1,000-feet beyond the runway ends, consistent with the RSA in those locations.

- **Taxiway Safety Areas and Taxiway Object Free Area (TSA, TOFA)** – These areas mirror the intent of the RSA and ROFA but are centered on taxiways and have smaller dimensional requirements. These areas also define safety zones for aircraft deviating from the paved operational surfaces. Based on the aircraft serving STIA, the TSA is designated as 214-feet-wide, and the TOFA is designated as 320-feet-wide, both centered on the taxiway.

- **Apron Area (AA)** – The defined area outside of the ROFA and TOFA, located adjacent to the terminal, aircraft maintenance and cargo buildings. Its primary function is to: 1) provide a place to safely accommodate aircraft during loading and unloading of passengers and cargo; 2) provide for circulation of aircraft and ground vehicles; and 3) provide a location for fueling, deicing, maintenance, and aircraft parking. The AA for STIA, inclusive of the cargo hardstand areas, drain to the IWS, and are treated by STIA's on-site IWTP.

- **Runway Protection Zone (RPZ) and Protected Airspace (PA)** – The trapezoidal shaped ground area off the runway end that enhances the safety and protection of the public by controlling the land uses and eliminating incompatible objects and activities.

This PA is a family of related three-dimensional airspace surfaces designed to provide obstacle clearance to arriving and departing aircraft.

3.2.2 Assess Applicable LID Restrictions

Table 3-1 summarizes restrictions on LID implementation at STIA based on regulatory requirements of the FAA, Ecology, and local jurisdictions.

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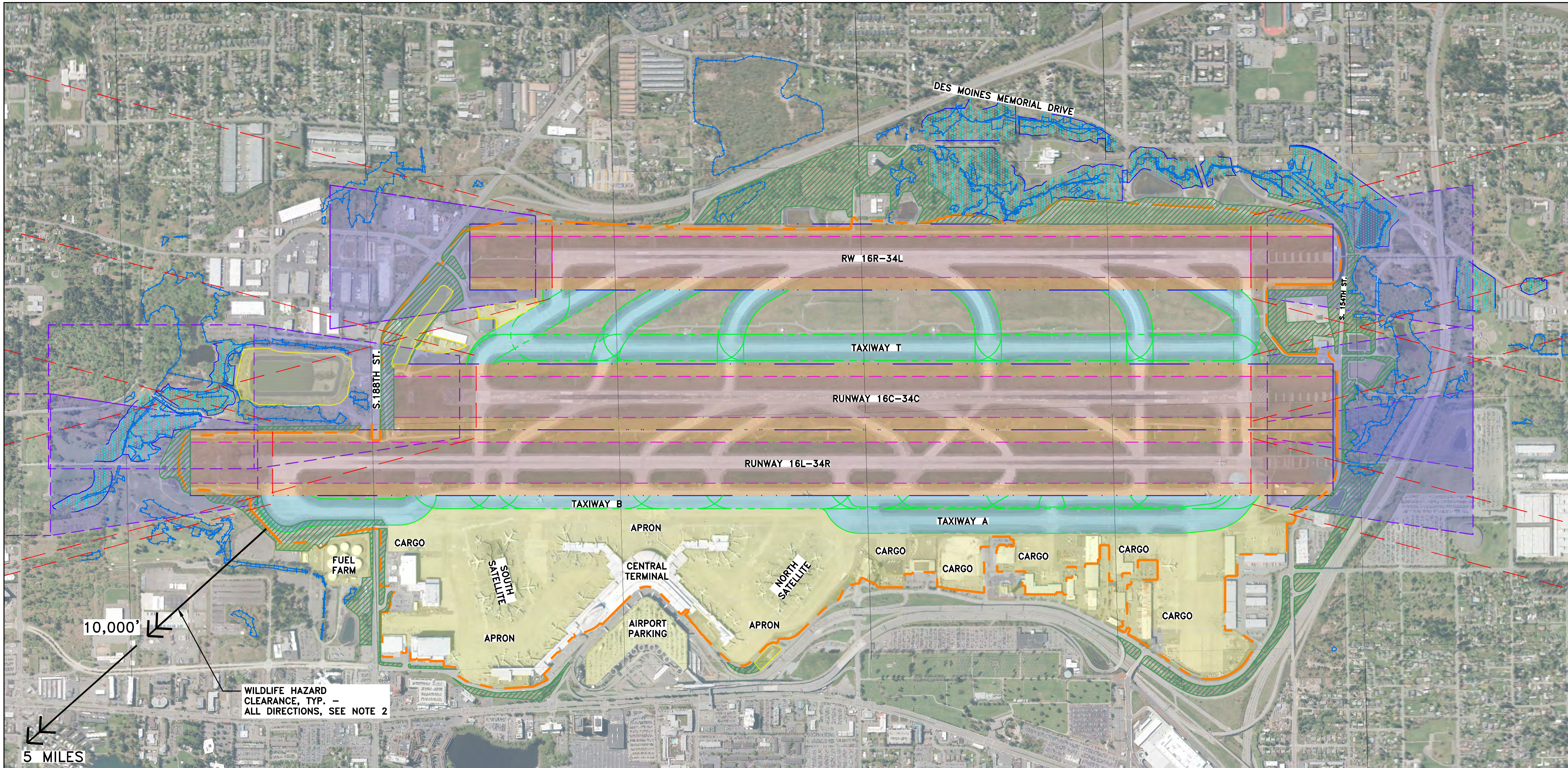

LEGEND:

- RUNWAY SAFETY AREA (RSA)
- RUNWAY PROTECTION ZONE (RPZ)
- APRON: AIRCRAFT PARKING, CARGO HARDSTAND OR OTHER INDUSTRIAL USE AREAS DRAINING TO IWS (INCLUDES FUELING AND AIRCRAFT DEICING AREAS)
- RUNWAY OBJECT FREE AREA (ROFA)
- TAXIWAY OBJECT FREE AREA (TOFA)
- RESTRICTED COVENANT
- AOA BOUNDARY
- WETLAND BOUNDARY
- RUNWAY DEPARTURE SURFACES
- MSE WALL AND CONSTRUCTED EMBANKMENT AREAS SUPPORTING AIRPORT, FAA AND PUBLIC INFRASTRUCTURE

NOTES:

1. WHERE ZONES OVERLAP, THE MORE STRINGENT STANDARDS APPLY.
2. "FAA ADVISORY CIRCULAR NUMBER 150/5200-33B, HAZARDOUS WILDLIFE ATTRACTANTS ON OR NEAR AIRPORTS" RECOMMENDS A SEPARATION DISTANCE OF 10,000 FEET BETWEEN ANY HAZARDOUS WILDLIFE ATTRACTANTS AND THE AIRPORT'S AOA AND 5 STATUTE MILES OF SEPARATION FOR WHERE THAT ATTRACTANT COULD CAUSE HAZARDOUS WILDLIFE MOVEMENT INTO OR ACROSS THE APPROACH OR DEPARTURE AIRSPACE. THIS INCLUDES THE LANDSIDE AND TERMINAL AREAS EAST OF THE AIRFIELD.

HNTB

N

600 0 600 1200
Scale Feet

FIGURE 3-2: STIA FAA DESIGNATED OPERATION ZONES LIMITING LOW IMPACT DEVELOPMENT IMPLEMENTATION

JUNE 30, 2016

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Table 3-1
Summary of LID Restrictions Based on Competing Needs for STIA Operations

LID Restriction	Applicable Operation Zones	Summary of Regulatory Competing Need
1. No infiltration permitted in IWS service area	AA	• Ecology – Permit does not allow non-stormwater discharges to groundwater • Ecology – Compliance with groundwater management standards is required (degradation in quality not permitted) • Ecology – Mobilization of existing subsurface contamination is not permitted • FAA – Apron's drainage design consistency with FAA standards and NFPA fire containment and life safety regulations
2. Airfield soils compaction requirements	All zones within AOA	• FAA – Requirements for structural subgrade soil compaction • FAA – Non-pavement surfaces required to support snow removal and firefighting equipment, and occasional passage of aircraft without causing structural damage • FAA – Standing water not allowed to flow conveyance unless covered (i.e., pipes, vaults, structures)
3. Runways, taxiways, and shoulders slope and grade limitations	All zones within AOA	• FAA – Slope and grade change criteria limitations apply beyond runway pavements • FAA – Hazardous ruts, humps, depressions, and surface features projecting above adjacent runway grades not permitted • FAA – Rapid removal of drainage required through efficient drainage collection and conveyance systems
4. Runway embankment and wall zone infiltration limitations	All zones within AOA	• FAA – Requirements to maintain the structural integrity of third runway embankment fill and associated MSE wall in the zone of hydrologic influence • FAA – Requirements for efficient subgrade drainage to avoid runway subgrade saturation • Ecology – Requirements to limit infiltration above steep slope hazard areas
5. Wildlife hazard management	All zones within and beyond AOA	• FAA – Standing water not allowed to depth greater than 4 inches for durations exceeding 48 hours • FAA – Requirements to avoid creation of hazardous wildlife roosting or refuge habitats • FAA – Requirements to avoid actions that could cause hazardous wildlife movement across the STIA approach or departure airspace
6. Airfield vegetation use limitations	All zones within AOA	• FAA – Requirement to limit airfield vegetation to turf to limit FOD generation • FAA – Requirements for vegetation type consistency with WHMP limitations
7. Landside vegetation use limitations	All zones beyond AOA	• FAA – Requirements for vegetation types consistency with WHMP limitations • FAA – Requirements for vegetation heights not extending into defined airspace obstacle clearance surfaces

LID Restriction (Continued)	Applicable Operation Zones	Summary of Regulatory Competing Need
8. Airfield FOD management	All zones within AOA	• FAA – Requirement that non-pavement areas are limited to turf • FAA – No loose materials or permeable pavements permitted that could generate FOD, which can be mobilized by jet-blast or vehicles track-out
9. Transportation facility/corridor space limitations	All zones	• Ecology and WSDOT – LID use may be excluded where future expansion or multi-modal public transportation needs take precedence in high-density rights-of-way/corridors with space limitations
10. STIA and local jurisdiction stormwater facilities, critical areas, and NPDES compatibility	All zones	• Ecology – Existing stormwater facilities operations consistency with NPDES IP and associated outfall effluent limitations • Local Jurisdiction – Receiving water stormwater facilities suitability, critical areas impacts, and consistency with NPDES Phase II MS4 Permit regulations (beyond AOA)

Abbreviations:

AA= Apron Area
AOA = Airport Operations Area
Ecology = Washington State Department of Ecology
FAA = Federal Aviation Administration
FOD = Foreign Object Debris
IWS = Industrial Wastewater System
LID = low impact development
IP = Individual Permit
MSE = mechanically stabilized earth
MS4 = Municipal Separate Storm Sewer System
NFPA = National Fire Protection Act
NPDES = National Pollutant Discharge Elimination System
STIA = Seattle Tacoma International Airport
WHMP = *Wildlife Hazard Management Plan, Seattle-Tacoma International Airport*
WSDOT = Washington State Department of Transportation

3.3 Step 3: Assess Dispersion Feasibility

Dispersion BMPs include full dispersion, sheet flow dispersion, and concentrated flow dispersion per Chapter 5, Volume V of the SWMMWW. Dispersion feasibility assessment is conducted in two steps, as follows:

- ***Step 3.1*:** Evaluate horizontal setbacks and site constraints
- ***Step 3.2*:** Evaluate use of dispersion to meet minimum requirements

Each step is discussed below.

Step 3.1: Evaluate horizontal setbacks and site constraints

Assess horizontal setbacks, flow path requirements, and site constraints to determine dispersion feasibility for the project site, as follows:

Horizontal Setbacks

Horizontal setbacks vary depending on the type of dispersion BMP selected. Refer to Chapter 5, Volume V of the SWMMWW for horizontal setback requirements for each dispersion BMP.

Flow Path Requirements

Dispersion BMPs have minimum requirements for a vegetated flow path that can be difficult or infeasible for many STIA project sites. The minimum required flow paths for dispersion BMPs are as follows:

- Full Dispersion – The flowpath shall be directed over a minimum of 100 feet of vegetation.
- Sheet Flow Dispersion – The flowpath shall be directed over a minimum of 10 feet of vegetation.
- Concentrated Flow Dispersion, Trench Downspout Dispersion and Splashblock Downspout Dispersion – The flowpath shall be directed over a minimum of 25 feet of vegetation.

Site Constraints

- Steep Slope or Landslide-prone Areas – The dispersion flow path is not typically permitted within landslide hazard areas, on a steep slope (>15%), or within a setback of 10 times the height of the steep slope to a maximum of 500 feet above a steep slope area.
- Septic Systems and Drain Fields – The dispersion flow path is not permitted within 10 feet of a proposed or existing septic system or drain field.
- Contaminated Sites and Landfills – The dispersion flow path is not permitted within 100 feet of a contaminated site or landfill (active or closed).

Step 3.2: Evaluate use of dispersion to meet minimum requirements

If dispersion is feasible for the site based on the previous step, evaluate the feasibility of individual dispersion BMPs in accordance with Chapter 5 of Volume V of the SWMMWW.

3.4 Step 4: Assess Infiltration Feasibility

Infiltration feasibility assessment entails the following 7 steps (Figure 3-3):

- ***Step 4.1*****:** Review the STIA Infiltration Infeasibility Map (Figure 3-4)
- ***Step 4.2*****:** Evaluate horizontal setbacks and site constraints
- ***Step 4.3*****:** Conduct subsurface investigation and evaluate vertical separation requirements
- ***Step 4.4*****:** Conduct infiltration testing
- ***Step 4.5*****:** Determine design infiltration rate
- ***Step 4.6*****:** Conduct groundwater monitoring, receptor characterization, and mounding and seepage analysis, and acceptance testing, if applicable
- ***Step 4.7*****:** Evaluate use of infiltration to meet minimum requirements

Steps 4.3 through 4.6 may be performed concurrently, or in series. Larger projects may benefit from consulting with a licensed professional early in project development.

Seasonal timing for geotechnical/soils investigations, infiltration testing and groundwater monitoring requirements for infiltration facilities can impact project schedules. Subsurface investigations shall be scheduled during the wet season, between December and March, whenever possible.

The flow chart in Figure 3-3 illustrates these steps for completing the infiltration feasibility assessment. Figure 3-4 (Figure 11 in the *STIA Infiltration Infeasibility Assessment Report* [Aspect 2018], Appendix B) shows the STIA areas that have been pre-determined to be infeasible for infiltration in purple. Those areas mapped as infeasible for infiltration do not require further infiltration investigation.

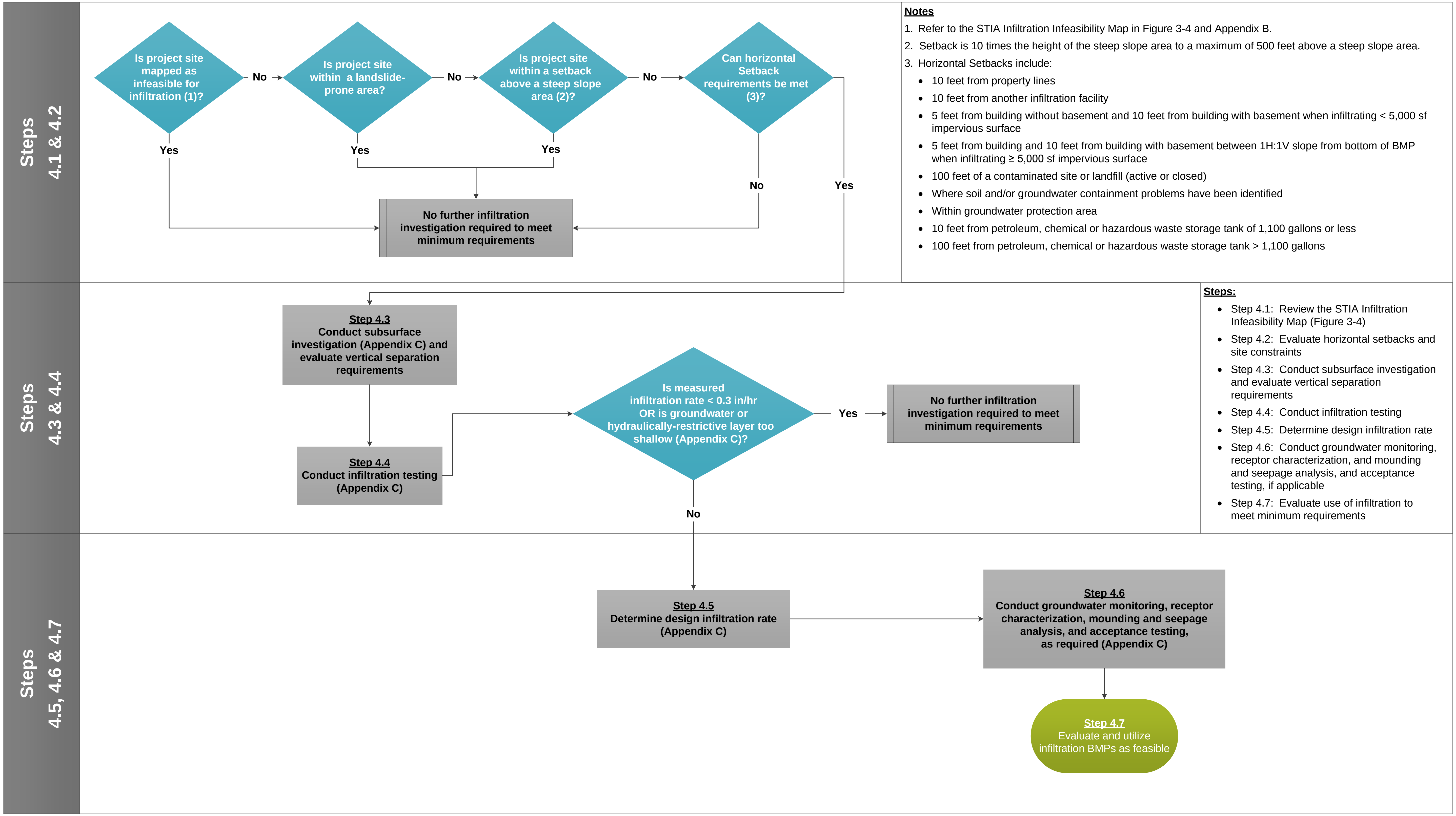

Figure 3-3
Infiltration Feasibility Assessment Flow Chart

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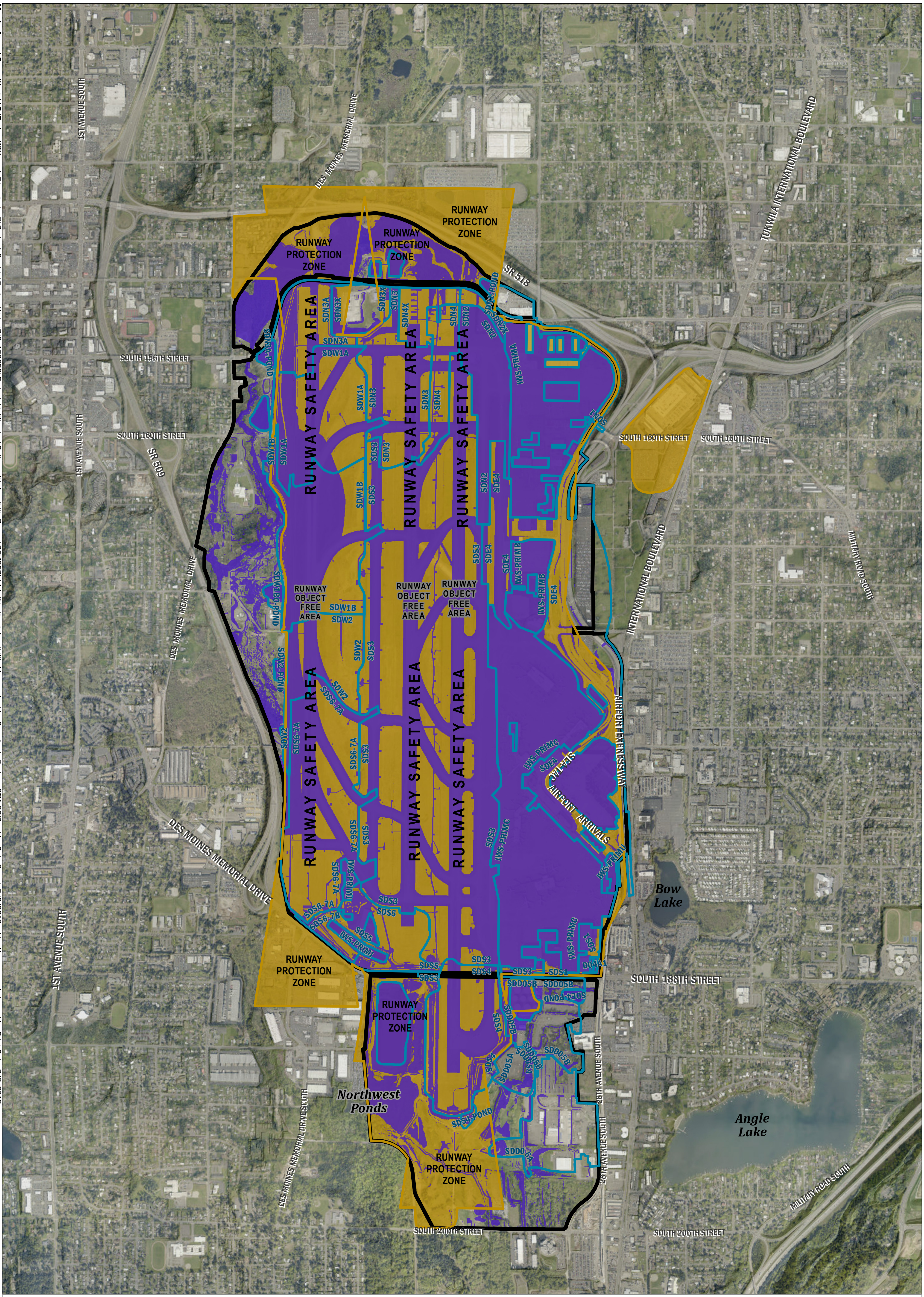

Infeasible for Infiltration

Less Feasible Areas for Infiltration:
- Airport Operations Area
- FAA-Regulated Areas
- Areas of Historical Industrial Activity

Storm Drainage Subbasin

Project Extent

N

0 750 1,500
Feet

FIGURE 3-4

Infiltration Infeasibility Map

Seattle Tacoma International Airport Infiltration Infeasibility Assessment

MAP BY: Aspect CONSULTING | RKI planning engineering | Port of Seattle

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Step 4.1: Review the STIA Infiltration Infeasibility Map

The first step in determining infiltration feasibility is review of the STIA Infiltration Infeasibility Map (Appendix B). For portions of the project site mapped as infeasible for infiltration based on this map, further infiltration investigations are not required. An applicant may still elect to investigate infiltration BMPs; but this is not required.

Step 4.2: Assess Horizontal Setbacks and Site Constraints

For portions of the site that were not demonstrated to be infeasible for infiltration based on the previous step, assess horizontal setbacks and site constraints to determine infiltration feasibility for those portions of the site, as follows:

<u>Horizontal Setbacks</u>

For bioretention, horizontal setbacks are measured from the vertical extent of the cell or basin (e.g., top of the bioretention soil). For infiltration chambers, horizontal setbacks are measured from the outside bottom of the structure. For all other infiltration BMPs, horizontal setbacks are measured from the edge of the aggregate within the BMP.

Infiltration is not permitted in the following areas:

- Within 10 feet of property lines;
- Within 10 feet of another infiltration facility;
- Within the following setbacks from on-site and off-site structures:
    - When runoff from less than 5,000 square feet of impervious surface area is infiltrated on the project site, the infiltration BMP shall not be within 5 feet from a building without a basement, and/or 10 feet from a building with a basement.
    - When runoff from 5,000 square feet or more of impervious surface area is infiltrated on the project site, a building shall not intersect with a slope 1 Horizontal to 1 Vertical (1H:1V) from the bottom edge of an infiltration BMP. The resulting setback shall be no less than 5 feet from a building without a basement and/or 10 feet from a building with a basement. For setbacks from buildings or structures on adjacent lots, potential buildings or structures shall be considered for future build-out conditions.
- Within 500 feet of any of the engineered slopes, embankment or Mechanically Stabilized Earth (MSE) walls at STIA (Appendix A).

<u>Site Constraints</u>

- Steep Slope or Landslide-Hazard Areas – Infiltration is limited within landslide-prone areas or within a setback of 10 times the height of the steep slope to a maximum of 500 feet above a steep slope area. Infiltration within this area may be feasible provided a detailed slope stability analysis is completed by a licensed engineer or engineering geologist. The analysis shall determine the effects that infiltration would have on the landslide-prone or steep slope area and adjacent properties.

- Septic Systems and Drain Fields – Refer to local jurisdiction code and requirements for applicable infiltration setback requirements.

- Drinking Water Supply Wells or Springs – Refer to local jurisdiction code and requirements for applicable infiltration setback requirements.

- Contaminated Sites and Landfills –

    - Within 100 feet of a contaminated site or landfill (active or closed). For projects where runoff from 5,000 square feet or more of impervious surface area will be infiltrated on the project site, infiltration within 500 feet up-gradient or 100 feet down-gradient of a contaminated site or landfill (active or closed) requires analysis and approval by a qualified professional.

    - Where soil and/or groundwater contamination problems have been identified, including, but not limited to, the following:

        - EPA Superfund Program site list (www.epa.gov/superfund/sites/index.htm)

        - EPA Resource Conservation and Recovery Act (RCRA) Program site list (www.epa.gov/epawaste/hazard/correctiveaction/facility/index.htm)

        - EPA mapping tool that plots the locations of Superfund and RCRA-regulated sites (www2.epa.gov/cleanups/cleanups-my-community)

        - Ecology regulated contaminated sites (www.ecy.wa.gov/fs)

        - Ecology Toxics Cleanup Program website (www.ecy.wa.gov/cleanup.html)

- Underground or Above Ground Storage Tanks –

    - Within 10 feet of an underground or above-ground storage tank or connecting underground pipes when the capacity of the tank and pipe system is 1,100 gallons or less. (Applicable to tanks used to store petroleum products, chemicals, or liquid hazardous wastes.)

    - Within 100 feet of an underground or above ground storage tank or connecting underground pipes when the capacity of the tank and pipe system is greater than 1,100 gallons. (Applicable to tanks used to store petroleum products, chemicals, or liquid hazardous wastes.)

Step 4.3: Conduct subsurface investigation and evaluate vertical separation requirements

Refer to Appendix C.

Step 4.4: Conduct infiltration testing

Refer to Appendix C.

Step 4.5: Determine design infiltration rate

Refer to Appendix C.

Step 4.6: Conduct groundwater monitoring, receptor characterization, and mounding and seepage analysis, and acceptance testing, if applicable

Refer to Appendix C.

Step 4.7: Evaluate Use of Infiltration to Meet Minimum Requirements

If infiltration is feasible for the site based on the previous steps, evaluate the feasibility of individual infiltration BMPs in accordance with Chapter 5 of Volume V of the SWMMWW.

3.5 Step 5: Select LID BMPs

If the project triggers MR #5, LID BMPs shall be selected based on the LID BMP List approach provided below. To use the list-based approach:

1. Delineate the project site based on the following surfaces:
    - Lawn and landscaped areas;
    - Roofs; and
    - Other hard surfaces (e.g., driveways, roadways, parking, sidewalk, plazas, etc.).
2. If the project site lies within multiple operation zones, delineate the surfaces for each operation zone separately.
3. For each surface in each operation zone, consider the LID BMPs in Table 3-2 the order listed for that type of surface within that operation zone.
4. Use the first BMP that is considered feasible. No other LID BMP is necessary for that surface in that operation zone.
5. Repeat for other surfaces and/or operation zones.

Feasibility shall be determined based on:

- Design criteria, limitations, and infeasibility criteria identified for each LID BMP in the SWMMWW;
- Competing needs criteria (Section 3.2); and
- LID BMP applicability and exclusions by operation zone (Table 3-2).

The LID BMPs provided in Table 3-2 have been screened with respect to FAA and STIA-specific requirements. However, not all the listed LID BMPs are applicable or feasible for all FAA operation zones, as summarized in the table. Refer to *MEMORANDUM: FAA Limitations and Exclusions to Applying LID at STIA* (Appendix A) for additional detail.

Alternative LID BMPs

If approved by Port reviewers, the alternative LID BMPs listed in Table 3-2 may be used in accordance with the LID Performance Standard per Volume I, Section 2.5.5 of the SWMMWW.

Table 3-2
LID BMP Exclusions and Applicability by Operation Zone

Legend:

- = Allowable BMP
- = Allowable BMP with modifications [a]
- = Not applicable
- # = Excluded BMP [b]

	On-Airfield Areas: RSA, ROFA, TSA, and TOFA within AOA	Apron and IWS Areas	Near-Airfield Areas: RPZ, Airspace Zones, and Landside Terminals	Embankments and Retaining Wall Influence Zones	Landside Areas Inside WHA, Outside Other Zones	Critical Areas
On-site Stormwater Management BMPs – Lawn and Landscape Surfaces [c]						
Extended Compost-amended Vegetated Filter Strips		1		4		
BMP T5.13: Post-construction Soil Quality and Depth		1, 5		4, 5		
On-site Stormwater Management BMPs – Roof Surfaces [c]						
BMP T5.30: Full Dispersion	3	1		4		
BMP T5.10A: Downspout Full Infiltration Systems		1		4		
BMP T5.14B: Bioretention	2, 5	1, 5		4, 5		
BMP T5.10B: Downspout Dispersion Systems		1		4		
BMP T5.10C: Perforated Stub-out Connections		1		4		
On-site Stormwater Management BMPs – Other Hard Surfaces [c]						
Extended Compost-amended Vegetated Filter Strips		1		4		
BMP T5.30: Full Dispersion	3	1		4		
BMP T5.15: Permeable Pavements [d]	8	1, 8		4		
BMP T5.14B: Bioretention [d]	2, 5	1, 5		4, 5		
BMP T5.12: Sheet Flow Dispersion		1		4		
BMP T5.11: Concentrated Flow Dispersion	3	1		4		
Infiltration and Treatment BMPs [e]						
BMP T7.10: Infiltration Basins	2, 5	1, 5		4, 5		
BMP T7.20: Infiltration Trenches	2, 5	1, 5		4, 5		

Table 3-2 (Continued) - LID BMP Exclusions and Applicability by Operation Zone

Legend:
- = Allowable BMP
- = Allowable BMP with modifications [a]
- = Not applicable
- # = Excluded BMP [b]

	On-Airfield Areas: RSA, ROFA, TSA, and TOFA within AOA	Apron and IWS Areas	Near-Airfield Areas: RPZ, Airspace Zones, and Landside Terminals	Embankments and Retaining Wall Influence Zones	Landside Areas Inside WHA, Outside Other Zones	Critical Areas
BMP T7.30: Bioretention Cells and Swales	2, 5	1, 5		4, 5		
BMP T7.40: Compost-amended Vegetated Filter Strips (CAVFS)		1		4		
BMP T8.40: Media Filter Drain	2, 3, 5, 6, 8	1	1, 5, 7, 9	4		
Alternative LID BMPs (by Port Approval Only)						
BMP T5.14A: Rain Gardens	2, 5	1, 5	5	4, 5	5, 9, 10	
BMP T5.16: Tree Retention and Tree Planting	5, 6	1, 5, 6				
BMP T5.17: Vegetated Roofs	5, 6	5, 6	5, 6	5, 7		
BMP T5.18: Reverse Slope Sidewalks		1		4		
BMP T5.19: Minimal Excavation Foundations		1		4		
BMP T5.20: Rainwater Harvesting						
BMP T5.40: Preserving Native Vegetation	5, 6	1, 5,6				
BMP T5.41: Better Site Design						

Notes:

a. Refer to Section 3.6 for required LID BMP design modifications.
b. Numbers in cells for Excluded BMPs refer to the LID BMP Restrictions summarized in Table 3-1.
c. In addition to MR #5, certain On-site Stormwater Management BMPs can be used to fully or partially meet Runoff Treatment (MR #6) and Flow Control (MR #7) requirements per Section 4 in the Port SWMM.
d. For projects that trigger MR #1-5 only, permeable pavement or bioretention may be prioritized equally for other hard surfaces. For projects that trigger MR #1-9, permeable pavement shall be prioritized over bioretention for other hard surfaces.
e. Infiltration and Treatment BMPs can be used to fully or partially meet Runoff Treatment (MR #6) and Flow Control (MR #7) requirements per Volume III and Volume V of the SWMMWW.

Abbreviations:

AOA = Airport Operations Area
BMP = Best Management Practice
IWS = Industrial Wastewater System
ROFA = Runway Object Free Area
RPZ = Runway Protection Zone
RSA = Runway Safety Area
TSA = Taxiway Safety Area
TOFA = Taxiway Object Free Zone
WHA = Wildlife Hazard Area

3.6 Step 6: Design and Construct LID BMPs

LID BMPs shall be designed and constructed in accordance with the Port SWMM, the SWMMWW, and the 2012 LID Technical Guidance Manual for Puget Sound, with the design modifications provided in Appendix A and summarized in Table 3-3. The Port will review project LID proposals as part of the Stormwater Site Plan (SSP) review in accordance with this Guideline and the requirements of the Port SWMM. LID applicability along with other project-specific stormwater management requirements will be identified during project notebook development and defined fully within the SSP no later than the 60% design phase.

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Table 3-3
Summary of Required LID BMP Design Modifications for STIA [a]

LID BMP	Required Modifications for STIA
BMP T5.10A: Downspout Full Infiltration Systems	• None
BMP T5.10B: Downspout Dispersion Systems	• Vegetation and conveyance system consistent with STIA WHMP
BMP T5.10C: Perforated Stub-out Connections	• None
BMP T5.11: Concentrated Flow Dispersion	• Vegetation and conveyance system consistent with STIA WHMP
BMP T5.12: Sheet Flow Dispersion	• Grass only in on-airfield areas • Vegetation and conveyance system consistent with STIA WHMP
BMP T5.13: Post-construction Soil Quality and Depth	• Incorporation of 2 inches of compost into the upper 4 inches of uncompacted soil to increase organic matter content to 10% or greater • Underlying subgrade compacted to no less than 95% in the RSA
BMP T5.14B: Bioretention	• Constructed with underdrain • Maximum ponding depth of 4 inches • Facility must drain within 48 hours • Vegetation consistent with STIA WHMP
BMP T5.15: Permeable Pavements	• Must meet structural and maintenance requirements of *FAA CAN 150/5370-10G, Standards for Specifying Construction of Airports* and *MEMORANDUM: Federal Aviation Administration Limitations and Exclusions to Applying LID Standards at STIA* (Appendix A) for airfield pavements. These requirements include, but are not limited to: o 97% consolidation (ASTM C642) for concrete pavements o 96% mat density (ASTM D3665) for asphalt pavements o 100% compaction for base course and subbase compaction (ASTM 1557) o 95% subgrade compaction o Rapidly draining base materials and subgrades o Pavements that are constructed using FAA funds must be designed to achieve a minimum useful life of 20 years under the effects of frequent heavy loading
BMP T5.16: Tree Retention and Tree Planting	• Vegetation consistent with STIA WHMP • Vegetation may not compromise the integrity of embankments or structural walls and shall allow for inspection

LID BMP (Continued)	Required Modifications for STIA
BMP T5.17: Vegetated Roofs	• No open water storage as wildlife attractant • Vegetation consistent with STIA WHMP
BMP T5.18: Reverse Slope Sidewalks	• Vegetation consistent with STIA WHMP
BMP T5.19: Minimal Excavation Foundations	• Meet structural and maintenance requirements (Appendix A)
BMP T5.20: Rainwater Harvesting	• No open water storage as wildlife attractant
BMP T5.30: Full Dispersion	• Vegetation consistent with STIA WHMP
BMP T5.40: Preserving Native Vegetation	• Vegetation consistent with STIA WHMP • Vegetation may not compromise the integrity of embankments or structural walls and shall allow for inspection
BMP T7.10: Infiltration Basins	• Maximum ponding depth of 4 inches • Facility must drain within 48 hours • Vegetation consistent with STIA WHMP
BMP T7.20: Infiltration Trenches	• Maximum ponding depth of 4 inches • Facility must drain within 48 hours • Vegetation consistent with STIA WHMP
BMP T7.30: Bioretention Cells and Swales	• Constructed with underdrain • Maximum ponding depth of 4 inches • Facility must drain within 48 hours • Vegetation consistent with STIA WHMP
BMP T7.40: Compost-amended Vegetated Filter Strips (CAVFS)	• Grass only in on-airfield areas • Incorporation of only 2 inches of compost into the upper 4 inches of soil • Vegetation consistent with STIA WHMP in other areas
BMP T8.40: Media Filter Drain	• Constructed with underdrain • Vegetation consistent with STIA WHMP • Vegetation may not compromise the integrity of embankments or structural walls and shall allow for inspection

Notes:

a. Refer to *MEMORANDUM: FAA Limitations and Exclusions to Applying LID Standards at STIA* (Appendix A) for additional detail.

Abbreviations:

BMP = Best Management Practice
RSA = Runway Safety Area
STIA = Seattle-Tacoma International Airport
WHMP = *Wildlife Hazard Management Plan*

3.7 Step 7: Conduct Long-term Operation and Maintenance

For projects that trigger Minimum Requirement No. 9 – Operation and Maintenance, an operation and maintenance (O&M) manual consistent with the Port's *Stormwater Facilities, Inspections, Maintenance, and Operations Procedures Manual* and with Volume V of the Port SWMM shall be provided for proposed stormwater facilities and BMPs. The party (or parties) responsible for maintenance and operation shall be identified.

At private facilities, a copy of the O&M manual shall be retained on-site or within reasonable access to the site and shall be transferred with the property to the new owner. For Port facilities, a copy of the O&M manual shall be retained in Port's Aviation Facilities and Infrastructure Department and the Aviation Maintenance Department.

In coordination with the Facilities and Infrastructure Department, the Maintenance Department shall add the new facility to the Port's MAXIMO maintenance management system. For private facilities, a log of maintenance activity that indicates what actions were taken shall be kept and be available for inspection by the Port.

Inspection, operation, and maintenance of LID BMPs shall be in accordance with the following State of Washington guidance documents:

- SWMMWW;
- 2012 LID Technical Guidance Manual for Puget Sound; and
- 2013 Washington State Department of Ecology LID O&M Manual

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Appendix A: MEMORANDUM: FAA Limitations and Exclusions to Applying LID Standards at STIA (HNTB 2016)

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MEMORANDUM: Federal Aviation Administration Limitations and Exclusions to Applying Low Impact Development Standards at Seattle-Tacoma International Airport

May 23, 2016

Prepared for:

Port of Seattle

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A. BACKGROUND

The Washington Department of Ecology (DOE) has specified the implementation of Low Impact Development (LID) standards for management of stormwater at all development and redevelopment sites. LID standards utilize on-site stormwater Best Management Practices (BMPs) that attempt to mimic or restore, as practicable, the natural site hydrology. Specific LID BMP requirements are detailed in the agency's *Stormwater Management Manual for Western Washington* (SMMWW) (April 2012) Volume V Section 5.3. The SMMWW states that these on-site stormwater management BMPs can be superseded or reduced where they are in conflict with Federal Aviation Administration (FAA) requirements for airports (SMMWW 5.3.1).

This technical memorandum identifies FAA requirements, regulations and limitations that may conflict with the implementation of LID BMPs at Seattle-Tacoma International Airport (STIA). Conflicts as they apply to airports with regularly scheduled air carrier service, as well as to specific STIA locations, are identified. Recommendations for implementation, restriction or modification of the LID BMPs included in the DOE SMMWW (April 2012) Volume V Chapter 5 and 7 are also provided. A summary matrix of airport zones and their specific LID limitations are included at the end of this memorandum in Table 1. The accompanying Figure 1 depicts the airport zones.

B. FEDERAL REGULATION OF AIRPORT DESIGN AND OPERATIONS STANDARDS

FAA standards covering airports and their environs are principally regulated by Federal Code. In the case of STIA, an airport with regularly scheduled air carrier service, regulations derive specifically from the *Title 14 Code of Federal Regulations (CFR) Part 139, Certification of Airports*, subparts C (Airport Certification Manual) and D (Operations). As a Part 139 airport, STIA must be maintained and operated in a condition which meets all requirements deriving out of CFR Part 139. The airport is inspected yearly by the FAA to maintain this certification.

There are innumerable FAA guiding documents which fall out from CFR Part 139 covering almost every aspect of airport design and operations. Modification from the standards without Federal approval is not permitted for Part 139 airports such as STIA. As related to those items which may allow, limit or completely restrict implementation of certain on-site stormwater BMPs, there are several FAA documents which should be referenced:

1. <u>FAA Advisory Circular Number 150/5300-13A, Airport Design</u>: This document prescribes airfield layout standards which result in a high level of passenger and aircraft safety around the runway and taxiway operational surfaces. It defines a number of operationally based safety zones (e.g., object free area, runway safety area) and the specific design standards (e.g., grading, surface features) applicable to each zone based upon the largest aircraft regularly utilizing the airport.
2. <u>FAA Advisory Circular Number 150/5200-33B, Hazardous Wildlife Attractants On Or Near Airports</u>: This document provides guidance on certain land uses that have the potential to attract hazardous wildlife on or near public-use airports.

3. FAA Advisory Circular Number 150/5370-10G, Standards for Specifying Construction of Airports: This document prescribes the materials and methods used for the construction on airports. Items covered include earthwork, subgrade, base courses, pavements, drainage, and turf.
4. FAA Advisory Circular Number 150/5210-24, Airport Foreign Object Debris (FOD) Management: FOD has the potential to damage aircraft during critical phases of flight, which can lead to catastrophic loss of life and airframes. This document provides guidance on implementing management practices to reduce the risk of FOD within the Air Operations Area (AOA).
5. FAA Advisory Circular Number 150/5380-6C, Guidelines and Procedures for Maintenance of Airport Pavements: This document describes methods for maintaining airport pavements used by aircraft, including guidelines and requirements for drainage and control of surface and subsurface water.
6. FAA Advisory Circular Number 150/5320-6E, Airport Pavement Design and Evaluation: This document describes methods for designing and evaluating airport pavements used by aircraft, including structural pavements and shoulder pavements.
7. FAA Advisory Circular Number 150/5320-5D, Airport Drainage: This document provides guidance on the design and construction of airport surface storm drainage systems; and subsurface drainage systems for paved runways, taxiways, and aprons.

In addition to FAA mandated design standards, there are several STIA site-specific usage characteristics which limit implementation of certain LID standards in some locations. Such locations include: (1) the Apron (defined as the aircraft parking and cargo areas), governed by both National Fire Protection Association (NFPA) and FAA standards, but also drained and treated by the STIA industrial waste system; (2) areas where constructed, engineered embankments and vertical retaining walls support airport, public and FAA infrastructure; and (3) areas already utilized for stormwater treatment and detention (e.g., ponds and vaults) and environmentally sensitive areas (e.g., restricted covenants, existing forested lands, wetlands).

C. ON-AIRFIELD PROTECTION ZONES

FAA Advisory Circular Number 150/5300-13A, *Airport Design* defines a number of on-airport operational zones that ensure the safety of airfield operations and limit risks to both passenger and public safety should aircraft deviate from the defined runway and taxiway surfaces. The on-airfield FAA specified zones of interest as related to an LID implementation strategy are as follows: Runway Safety Area (RSA), Runway Object Free Area (ROFA); Taxiway Object Free Area and Safety Area (TOFA/TSA), Apron, and Air Operations Area (AOA). These areas are depicted on the attached figure and are detailed below:

1. Runway Safety Area (RSA): The RSA is a defined ground surface that includes and surrounds the runway and is prepared for the express purpose of reducing catastrophic loss of life and damage to aircraft in the event of an undershoot, overshoot, or excursion from the runway surface. From an LID implementation standpoint, the RSA is the most restrictive of all airport zones and modification of the FAA standards is not permitted. RSA standards for STIA and other airports handling air-carrier operations of Group V aircraft can be summarized as follows:

a. The RSA shall be 500-ft wide, centered on the runway and extend 1,000-ft beyond the runway ends.
b. The RSA shall be completely clear of any ruts, ditches, swales, depressions, grade breaks or other surface variations and shall be graded with the following specific standards:
    i. Transverse grades must have positive drainage away from the paved surfaces at all locations, at slopes of 1.5% to 3%. No transverse grade breaks are permitted within the RSA.
    ii. Maximum longitudinal grades are +/- 1.5% with a maximum allowable grade of +/- 0.8% within the first and last quarter of the runway, or first and last 2,500 ft, whichever is less. Longitudinal grade changes are restricted to +/- 1.5% and these must be parabolic in nature with a vertical curve length equal to 1,000 feet per 1% of change. Furthermore, no longitudinal grade breaks are allowed within the first and last quarter of the runway, or first and last 2,500 ft, whichever is less.
c. The RSA shall be free of objects, except those that need to be located in the RSA because of their function for purposes of Aeronautical Navigation (NAVAIDs).
d. The RSA shall be drained by grading or storm sewers to prevent accumulation of water.
e. The un-paved terrain within the RSA shall be prepared so as to support snow removal equipment, aircraft rescue and firefighting (ARFF) vehicles, and occasional passage of aircraft without causing structural damage to the aircraft. Preparation of RSA terrain is covered under FAA Advisory Circular Number 150/5370-10G, *Standards for Specifying Construction of Airports*, and includes both compaction and terrain deviation standards:
    i. Compaction shall be to not less than 95% of maximum density (for non-cohesive soils such as at STIA) as determined by ASTM D1557.
    ii. Terrain within the safety area shall be of such smoothness that it will not vary by more than 0.10 feet from true grade, as designed in accordance with the mandated grading standards.
    iii. To account for use of topsoil and development of turf on all areas outside of pavement, no compaction is required within the top 4 inches.
    iv. Turf is the only vegetation allowed within the RSA.
f. Stabilization of the RSA with turf is the only acceptable, non-pavement stabilization technique allowed. Gravel, rip-rap, ballast, erosion control blankets and other jet-blast susceptible and Foreign Object Debris (FOD) producing surfaces and materials are prohibited.

2. <u>Runway Object Free Area (ROFA)</u>: The ROFA is a defined area centered on the runway provided to enhance the safety of aircraft operations by remaining completely clear of objects, including terrain variations, that protrude above the elevation of the nearest point of the RSA surface. ROFA standards are as follows:

    a. The ROFA shall be 800-ft wide, centered on the runway and extend 1,000-ft beyond the runway ends, co-located with the RSA.

b. Within the ROFA, surface variations of the area outside the RSA shall be limited and be graded with the following specific standards:
   i. Transverse grades follow from the RSA grades detailed above and should continue positive drainage away from the RSA limits at between 0% grade and a 16:1 maximum slope. Where existing conditions are such that a grade break inside the ROFA is required, it must take place outside of the RSA and the terrain must not protrude above the elevation of the nearest point of the RSA surface.

c. The ROFA shall be free of objects non-essential for purposes of Aeronautical Navigation or ground maneuvering purposes.

d. All other requirements listed above for the RSA apply to the ROFA with regard to clearance of objects, drainage, compaction, smoothness, vegetation and allowable surface stabilization regimens.

3. <u>Taxiway Object Free and Safety Areas (TOFA/TSA)</u>: The TOFA and its associated Taxiway Safety Area (TSA) mirror the requirements of the ROFA and RSA as described above but with smaller dimensional requirements. Like the ROFA and RSA, these areas define safety zones for aircraft deviating from the paved operational surfaces. Where the TOFA and TSA physically overlap the ROFA and RSA, the more rigorous runway standards apply. TOFA and TSA standards are as follows:

   a. Based on the aircraft serving STIA, the TOFA shall be 320 ft wide and the TSA shall be 214 ft wide, both centered on the taxiway.

   b. The TSA shall be completely clear of any ruts, ditches, swales, depressions, grade breaks or other surface variations and shall be graded with the following specific standards:
      i. Transverse grades must have positive drainage away from the paved surfaces at all times and be sloped between 1.5% and 3%.
      ii. Maximum longitudinal grades are +/- 1.5% with a maximum allowable grade change of 3%. These must be parabolic in nature with a vertical curve length equal to 100 ft per 1% of change.

   c. Within the TOFA, surface variations shall meet the following standards:
      i. Transverse grades outside the TSA follow from the TSA grades detailed above and should continue positive drainage away from the TSA limits at between 0% grade and a 4:1 maximum slope. Where existing conditions are such that a grade break inside the TOFA is required, it may be allowed but with a maximum 4:1 slope.

   d. All other requirements listed above for the RSA and the ROFA apply to the TOFA and TSA with regard to clearance of objects, drainage, compaction, smoothness, vegetation and allowable surface stabilization regimens.

4. <u>Aprons</u>: An Apron is defined by the FAA as the area outside of the Taxiway and Runway Object Free areas and located adjacent to the terminal, aircraft maintenance and cargo buildings of an airport. Its primary function is to (1) provide a place to safely accommodate aircraft during loading and unloading of passengers and cargo; (2) provide for circulation of aircraft and ground vehicles; and (3) provide a location for fueling, de-icing, maintenance and aircraft parking. The

Apron areas for STIA, inclusive of the cargo hardstand areas, are depicted on the attached figure. These areas drain via STIA's separate Industrial Waste Sewer (IWS) system and are treated by STIA's on-site Industrial Waste Treatment Plant (IWTP). Design of grading, surface features and drainage improvements on Aprons is driven by FAA design standards, National Fire Protection Association (NFPA) standards, and the industrial nature of the Apron runoff. Characteristics are as follows:

a. Almost all Apron areas surrounding the terminals, maintenance buildings and cargo buildings are paved. The use of pavement almost exclusively as a surface within the aircraft parking and cargo areas derives from the following operational, safety and fire code requirements:
    i. The Apron must be able to support the loads, quantity, and variability of aircraft and support vehicle movements and parking at STIA and thus airfield pavements meeting FAA requirements are utilized.
    ii. The spacing between the aircraft parking positions, buildings, and support vehicles must be at all times allow access by ARFF vehicles and snow removal equipment. Paved areas between parking positions are therefore used due to the density of infrastructure and aircraft parking positions, as well as to ensure maximum flexibility of use to meet airport needs.
    iii. The Apron is subjected to close, continuous and multi-directional jet-blast. Pavement provides the safest form of FOD management.
    iv. Pavement on the Apron allows drainage of jet fuel, oil, heavy metals and glycol contaminated runoff directly to the separate industrial waste sewer system.
b. Grading of aprons for use by aircraft of the type at STIA are governed by the following FAA and NFPA limitations:
    i. Maximum of 1% grade in any direction with a maximum grade change of 2%.
    ii. NFPA 415, *Standard on Airport Terminal Buildings, Fueling Ramp Drainage, and Loading Walkways* dictates that areas where fueling occurs must also slope away from buildings at 1% for the first 50 ft and at an uninterrupted, positive slope of no less than 0.5% thereafter to the point of entering the drainage system.
c. Drainage systems on the Apron must be designed to rapidly collect and carry runoff on the flatter slopes dictated by Apron design during critical storm events without impacting aircraft operations. The drainage system must also be able to collect and contain fuel spills, allow for the washing off of fuel spills and other fluids, allow for fire foam runoff flow during ARFF responses, and limit fire propagation through the storm system by utilizing designed fire-stops within the system. For these reasons, trench drains and catch basins with vapor traps are utilized within the paved areas of the Apron at STIA and are located at regular intervals. Use of open ditchlines or swales to collect this runoff is not permitted.

The Apron areas at STIA are subject to runoff co-mingled with varying levels of jet fuel, glycol, chemical foams, oil, and heavy metals contamination. The Apron is considered as an industrial use area. Under STIA's NPDES permit Stormwater Pollution Prevention Plan (SWPPP), runoff from these areas is drained by the dedicated IWS system and treated at STIA's on-site facility. The Port has completed a groundwater study of existing subsurface contamination on the Airport. The study concluded that contamination, although present under the Apron surface, was not impacting groundwater under existing hydrologic conditions. Infiltration of stormwater runoff on the Apron could modify this existing hydrologic condition. Any BMP strategies for impervious surface runoff or roof drain dispersion that include infiltration or rainwater capture within the Apron, such as permeable pavement, drywells, or infiltration trenches would potentially mobilize or increase contamination of subsurface water.

5. Air Operations Area (AOA): The AOA is the airport area where aircraft can operate, either under their own power or while in tow. The attached Figure 1 delineates the AOA boundary. It is defined physically by the airport perimeter fence and includes all areas with restricted access and located outside the airport terminal buildings, including runways, taxiways, aprons, ramps, hardstands, safety areas, perimeter roads and cargo areas. In addition to the standards for specific zones within the AOA (RSA, ROFA, TSA, TOFA, and Apron), general FAA guidance applies to all areas of the AOA. These standards cover management of jet blast, drainage, pavement design, foreign object debris (FOD) and wildlife attractants on airfields:

   a. FOD Management: FOD has the potential to damage aircraft during critical phases of flight, leading to catastrophic loss of life and aircraft. *FAA Advisory Circular Number 150/5210-24*, *Airport Foreign Object Debris (FOD) Management* requires Part 139 airports to manage FOD accordingly within all areas of the AOA. Areas with deteriorated and inadequate pavements, dust, sand, gravel, rocks, wildlife, and unstabilized topsoil, sod and compost are FOD generators. These items are spread by jet-blast, wind, mowing operations and vehicles. Vehicles traversing roads, equipment pads, aprons, taxiways and runways pick up FOD in tires and wheel wells where it can be deposited in the aircraft movement areas. Because of its potentially catastrophic nature, Part 139 airports take all steps to minimize FOD with regard to stabilization and pavement selection:

      i. Stabilization of unpaved areas is limited to turf. The turf species is selected carefully based on a demonstrated history of: not being a wildlife attractant, maintainability to the required airfield surface tolerances, and drought tolerance. Other vegetation is not permitted. Gravels, pebbles and crushed rock surfaces are not utilized within the AOA.

      ii. The FAA recognizes loose materials from failing and unmaintained pavements as the most common source of FOD. FAA Advisory Circular Number 150/5380-6C, *Guidelines and Procedures for Maintenance of Airport Pavements* provides guidelines and procedures for maintenance of airport pavements. Porous asphalts and permeable concrete pavements are not selected as being appropriate for the AOA due to their susceptibility of aggregate loss from the nominally bound wearing course. Likewise these pavements act as catch points for sand, grit and small size debris generated elsewhere. Open cell pavers and plastic grid systems with open graded gravel bases and turf regimens are generally not practical due to the airport equipment vehicle loads but are also potential FOD generation sources. These should likewise be prohibited from use with the AOA as well as near-AOA locations (e.g., maintenance and cargo facilities) traversed by equipment serving the AOA. Special consideration should be given to potential track-in of FOD by vehicles from near-AOA parking and service roads. Other pavement design factors such as loading, usage and wearabilty are discussed below.

b. Pavement Design: In addition to FOD generation concerns, the pavement within the AOA must be designed to handle the required loads of the aircraft, ARFF vehicles, snow removal equipment and aircraft ground support equipment. The thickness, usage frequency and construction standards for airfield pavements at STIA rule out the use of permeable pavement and open cell pavers from within the AOA. The FAA is prescriptive with regard to pavement design which references the following documents:

    i. FAA Advisory Circular Number 150/5300-13A, *Airport Design* prescribes the "amount" (e.g., width, length) of pavement required for operational surfaces (e.g., aprons, service roads, taxiways and runways).

    ii. FAA Advisory Circular Number 150/5320-6E, *Airport Pavement Design and Evaluation* provides a basis for design of pavements based on loading, projected use and service life that provides the "thickness" and "type" of the pavement layers (concrete, asphalt, base course, subbase and subgrade). Pavements within the AOA are subject to frequent, heavy loadings by aircraft as well as ARFF vehicles and Ground Service Equipment (GSE). Upper pavement layers at STIA vary from between 16 and 24 inches thick for runways, taxiways and aprons, while compacted underlying base courses and sub-bases vary from 8 inches to 24 inches. Pavement thicknesses of this magnitude are incompatible with permeable paving options.

    iii. FAA Advisory Circular Number 150/5370-10G, *Standards for Specifying Construction of Airports* describes the materials, mix designs, compaction, density and construction methods for airfield pavements. Porous asphalt and permeable concrete pavements utilize a mix design which omits finer gradations of aggregate and a wearing surface which does not fully bind the larger aggregates in the normal cementitious or asphaltic structure. The FAA requires 97% consolidation (ASTM C642) for concrete pavements and a mat density of 96% (ASTM D3665) for asphalt. SMMWW recommends voids within the wearing layer for porous asphalt at between 16-25%, while for concrete voids of 15-35% are recommended. Permeable pavements also require rapidly draining base materials and subgrades (SMMWW specifies 90-92%). FAA requirements for base course and subbase compaction (ASTM 1557) are both 100% while subgrade compaction standards are 95%. Pavements that are constructed using FAA funds must be designed to achieve a minimum useful life of 20 years, under grant obligations. The strict requirements for pavement construction are based on achieving a 20-year functional life under the effects of frequent heavy loading.

c. Storm Drainage Design: FAA Advisory Circular Numbers 150/5300-13A*, Airport Design* and 150-5320-5D, *Airport Drainage* provide guidance on airfield storm drainage. Guidance is primarily based upon avoidance of interruption to airfield operations, protection of pavement and safety areas from erosion and avoidance of wildlife hazard attractants, and includes the following:

i. Provide for surface drainage by the rapid removal of storm water from the airfield pavement including the drainage of the pavement base or subbase by a subdrain system.
ii. Provide an efficient mechanism for collecting airfield flows and conveying design flows to acceptable discharge points, within the strict grading standards for the various surfaces and areas within the AOA.
iii. Provide levels of storm water conveyance that protect airfield pavements and embankments from damage during large storm water events. Additionally any improvements required for airport operations such as utilities and NAVAIDs should be similarly protected.
iv. Provide for a safe level of operation for both airside and landside ground vehicles.
v. Address storm water quality issues in accordance with individual National Pollution Discharge Elimination System (NPDES) and state and local permit requirements.
vi. Account for future airport expansion and grading requirements.
vii. Follow airfield design requirements for Safety Areas and Object Free Areas.
viii. All drainage improvements and BMPs are subject to the guidelines of FAA Advisory Circular Number 150/5200-33B, *Hazardous Wildlife Attractants On Or Near Airports.*

d. Existing Airfield On-Site BMPs: On-site treatment for stormwater runoff on the airfield and outside of the Apron areas is currently provided by grass filter strips. These filter strips are located along pavement edges to treat runoff from pollution generating surfaces (e.g., Taxiways and Runways). These treatment systems are currently providing effective BMPs meeting the Department of Ecology approved AKART (all known available and reasonable technology) determination requirements for the STIA stormwater system (Reference: *Seattle Tacoma International Airport Stormwater Engineering Re*port, R.W. Beck, 2006) in accordance with the Airport NPDES permit.

   The Port has completed a number of analyses of filter strip requirements for STIA runways and taxiways. In general, these studies conclude that filter strip widths between 20 and 40 feet meet the minimum design requirements for basic treatment. In order to provide a greater level of treatment and to provide LID functions while complying with FAA design and operating standards, the Port has extended Airfield filter strips to over 100 feet for the majority of runways and taxiways. In addition, reconstructed filter strips are amended with 2-inches of compost prior to seeding and stabilization, increasing in-situ organic content to a minimum level of 10% and enhancing filter strip treatment capability.

D. NEAR-AIRFIELD AND STIA SPECIFIC ZONES

In addition to the FAA design standards for the On-Airfield Zones referenced in Section C of this memorandum, airports have several FAA mandated protection zones extending outside of the airfield AOA boundary designed to ensure the protection of aircraft approach and departure airspace. For purposes of LID implementation, adjacent land uses which create wildlife attractants within the airspace surrounding the airport are restricted. STIA also has several existing site usage and infrastructure features which limit implementation of certain LID standards in some locations. A discussion of the near-airfield and STIA specific zones is as follows:

1. <u>The Runway Protection Zone (RPZ) and Protected Airspace</u>: The RPZ refers to a trapezoidal shaped ground area off of the runway end that enhances the safety and protection of people on the ground by controlling the land uses and eliminating incompatible objects and activities. The Protected Airspace is a family of related three-dimensional airspace surfaces designed to provide obstacle clearance to arriving and departing aircraft. Examples of these surfaces include the runway Departure, Arrival, and the *Title 14 Code of Federal Regulations (CFR) Part 77* Surfaces. Like the RPZ, these extend from the runway ends to a specified distance beyond. They also extend out laterally from the runway area, including the "Landside" areas outside the AOA in the airport drivelane and parking areas. As it pertains to applying LID standards, the use of the ground areas below these surfaces are what is of primary importance and are referenced in FAA Advisory Circular Number 150/5200-33B, *Hazardous Wildlife Attractants On Or Near Airports* as the Arrival, Departure and Circling Airspace.

   Where the RPZs or Airspace Surfaces overlap with the previously described RSA/ROFA, TSA/TOFA, Apron and AOA exclusion zones, the more stringent area standards apply. Outside of these partially overlapping exclusion zones, implementation of LID BMPs in the RPZ and under the Protected Airspace are far less restrictive than the other airport zones described above in Section C. These Near-Airfield areas do however need to meet with FAA Advisory Circular Number 150/5200-33B and provide for obstacle clearance within the defined three-dimensional surfaces. Constructed or natural areas—such as poorly drained locations, detention/retention ponds, roosting habitats on buildings, landscaping, organic matter, wastewater treatment, agricultural or aquaculture activities, or wetlands—can provide wildlife with ideal habitat and feeding locations. The primary wildlife hazards of concern are birds. Birds can be ingested by jet engines and cause engine failure. Bird strikes can also cause other potentially catastrophic damage such as broken cockpit windows. A summary of general land use rules within the RPZ and the Approach/Departure and Circling Airspace as they apply to potential wildlife attractants are as follows:

   a. Airports Serving Turbine-Powered (Jet) Aircraft: The FAA recommends a separation distance of 10,000 feet at these airports between any of the hazardous wildlife attractants and the airport's AOA.
   b. Protection of Approach, Departure, and Circling Airspace: For all airports, the FAA recommends a distance of 5 statute miles between the farthest edge of the airport's AOA and the hazardous wildlife attractant if the attractant could cause hazardous wildlife movement into or across the approach or departure airspace.
   c. Storm water detention/infiltration ponds and bioretention swales: These functions are allowed provided that a maximum 48-hour detention period for the design storm is utilized and no greater than 4-inches of ponded water depth exists at any time. The FAA

recommends that airport operators avoid or remove retention ponds and detention ponds featuring dead storage to eliminate standing water. Detention basins should remain totally dry between rainfalls. Where constant flow of water is anticipated through the basin, or where any portion of the basin bottom may remain wet, the detention facility should include a concrete or paved pad and/or ditch/swale in the bottom to prevent vegetation that may provide nesting habitat. When it is not possible to drain a large detention pond completely, airport operators may use physical barriers, such as bird balls, wire grids, or netting, to deter birds and other hazardous wildlife.

d. Onsite Mitigation of Wetland Functions: The FAA may consider exceptions to locating mitigation activities outside the separations identified in D.1.a and D.1.b above if the affected wetlands provide unique ecological functions, such as critical habitat for threatened or endangered species or ground water recharge, which cannot be replicated when moved to a different location. Mitigation must not inhibit the airport operator's ability to effectively control hazardous wildlife on or near the mitigation site or effectively maintain other aspects of safe airport operations. Enhancing such mitigation areas to attract hazardous wildlife must be avoided. The FAA will review any onsite mitigation proposals to determine compatibility with safe airport operations. A wildlife damage management biologist should evaluate any wetland mitigation projects that are needed to protect unique wetland functions and that must be located in the separation criteria in D.1.a and D.1.b before the mitigation is implemented.

e. Vegetation Requirements: Vegetation that provides food, cover or habitat for hazardous wildlife should be eliminated. Vegetation must be from STIA's approved *Wildlife Hazard Management Plan* (WHMP). Additionally trees must not penetrate the defined Airspace Obstacle Clearance Surfaces.

2. <u>IWS Drainage Basin</u>: Predominantly this consists of the area defined above as the "Apron" (in Section C.4 of this memorandum). Other areas within the IWS drainage area include the airport parking garage, the fuel farm and the IWS ponds. Collection and treatment by dissolved air floatation and off-site secondary biological Publicly Owned Treatment Works (POTW) for high strength biological oxygen demand (BOD) is the Department of Ecology's AKART approved BMP for Apron runoff as specified in STIA's NPDES Permit *Storrmwater Pollution Prevention Plan* (SWPPP). As previously discussed, runoff from the Apron is co-mingled with varying levels of jet fuel, glycol, chemical foams, oil, and heavy metals contamination that should not be introduced into the groundwater profile. Likewise, legacy contamination is present to varying degrees within the subsurface of many of these areas. Therefore, the LID implementation for runoff generated in these Apron industrial use areas is infeasible.

   The current IWS drainage basin does include a number of impervious surface runoff sources associated with non-pollution generating surfaces (PGIS) such as rooftops. IWS rooftop runoff could be captured and reused in support of LID. However, non-PGIS Apron runoff cannot be infiltrated (e.g.; permeable pavement, drywells, or infiltration trenches) within the Apron due to restrictions associated with subsurface contamination. The area draining to the IWS system is depicted on the attached Figure 1.

3. Structural Embankment and Retaining Walls: STIA sits on a plateau in relation to its environs. As the airport has expanded outward, the expansion has utilized engineered embankments and vertical mechanically stabilized earth (MSE) retaining walls to support airport, public and FAA infrastructure. The attached Figure 1 depicts STIA areas outside of the AOA with MSE walls and constructed slopes of approximately 25% or more. Infiltration and dispersion of stormwater in and around steep embankments and retaining walls impacts the structural integrity of the engineered embankment material or wall and should be prohibited.

    a. As part of its 2015 *Infiltration Feasibility Assessment* study for the Port, Aspect Consulting considered infiltration in the slope hazard and large embankment fill areas around the airport's perimeter. The reinforced earth fill utilized for the Runway 16R-34L as well as the extended safety areas for all three STIA runways is designed for drained conditions. A criterion for operation is prohibition of direct infiltration in the vicinity of the filled area, so this area is deemed infeasible for both shallow and deep infiltration. Aspect Consulting recommends a buffer of 500 feet between these fill zones and any infiltration facility.
    b. The SMMWW likewise excludes LID infiltration and dispersion BMPs for naturally occurring steep slopes:

        i. Full Dispersion (BMP T5.30): Slopes within the dispersal area should be no steeper than 15%.
        ii. Permeable pavements (BMP T5.15): Exclude within areas designated as an erosion hazard, landslide hazard, or within 50 feet from the top of slopes that are greater than 20%.
        iii. Bioretention (SMMWW Vol. 5, Ch. 7): Exclude within 50 feet from the top of slopes that are greater than 20% and over 10 feet of vertical relief.
        iv. Sheet Flow Dispersion (BMP T5.12) and Concentrated Flow Dispersion (BMP T5.11): Do not allow sheet flow on or above slopes greater than 20%, or above erosion hazard areas, without evaluation by a geotechnical engineer or qualified geologist and approval by the Local Plan Approval Authority.
        v. Downspout Infiltration Trenches (BMP T5.10A): Infiltration trenches should not be built on slopes steeper than 25%. A geotechnical analysis and report may be required on slopes over 15% or if located within 200 feet of the top of slope steeper than 40%, or in a landslide hazard area.
        vi. Downspout Infiltration Drywells (BMP T5.10A): Downspout infiltration drywells must not be built on slopes greater than 25%. Drywells may not be placed on or above a landslide hazard area or on slopes greater than 15%.
        vii. Downspout Dispersion (BMP T5.10B): Do not place the discharge point on or above slopes greater than 15% or above erosion hazard areas.
        viii. Post-Construction Soil Quality and Depth (BMP T5.13): Exclude in ALL areas incorporated into a drainage facility or engineered as structural fill or slope. For

natural slopes, this BMP can be considered infeasible on till soil slopes greater than 33%.

4. Existing Critical Areas: Within its property line, STIA is bounded by a number of environmentally sensitive areas. In some cases, use of these areas for additional dispersion or infiltration may be considered an acceptable LID BMP. Maintaining the areas in their natural state can also be considered an acceptable BMP. Many of the wetlands, riparian corridors and buffers surrounding the Airport are subject to environmental restricted covenants associated with 1997 Master Plan Update (MPU) project impacts. These restrictive covenants limit use to mitigation for those impacts alone. Therefore, use of 1997 MPU restrictive covenant areas for additional LID implementation is not allowed unless otherwise approved by the Corps of Engineers and the Washington State Department of Ecology.

E. RECOMMENDATIONS FOR LID IMPLEMENTATION

Based upon FAA regulations governing the airfield and its near-airfield areas, as well as the STIA specific site characteristics and requirements, provisions for approval, modification or limitation of SMMWW LID BMPs can be developed. Summarized below are the recommendations for LID BMP implementation, modification and limitations. Also included is the summary matrix in Table 1.

1. **On-Airfield Zones**: Runway Safety Area (RSA), Runway Object Free Area (ROFA), Taxiway Safety Area (TSA), Taxiway Object Free Area (TOFA) and other portions of the Air Operations Area (AOA) which are outside of the STIA Industrial Waste Sewer system basins.
    a. Available On-Airfield LID BMPs:
        i. Dispersion: Modified, airfield-appropriate versions of the SMMWW Full and Sheet Flow Dispersion BMPs (T5.30 and T5.12), and Compost–amended Vegetated Filter Strips (CAVFS-BMP T7.40) can be utilized through use of grass filter strips between the paved surface and catch basins. Low points for the catch basins shall be as far away from paved surfaces as possible and shall be located outside the RSA or TSA. All grades shall meet FAA design requirements. Section C.5.d of this memorandum provides a brief background on filter strip use at STIA. Grass (turf) is the only allowable vegetation in the Safety Areas and AOA. Where grading is occurring in the filter strip area, the soil may be improved as noted below.
        ii. Post-Construction Soil Quality and Depth: A modified version of the SMMWW BMP T5.13 can be utilized while still meeting airfield compaction requirements. Two inches of compost can be amended into the upper four inches of uncompacted soil to increase organic matter content to 10% or greater. This practice has been on-going at STIA for any infield grading projects on the AOA.
        iii. Minimal Excavation Foundations: In certain circumstances, FAA navigational aids (NAVAIDs) need to be placed in the airfield. In certain circumstances, FAA

design standards may meet the criteria for Minimal Excavation Foundations (BMP T5.19).

b. Excluded On-Airfield LID BMPs:
    i. FAA Advisory Circular Number 150/5300-13A, *Airport Design* states that surface drainage shall be accomplished by the rapid removal of storm water from the airfield and pavement subbase. BMPs that could create standing water and/or pockets of subsurface water – or BMPs that reduce the bearing capacity of the safety areas should be excluded. (e.g., Bioretention, Infiltration and Dispersion Trenches or Basins, Drywells, Rain Gardens, Downspout Dispersion and Infiltration).
    ii. BMPs that include surfaces of gravel, unstabilized compost or other FOD generation sources (e.g., Bioretention, Infiltration Trenches and Dispersion Trenches, Permeable Pavements).
    iii. BMPs that utilize ditches and swales with grades not meeting FAA Design Circular requirements (e.g., Concentrated Flow Dispersion, Bioretention, Bio-swales)
    iv. Surface treatment BMPs that do not meet FAA airfield pavement and safety area standards, loading requirements and construction specifications (unmodified version of Post-Construction Soil Quality and Depth BMP, Permeable Pavements).
    v. BMPs that include vegetation other than grass turf species meeting STIA's approved *Wildlife Hazard Management Plan* (e.g., Bioretention, Tree Retention and Tree Planting, Vegetated Roofs, Preserving Native Vegetation)

2. **Apron and other Industrial Waste System (IWS) Zones**: The Apron, lying wholly within the Air Operations Area (AOA), drains to the STIA Industrial Waste Sewer system due to the nature of the co-mingled contaminants in the runoff stream and subsurface profile. Other IWS areas include the airport parking garage and fuel farm. Because fueling occurs on the Apron, design is also governed by the fire protection regulations of NFPA discussed in Section C.4.b. FAA grading, layout, FOD and pavement requirements also apply. Except as noted below, LID BMP implementation on the Apron is infeasible:
    a. Available Apron LID BMP :
        i. Rainwater harvesting from Non-PGIS rooftop surfaces is a potential BMP for buildings adjacent to the Apron. If utilized, the roof runoff could be collected and used in support of LID provided the collection system does not become a wildlife attractant and that the runoff is not infiltrated within the apron. As previously discussed, introduction of new stormwater sources into the subsurface profile would potentially mobilize the existing subsurface contaminants in the Apron areas.
    b. Excluded Apron LID BMPs:
        i. BMPs that introduce fuel and glycol contaminated runoff into the groundwater profile, or alternately introduce uncontaminated runoff (such as from a roof)

into existing subsurface contamination. (e.g., Bioretention, Infiltration and Dispersion Trenches and Basins, Rain Gardens, Downspout Dispersion and Infiltration, Drywells, Permeable Pavements)

ii. BMPs that include surfaces of gravel, unstabilized compost or other FOD generation sources (e.g., Bioretention, Infiltration Trenches and Dispersion Trenches, Permeable Pavements). Turf in areas subject to continuous jet blast should also be excluded.

iii. BMPs that do not meet NFPA requirements for fire code in aircraft fueling areas. (e.g., open trenches or swales, Concentrated Flow Dispersion)

iv. Surface treatment BMPs that do not meet FAA airfield pavement and safety area standards, loading requirements and construction specifications (unmodified version of Post-Construction Soil Quality and Depth BMP, Permeable Pavements).

3. **The Runway Protection Zone (RPZ) and Protected Airspace**: Implementation of LID BMPs in the RPZ and the protected airspace surfaces are primarily governed by what is permissible under FAA Advisory Circular Number 150/5200-33B, *Hazardous Wildlife Attractants On Or Near Airports* and in accordance with the FAA-approved *STIA Wildlife Hazard Management Plan (WHMP)*. As noted previously, the FAA recommends a separation distance of 10,000 feet at these airports between any of the hazardous wildlife attractants and the airport's AOA, and 5 statute miles of separation for where that attractant could cause hazardous wildlife movement into or across the approach or departure airspace. This includes the "Landside" and "Terminal" areas east of the airfield.

   a. Available Near-Airfield LID BMPs:

      i. Dispersion BMPs (T5.30, T5.11 and T5.12) and Compost-amended Filter Strips (CAVFS-BT7.40)

      ii. Downspout Dispersion, Infiltration, and Drywell BMPs (T5.10A-C)

      iii. Post-Construction Soil Quality and Depth BMP (T5.13)

      iv. Permeable Pavement BMP (T5.15), subject to limitations of loading capacity and usage frequency. Special consideration should be given to near-AOA sites to ensure that track-in of FOD by vehicles and equipment serving the AOA does not occur.

      v. Bioretention BMPs (T5.14B, T7.10, T7.20 and T7.30) provided detention of stormwater is a maximum of 48 hours and 4 inches depth.

      vi. Tree Retention and Tree Planting (T5.16) and Preserving Native Vegetation (T5.40) BMPs provided the BMP does not attract hazardous wildlife and is in accordance with the FAA approved *STIA Wildlife Hazard Management Plan.*

      vii. BMPs used with new structures provided they meet local code requirements of authority having jurisdiction: Reverse Slopes Sidewalks (T5.18), Minimal Excavation Foundations (T5.19), and Rainwater Harvesting (T5.20).

   b. Excluded Near-Airfield LID BMPs:

i. Vegetation used in combination with the above BMPs that creates a wildlife hazard or is not part of FAA-approved *STIA Wildlife Hazard Management Plan.*
ii. BMPs that retain stormwater for longer than 48 hours and more than 4 inches depth.
iii. BMPs that are known wildlife attractants such as Vegetated Roofs (BMP T5.17) or Rain Gardens (T5.14A) that provide roosting habitat or refuge.

4. **Embankments and Retaining Walls**: Infiltration and dispersion of stormwater in and around steep embankments and retaining walls impacts the structural integrity of the embankment material or wall and should be prohibited.
    a. Available LID BMPs:
        i. Tree Retention and Tree Planting (T5.16) and Preserving Native Vegetation (T5.40) BMPs provided the BMP does not attract hazardous wildlife and is in accordance with the FAA-approved *STIA Wildlife Hazard Management Plan.* Furthermore, the vegetation must not compromise the integrity of the embankment and shall allow for inspection.
    b. Excluded LID BMPs: Specific to STIA, infiltration facilities should be excluded within 500 feet of any of the engineered slopes, embankment or MSE walls at the airport. The SMMWW likewise excludes most LID BMPs from naturally occurring steep slopes. A specific list of exclusion criteria are provided in Section D.3 of this memorandum.

5. **Critical Areas**: Most of the BMPs available for use in in the Runway Protection Zone (RPZ) and Protected Airspace areas as noted in Section E.3 above are also applicable here, subject to the same exclusions provided by FAA Advisory Circular Number 150/5200-33B, *Hazardous Wildlife Attractants On Or Near Airports* and the FAA-approved *STIA Wildlife Hazard Management Plan.* Provided these areas do not become wildlife hazards, maintaining these areas in their natural state can be considered an acceptable BMP. As described previously, many of the wetlands, riparian corridors and buffers surrounding the Airport are subject to environmental restricted covenants associated with 1997 Master Plan Update (MPU) project impacts. These restrictive covenants limit use to mitigation for those impacts alone. Therefore, use of 1997 MPU restrictive covenant areas for additional LID implementation is not allowed unless otherwise approved by the Corps of Engineers and Ecology.

Table 1: Summary Matrix - Low Impact Development BMP Restriction by Airport Zone

(green) =Allowable BMP as noted; X = Excluded BMP; N/A = Not Applicable — Low Impact Development BMP		On-Airfield Areas: RSA, ROFA, TSA, TOFA, and AOA (see notes 1, 2)	Apron and IWS Areas (see note 3)	Near-Airfield Areas: RPZ, Airspace Zones, Landside, Terminals (see note 4)	Embankments and Retaining Walls (see note 5)	Existing Stormwater Facilities and Critical Areas (see note 4, 6, 8)
SMMWW Vol. V, Ch. 5 On-Site BMPs	BMP T5.10A: Downspout Full Infiltration	N/A	X		X	N/A - see note 9
	BMP T5.10B: Downspout Dispersion Systems	N/A	X		X	N/A - see note 9
	BMP T5.10C: Perforated Stub-out Connections	N/A	X		X	N/A - see note 9
	BMP T5.11: Concentrated Flow Dispersion	X	X		X	see note 8
	BMP T5.12: Sheet Flow Dispersion	Modify to meet FAA standards - see note 1	X		X	see note 8
	BMP T5.13: Post-Construction Soil Quality and Depth	Modify to meet FAA standards - see note 2	X		X	see note 8
	BMP T5.14A: Rain Gardens	X	X	X	X	N/A - see note 9
	BMP T5.14B: Bioretention	X	X	Max retention 48 hrs, 4" max depth	X	see note 7
	BMP T5.15: Permeable Pavements	X	X	As allowable by load and usage	X	As allowable by load and usage
	BMP T5.16: Tree Retention and Tree Planting	X	X	Vegetation must be approved - see note 4	Vegetation must be approved - see notes 4 & 5	Vegetation must be approved - see note 4
	BMP T5.17: Vegetated Roofs	X - Provides roosting habitat to hazardous wildlife				
	BMP T5.18: Reverse Slope Sidewalks	N/A	X	As allowable by local code requirements	X	N/A - See Note 9
	BMP T5.19: Minimal Excavation Foundations	As allowable by FAA NAVAID standards	X	As allowable by local code requirements	X	N/A - See Note 9
	BMP T5.20: Rainwater Harvesting	N/A	X	As allowable by local code requirements	X	N/A - See Note 9
	BMP T5.30: Full Dispersion	X	X		X	see note 8

	=Allowable BMP as noted X = Excluded BMP N/A = Not Applicable **Low Impact Development BMP**	On-Airfield Areas: RSA, ROFA, TSA, TOFA, and AOA (see notes 1, 2)	Apron and IWS Areas (see note 3)	Near-Airfield Areas: RPZ, Airspace Zones, Landside, Terminals (see note 4)	Embankments and Retaining Walls (see note 5)	Existing Stormwater Facilities and Critical Areas (see note 4, 6, 8)
	BMP T5.40: Preserving Native Vegetation	X	X	Vegetation must be approved - see note 4	Vegetation must be approved - see note 4, 5	Vegetation must be approved - see note 4
SMMWW Vol. V, Ch. 7 Infiltration/ Bioretention BMPs	BMP T7.10: Infiltration Basins	X	X	Max retention 48 hrs, 4" max depth	X	see note 7
	BMP T7.20: Infiltration Trenches	X	X	Max retention 48 hrs, 4" max depth	X	see note 7
	BMP T7.30: Bioretention Cells and Swales	X	X	Max retention 48 hrs, 4" max depth	X	see note 7
	BMP T7.40: Compost-amended Vegetated Filter Strips (CAVFS)	Modified to meet FAA standards - see notes 1 & 2	X	Vegetation must be approved - see note 4	X	see note 8

Notes:

1. All FAA standards with regard to clearance of objects, drainage, grading, compaction, smoothness, vegetation and allowable stabilization must be met - see section C of memorandum.

2. A modified version of the SMMWW BMP T5.13 can be utilized while still meeting airfield compaction requirements.

3. Conveyance and treatment of Apron runoff and subsurface drainage by the IWS system is the current BMP specified for the Apron under STIA's NPDES Permit Stormwater Pollution Prevention Plan (SWPPP).

4. BMPs in the RPZ and Airspace Zones must meet *FAA Advisory Circular Number 150/5200-33B, Hazardous Wildlife Attractants On Or Near Airports* and be in accordance with the FAA approved *STIA Wildlife Hazard Management Plan (WHMP).*

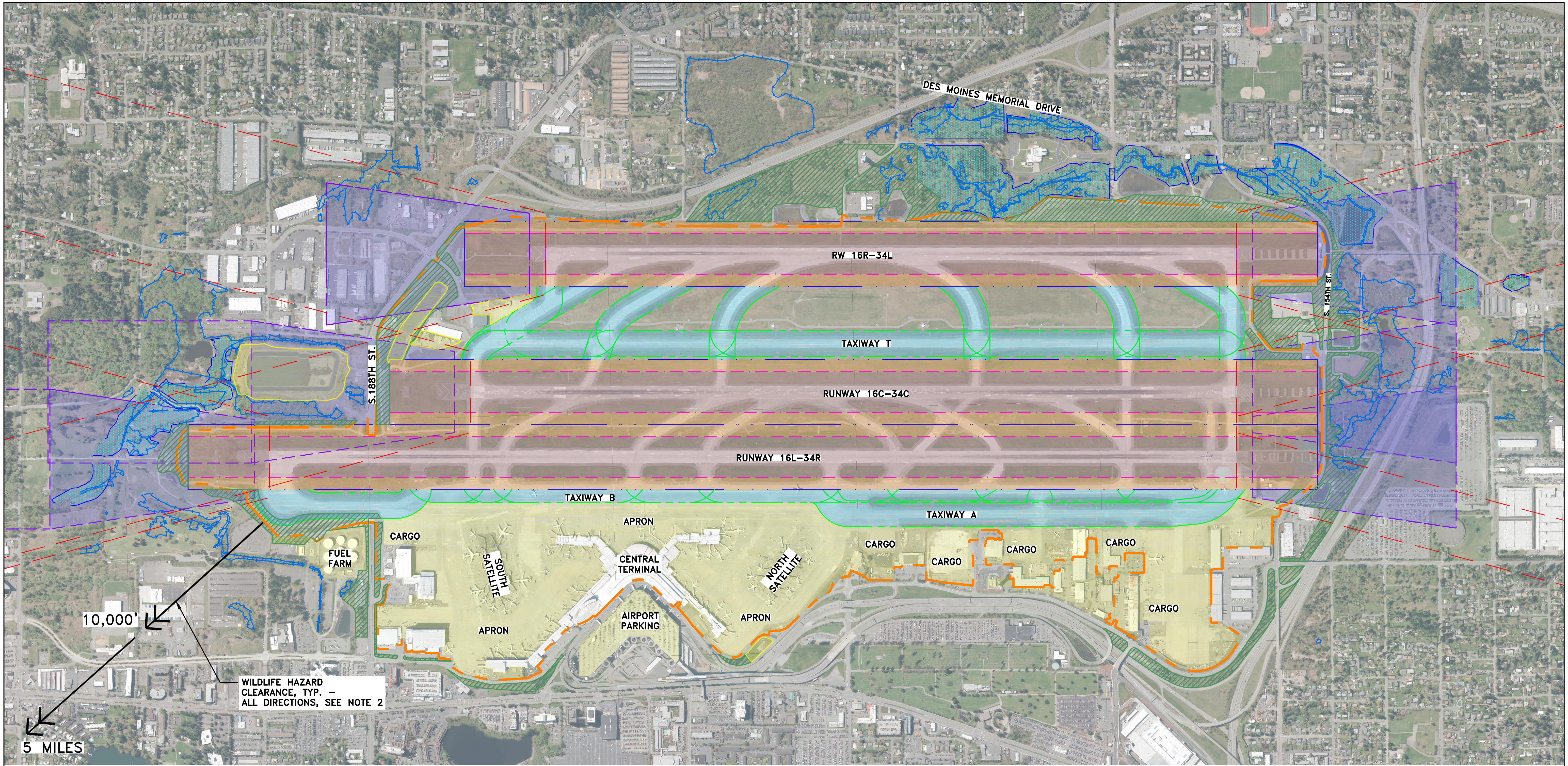
5. Infiltration and dispersion of stormwater in and around steep (approx. 20% or more) constructed embankments and retaining walls should be prohibited. Vegetation must not be detrimental to embankment or restrict inspection.

6. Retaining existing critical areas on-site can be considered an LID BMP.

7. Existing stormwater flow control facilities may provide some bioretention/infiltration functions.

8. Implementation of constructed LID BMPs and other infrastructure within or adjacent to these areas may be restricted by prior inter-agency agreements and maintaining mandated creek basin boundaries.

9. Pertains to new structures/buildings and site development likely not allowable in wetlands/restricted covenant areas.



LEGEND:

- RUNWAY SAFETY AREA (RSA)
- RUNWAY PROTECTION ZONE (RPZ)
- APRON: AIRCRAFT PARKING, CARGO HARDSTAND OR OTHER INDUSTRIAL USE AREAS DRAINING TO IWS (INCLUDES FUELING AND AIRCRAFT DEICING AREAS)
- RUNWAY OBJECT FREE AREA (ROFA)
- TAXIWAY OBJECT FREE AREA (TOFA)
- RESTRICTED COVENANT
- AOA BOUNDARY
- WETLAND BOUNDARY
- RUNWAY DEPARTURE SURFACES
- MSE WALL AND CONSTRUCTED EMBANKMENT AREAS SUPPORTING AIRPORT, FAA AND PUBLIC INFRASTRUCTURE

NOTES:

1. WHERE ZONES OVERLAP, THE MORE STRINGENT STANDARDS APPLY.
2. "FAA ADVISORY CIRCULAR NUMBER 150/5200-33B, HAZARDOUS WILDLIFE ATTRACTANTS ON OR NEAR AIRPORTS" RECOMMENDS A SEPARATION DISTANCE OF 10,000 FEET BETWEEN ANY HAZARDOUS WILDLIFE ATTRACTANTS AND THE AIRPORT'S AOA AND 5 STATUTE MILES OF SEPARATION FOR WHERE THAT ATTRACTANT COULD CAUSE HAZARDOUS WILDLIFE MOVEMENT INTO OR ACROSS THE APPROACH OR DEPARTURE AIRSPACE. THIS INCLUDES THE LANDSIDE AND TERMINAL AREAS EAST OF THE AIRFIELD.

N

600 0 600 1200
Scale Feet

FIGURE 1: AIRPORT ZONES LIMITING LOW IMPACT DEVELOPMENT IMPLEMENTATION

Appendix B: Infiltration Infeasibility Assessment Report (Aspect 2018)

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INFILTRATION INFEASIBILITY ASSESSMENT

Seattle-Tacoma International Airport
SeaTac, Washington

Prepared for: The Port of Seattle
Aviation-Environmental Division

Project No. 150050 • July 17, 2018 Final

Aspect
CONSULTING

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Aspect CONSULTING

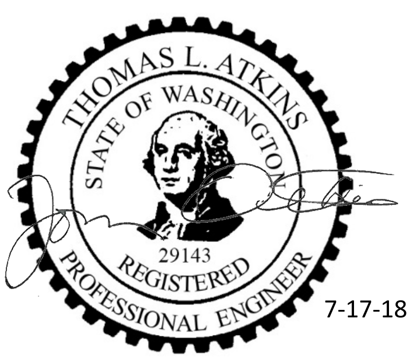
INFILTRATION INFEASIBILITY ASSESSMENT

Seattle-Tacoma International Airport
SeaTac, Washington

Prepared for: The Port of Seattle
Aviation-Environmental Division

Project No. 150050 • July 17, 2018 Final

Aspect Consulting, LLC
in association with Robin Kirschbaum, Inc.



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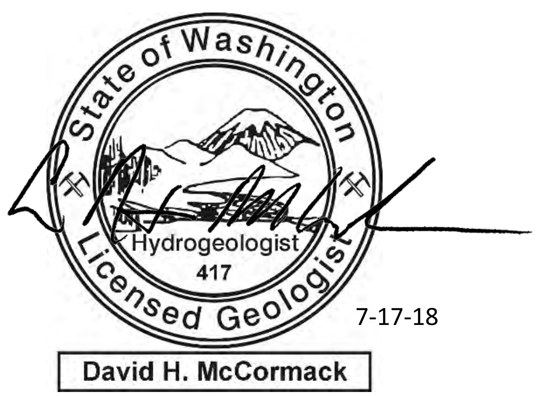

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1 Introduction

Aspect Consulting, LLC (Aspect), in association with Robin Kirschbaum, Inc. (RKI), has prepared this report to provide a screening-level map of infiltration infeasibility. The map will be used by Port of Seattle (Port) staff and development project applicants to determine whether infiltration has been pre-mapped as infeasible for proposed project sites, and determine whether site-specific infiltration assessments (generally including explorations and infiltration testing) are required. See the Stormwater Management Manual for Port Aviation Division Property (Port SWMM) (Port, 2017), Volume 1, Section 2.4 for information on stormwater minimum requirements for new and redevelopment projects, and Section 3.4 of the Low Impact Development (LID) Guideline (RKI, 2017) for requirements to assess infiltration feasibility for projects that trigger Minimum Requirement (MR) #5 (On-site Stormwater Management).

1.1 Document Organization

This document is organized into five sections, as described below:

- Section 1 provides an introduction and background information.
- Section 2 summarizes the physical characteristics of the STIA study area, including topography, geology, and hydrogeology.
- Section 3 provides the infiltration infeasibility criteria, including the requirements for infeasibility mapping.
- Section 4 summarizes the results including a map showing the distribution of infiltration infeasibility (Figure 11). Proposed projects located in the areas mapped as infeasible for infiltration in Figure 11 are not required to conduct additional infiltration feasibility assessment for purposes of satisfying Minimum Requirements #5 (On-site Stormwater Management), #6 (Runoff Treatment), or #7 (Flow Control) in accordance with the Port SWMM.

A list of references cited is provided at the end of the document.

1.2 Background Information

Infiltration refers to the practice of directing stormwater runoff to the subsurface and letting it seep into groundwater. This report provides an infiltration infeasibility assessment for Seattle-Tacoma International Airport (STIA) following the regulatory requirements and criteria provided in the following documents:

- STIA National Pollutant Discharge Elimination Permit (NPDES) Individual Permit No. WA-002465-1;
- Stormwater Management Manual for Western Washington (SWMMWW) (Washington State Department of Ecology [Ecology], 2014);
- Port SWMM; and

- LID Guideline.

Ecology has defined LID infeasibility criteria in the SWMMWW, and the infeasibility criteria are described in Chapter 3.1.1 of Volume 3, and Chapters 5.3 and 7.4 in Volume 5. The SWMMWW states in Volume 1, Section 2.5.5 Minimum Requirement #5: On-site Stormwater Management that: *"Projects shall employ on-site stormwater management BMPs [best management practices] in accordance with the following projects thresholds, standards, and lists to infiltrate, disperse, and retain stormwater runoff on-site to the extent feasible without causing flooding or erosion impacts."* The SWMMWW later states in the same section: *"Feasibility shall be determined by evaluation against: 1. Design criteria, limitations, and infeasibility criteria identified for each BMP in this manual; and 2. Competing Needs Criteria listed in Chapter 5 of Volume 5 of this manual."*

1.3 Study Area

STIA is located in southwestern King County within the City of SeaTac, approximately 12 miles south of downtown Seattle (Figure 1). STIA has an approximately 1,600-acre drainage area with runoff flowing into four local streams—Des Moines, Miller, Walker and Gilliam Creeks—which discharge to the Puget Sound (Figure 2). Stormwater drainage at STIA is separated into two different collection systems: the Industrial Wastewater System (IWS) and the Storm Drainage System (SDS). The IWS collects stormwater from the approximately 375 acres where industrial activities are conducted, which is treated in the Industrial Wastewater Treatment Plant (IWTP) before discharged through an individual outfall. The SDS collects stormwater from the remaining approximately 1,200 acres, with runoff conveyed to Lake Reba and subsequently to Miller Creek to the north, to the Northwest Ponds and Des Moines Creek to the south, and Walker Creek to the west.

The study area for the infiltration infeasibility study is the STIA Stormwater Utility Boundary. The STIA study area boundary is noted on several figures provided at the end of this report.

1.4 Competing Needs for STIA Operations

Competing needs for STIA operations need to be considered to determine whether use of LID BMPs is superseded or restricted by regulatory requirements. From Section 3.2 of the LID Guideline, competing needs applicable to STIA operations include the following:

- Federal Aviation Administration (FAA) standards and requirements for airports;
- Transportation regulations to maintain the option for future expansion or multimodal use of transportation facilities and public rights-of-way; and
- Public health and safety standards.

Section 3.2.1 of the LID Guideline identifies STIA's operation zones and the key FAA regulatory requirements affecting LID implementation in each zone. The regulatory requirements are summarized in the memorandum *Federal Aviation Administration*

Limitations and Exclusions to Applying LID Standards at Seattle-Tacoma International Airport (HNTB, 2016), which is provided in Appendix A of the LID Guideline.

The FAA defines several operation zones with specific requirements for siting and design of stormwater facilities, including LID BMPs. These zones are described briefly below and are mapped in Figure 3-2 (Appendix A) (this table is reproduced from the LID Guideline):

- Airport Operations Area (AOA) – The area of an airport used or intended for use for landings, takeoffs, or surface maneuvering of aircraft. The AOA is the area where aircraft can operate, either under their own power or while in tow. At STIA, the AOA is defined physically by the airport perimeter fence and includes all areas with restricted access and located outside the airport terminal buildings, including runways, taxiways, aprons, ramps, hardstands, safety areas, perimeter roads, and cargo areas.

- Runway Safety Area (RSA) – The defined ground space surface that includes and surrounds the runway and is prepared for the express purpose of reducing catastrophic loss of life and damage to aircraft in the event of an undershoot, overshoot, or excursion from the runway surface. At STIA, the RSA for air-carrier operations of Group V aircraft is 500 feet wide, centered on the runway, and extends 1,000 feet beyond the runway ends.

- Runway Object Free Area (ROFA) – The defined area centered on the runway enhances the safety of aircraft operations by remaining completely clear of objects, including terrain variations, that protrude above the elevation of the nearest point of the RSA surface. At STIA, the ROFA is 800 feet wide, centered on the runway, and extends 1,000feet beyond the end of the runway, consistent with the RSA in those locations.

- Taxiway Safety Areas and Taxiway Object Free Area (TSA, TOFA) – These areas mirror the intent of the RSA and ROFA, but are centered on taxiways and have smaller dimensional requirements. These areas also define safety zones for aircraft deviating from the paved operational surfaces. Based on the aircraft serving STIA, the TSA is designated as 214 feet wide, and the TOFA is designated as 320 feet wide, both centered on the taxiway.

- Apron Area (AA) – The defined area outside of the ROFA and TOFA, located adjacent to the terminal, aircraft maintenance, and cargo buildings. Its primary function is to: (1) provide a place to safely accommodate aircraft during loading and unloading of passengers and cargo; (2) provide for circulation of aircraft and ground vehicles; and (3) provide a location for fueling, deicing, maintenance, and aircraft parking. The AA for STIA, inclusive of the cargo hardstand areas, drain to the IWS, and are treated by STIA’s on-site IWTP.

- Runway Protection Zone (RPZ) and Protected Airspace (PA) – The trapezoidal-shaped ground area off of the runway end that enhances the safety and protection of the public by controlling the land uses and eliminating incompatible objects and activities. This PA is a family of related three-dimensional airspace surfaces designed to provide obstacle clearance to arriving and departing aircraft.

Table 3-1 (Appendix B) summarizes the restrictions on LID implementation at STIA based on regulatory requirements of the FAA, Ecology, and local jurisdictions (this table is reproduced from the LID Guideline).

2 Topography, Geology, Surface Water and Other Notable Features

This section summarizes the topography, geology, hydrogeology, surface water bodies and other notable features of the STIA study area.

2.1 Information Sources

The assessment utilized the substantial amount of existing soils and groundwater information for the STIA's property, including the *Phase 1 Groundwater Study* (Aspect, 2008, hereafter referred to as the Groundwater Study), which provided a relatively well-developed understanding of the area's hydrogeology.

Subsurface geologic and hydrogeologic information from the Groundwater Study included extensive review of existing boring and well logs, groundwater elevation monitoring, development of a conceptual model that included hydrostratigraphic units above bedrock, and development of a numerical groundwater model that simulated groundwater flow and contaminant transport in the vicinity of STIA. The Groundwater Study focused on regional groundwater occurrence and flow for purposes of modeling long-term contaminant transport from potential sources of contamination within the STIA Aircraft Operations and Maintenance Area to regional surface water and groundwater receptors. It did not focus on infiltration potential or develop hydrogeologic information that would support site-specific stormwater infiltration analysis.

Other sources of geologic, hydrogeologic, and topographic information included:

- Surficial geologic maps, including quadrangle geologic mapping by Booth and Waldron (2004).
- Best-available ground surface elevation data, such as Light Detection and Ranging (LiDAR) elevation data or Port of Seattle topographic survey information.

Additional geologic and hydrogeologic information from the following sources was used to fill in identified data gaps as needed:

- Geologic information contained in the Port of Seattle Environmental Management Information System (EMIS) database.
- *Effects on Infiltration and Base Flow Proposed Third Runway Embankment* (Hart Crowser, 2000).
- *Stormwater Infiltration Facility Site Analysis and Evaluation* – Draft Report (Landau, 2003).
- *Geotechnical Engineering Design Study – Port of Seattle Maintenance Warehouse* (Hart Crowser, 2007).
- *Design Infiltration Rate for Cell Phone Lot* (Otak, 2013).

- *South Employee Parking Lot Stormwater Infrastructure Improvements* (GeoEngineers, 2014).
- *Report on Infiltration Tests of Third Runway Embankment Fill (Round 3)* (Pacific Groundwater Group, 2015).
- *Lora Lake Pump Down/Pump-back Test* (Aspect Consulting, 2015).

Notable areas within STIA property, including surface waters, wetlands, steep slopes, built areas with special structural considerations (such as the Third Runway Embankment infiltration exclusion zone), and FAA-regulated zones were based on available GIS data from the Port, state, King County, and local municipalities and agencies.

2.2 Topography

Ground surface elevations for the STIA study area are shown on Figure 3. This shaded relief topographic map was created using King County 2015 LiDAR digital terrain model data with a 3-ft resolution. As indicated on Figure 3, the topography rises from approximately 60 feet above mean sea level (amsl) in the southwest portion of the study area near Des Moines Creek, to elevations of approximately 500 amsl in the center of the study area.

2.3 Geology

The surficial and near-surface geology of the Puget Sound basin results from long periods of erosion and nonglacial sedimentation in depositional environments similar to those present in predevelopment times, punctuated by multiple glacial advances into the Puget Sound lowland. The most recent glaciation, the Vashon Stade of the Fraser glaciation, ended about 13,000 years ago. The resulting landform consists of glacially sculpted uplands composed of north-to-south elongated glacial drumlins and flutes, and the broad river valleys and waterways of Puget Sound. Post-glacial erosion has locally incised the uplands and created steep-sided ravines and steep bluffs near coastal areas and river valleys. Alluvial soils have been deposited in river and stream valleys since the end of the Vashon glaciation.

Figure 4 illustrates the surficial geology of the STIA study area based on the surficial geologic units that were modeled in the Groundwater Study (Aspect, 2008). Regionally significant geologic units of the study area are also shown on Figure 4. Note that not all of these units may be present at the surface and/or in the shallow surface of the STIA study area, but are included here as they may be grouped with other geologic units to form regional hydrostratigraphic units.

Figures 5 through 8 show regional hydrostratigraphic sections and modeling units that were developed for the Groundwater Study (Aspect, 2008). The locations of the sections are shown on Figure 4. The 2008 study sections have been updated for this report to include areas of significant fill placed for the STIA Third Runway construction project, and other major changes in surface grades.

Hydrostratigraphic units used in the 2008 study were grouped into predominantly coarse-grained (i.e. primarily sand or gravel) units identified as C0 through C5 (youngest to oldest), or predominantly fine-grained (i.e. primarily silt or clay or low permeability units such as till) identified as F0 through F5. Some of the hydrostratigraphic units can be correlated with known geologic units. Where those correlations can be made, they are noted in the discussions of geologic units below.

The regional geologic units are divided into the following general categories (from generally older to younger):

- **Pre-Fraser-Glaciation-Age Glacial and Nonglacial Deposits:** Pre-Fraser-glaciation-age deposits includes all undifferentiated soils of older glacial or nonglacial origin. This group of pre-Fraser soils has generally not been dated or regionally correlated with specific named glacial or nonglacial formations of sequences, and consequently they are subdivided based on dominant grain size and hydraulic properties into fine-grained and coarse-grained subunits.

  Pre-Fraser Fine-Grained Deposits $Qpf_{(f)}$ includes deposits of glacial and nonglacial origins that are predominantly fine grained (composed chiefly of silt and clay). Due to the relatively high percentage of fine soil particles, these deposits are generally considered poor for infiltration and form aquitards or perching strata. They are identified as units F2 through F6 on the geologic cross sections, Figures 5 through 8.

  The Pre-Fraser Coarse-Grained Deposits $Qpf_{(c)}$ includes the older glacial and nonglacial deposits that are primarily coarse grained. These are generally aquifers where saturated, or are considered potentially feasible for infiltration where unsaturated. They are identified as units C2 though C6 on the sections on Figures 5 through 8.

- **Vashon Deposits:** Deposited during the recent Vashon glaciation, these deposits include the following units (from oldest to youngest): advance outwash (Qva), glacial till (Qvt) and subglacial meltout till (Qvtm), ice-contact deposits (Qvi), and recessional outwash (Qvr).

  The Qva advance outwash unit is a predominately slightly silty to clean, fine-to-medium-grained sand unit that lies stratigraphically below the glacial till. In some of the STIA study area, the Qva unit lies directly above older coarse-grained deposits ($Qpf_{(c)}$). Where they are present, they were considered a combined aquifer, but hereafter are referred to as the advance outwash aquifer. Where present, it is generally considered moderately permeable, with moderate infiltration capacity. It forms an aquifer where saturated and a potential infiltration target where unsaturated. Vashon advance outwash is unit C1 on the sections on Figures 5 through 8.

  Vashon Qvt basal glacial till covers much of the STIA high plateau area. It generally consists of a very dense mixture of silt, sand, and gravel and is considered relatively impermeable. The Groundwater Study (Aspect, 2008) indicated an average glacial till thickness of about 10 feet and a maximum of about 40 feet. A till subunit, subglacial meltout till, (Qvtm), is locally present in place of the Qvt basal till or occurs below the basal till. It consists of interbedded sandy till-like layers and silty outwash-like lenses and layers. Due to the lack of hydraulic continuity between the sandy lenses and layers, the unit as a whole has low permeability, and is an aquitard. Vashon till is unit F1 on the sections on Figures 5 through 8.

The Qvi ice-contact deposits are commonly transitional in texture between glacial till and recessional outwash deposits and are mapped in isolated areas on the flanks of hills around STIA. The permeability of the ice-contact deposits is generally between that of glacial till and advance outwash. In this assessment, Qvi is considered a low permeability unit and would be included in unit F1 on the sections on Figures 5 through 8.

Vashon recessional outwash, generally consists of moderately to highly permeable sand and gravel, is relatively extensive in the low-lying areas near the margins of the STIA study area. It, along with recent alluvial deposits (Qal – described below), forms the uppermost aquifer in the Groundwater Study (Aspect, 2008), and is shown as unit C0 on the sections. Recessional outwash is often underlain by glacial till and may contain shallow groundwater.

- **Post-glacial (Recent) Deposits:** Deposited after the most recent glaciation, these deposits include alluvial deposits (Qal), wetland deposits (Qw), and modified land (m).

  In the STIA study area, alluvial deposits, which are typically relatively permeable, are restricted to the narrow channels of narrow drainages that flow from uplands around STIA. Due to proximity to stream beds, they are generally saturated and are not significant targets for infiltration. The coarse-grained alluvial deposits are included within unit C0 on the sections on Figures 5 through 8.

  Wetland deposits are generally associated with surface water bodies and are typically saturated, fine grained, and unsuitable for infiltration. Wetland deposits are included within the F0 unit on the sections on Figures 5 through 8.

  The modified land unit includes areas of fill associated with regrading for STIA and other developments around the STIA area. Due to variable hydraulic properties, modified lands and fills are not considered targets for infiltration. Most structural fills in the STIA operations area are coarse grained and would fall within the C0 unit. The Third Runway Embankment fill has been tested (Pacific Groundwater Group, 2015) and identified as generally low permeability.

The complex geologic and glacial history of the STIA study area has resulted in multiple periods of erosion and deposition. Thus, it should be noted that not all of the above hydrostratigraphic or geologic units are typically present at any one location. For example, the advance outwash hydrostratigraphic unit is typically not present in relatively low-lying areas where subglacial erosion during advance of the Vashon ice sheet and later incision of creeks have eroded this hydrostratigraphic unit.

2.4 Hydrogeology

Based on review of existing information, three primary hydrostratigraphic units of most importance have been identified in the study area: the near-surface Vashon till groundwater perching unit (F1), the recessional outwash aquifer (C0), and the advance outwash/pre-Fraser coarse-grained deposits ($Qpf_{(c)}$) unit (C1 and C2). This section summarizes the characteristics and implications of these units.

Near-surface perched groundwater occurs when low-permeability soils are present near the ground surface and are overlain by higher permeability soils. In particular, perched groundwater frequently occurs within the recessional outwash unit (C0), where it lies above the glacial till that caps most of the uplands and gentle flanks of the hill composing the STIA study area. Depending on a variety of factors, such as facility size and horizontal permeability, groundwater mounding on glacial till can reduce the infiltration capacity of the facility by an order of magnitude or more in comparison with short-term infiltration testing results and, in most situations, render shallow infiltration ineffective.

The recessional outwash aquifer occurs in the recessional outwash deposits (C0) in the low-lying and gently sloping flanks of the STIA study area. This aquifer may be perched on top of glacial till deposits that underlie the recessional outwash, or in areas where the glacial till is not present, it may be in direct connection with the advance outwash aquifer or older fine- or coarse-grained geologic and hydrostratigraphic units. The depth to groundwater in the recessional outwash was not a significant parameter in the Groundwater Study (Aspect, 2008) and is not well documented. Elevations of the recessional outwash aquifer can be inferred in places based on the presence of lakes, streams, and wetlands around STIA. In addition to Miller and Walker Creeks, a number of lakes and wetlands are shown on Figure 4.

Although site-specific conditions vary considerably, in general, sites nearer to surface water bodies will have thinner zones of unsaturated recessional outwash. Thus, the feasibility of infiltration in those areas generally decreases with decreasing distance to surface water bodies.

Shallow infiltration within the recessional outwash aquifer also has the potential to mound groundwater and locally increase discharge to nearby wetlands. Impacts of changing water table height and baseflow or timing of flow to wetlands may need to be considered for some sensitive site areas.

The advance outwash aquifer was a significant aquifer (C1) in the Groundwater Study (Aspect, 2008), and flow in the aquifer was simulated in the groundwater model. Based on the results of the modelling, it was interpreted that the advance outwash aquifer generally discharges to Miller and Walker Creeks in the central western portion of the STIA study area and to Des Moines Creek near the southern end.

Infiltration into the advance outwash aquifer has the potential to increase baseflow to discharge basins. Changes to baseflow, and timing of flow changes, could be a consideration for some sites.

2.5 Surface Water, Wetlands, and Other Notable Features

Figure 9 shows surface water bodies, wetlands, FAA-regulated zones, the Third Runway Embankment fill, drinking water wells, and areas of historical industrial activity within the STIA study area based on available GIS data and other relevant information. These areas that have potential impacts on stormwater infiltration are discussed below:

- **Surface water bodies and wetlands**: Surface water bodies and wetlands are classified as infeasible for infiltration. The wetland boundaries are based on the 2016 wetland delineation provided by Environmental Science Associates (ESA). No buffers were considered for surface water bodies or wetlands.

- **FAA-regulated zones, IWS area, and pavements within the AOA**: The FAA operational zones are described in Section 1.3 of this memorandum. The influence of FAA-regulated zones on potential infiltration (and other LID) opportunities is described in *Federal Aviation Administration Limitations and Exclusions to Applying Low Impact Development Standards at Seattle Tacoma International Airport* (HNTB, 2016). Table 3-1 (Appendix B) summarizes restrictions on LID implementation at STIA based on regulatory requirements of the FAA. Infiltration within the AA and IWS drainage areas is excluded based on the STIA NPDES permit and/or FAA regulations (see Figure 3-2, Appendix A). In addition, all pavements in the AOA are deemed infeasible for infiltration based on several FAA requirements associated with airport pavement design and operation, including fill compaction requirements for heavily loaded pavements and the need for positive drainage of pavements to divert fuel, glycol, metals, oils, etc. to the IWS storm sewers.

- **Third Runway Embankment fill:** The Third Runway Embankment fill area was estimated by comparing pre- and post-construction topography provided by the Port. Buffers were not included for the Third Runway Embankment fill. The reinforced earth fill composing much of the Third Runway area is designed for drained conditions. A criterion for operation is prohibition of direct infiltration in the vicinity of the filled area, so this area was deemed infeasible for infiltration.

- **Drinking water wells:** Areas containing a Group A or Group B drinking water well as identified by the Washington State Department of Health (DOH), including a 100-foot buffer, are designated infeasible for infiltration. Only one of these wells was identified within study area boundaries, located in the very southern portion of the STIA study area. Other water supply wells exist with the STIA study area; however, these wells were not excluded from consideration for infiltration since they are not classified as a Group A or B drinking water wells. Site-specific evaluations would be needed to verify that stormwater infiltration would not negatively influence relevant wellhead protection zones. As described in the SWMMWW (Ecology, 2014), Volume III, Chapter III-3.3.7 Site Suitability Criteria for wellhead protection zones:
    - Stormwater infiltration facilities should be set back at least 100 feet from drinking water wells, septic tanks or drainfields, and springs used for public drinking water supplies;
    - Infiltration facilities upgradient of drinking water supplies and within the 10-year time of travel zone must comply with the Washington State Wellhead Protection Program Guidance Document, (DOH, 2010);

  - Infiltration systems that qualify as Underground Injection Control (UIC) wells must follow "Guidance for UIC Wells that Manage Stormwater," (Ecology, 2006); and
  - Setback requirements are generally required by local regulations, uniform building code requirements, or other state regulations.

- **Areas of historical industrial activity**: Previous environmental investigations have identified areas of known and/or suspected soil contamination around STIA associated with historical industrial activity. Aspect staff familiar with previous STIA environmental investigations were consulted for input, and areas of historical industrial activity were identified. Detailed information on potentially contaminated sites is provided in the Groundwater Study (Aspect, 2008), which includes Figure 6-1 showing all known and potential contaminated sites that were evaluated for the study. In addition, a detailed list of relevant historical reports for the main sites is provided in the Groundwater Study. Since site-specific delineations would be needed to more accurately depict the extent of current soil contamination associated with historical industrial activity, these areas were not mapped as infeasible for the purpose of this study. However, if soil contamination does exist, then an area may not be suitable for shallow infiltration and implementation of LID practices could be limited.

- **Steep surface slopes:** Infiltration is generally considered more feasible in flat areas and less feasible on steep slopes due to the potential for shallow infiltration to migrate along a perching layer and daylight at the ground surface or in a crawl space/basement down slope from the infiltration facility. In addition, surface slope can affect the cost of construction of shallow infiltration facilities, due to the addition of weirs or other structures to create storage on steep slopes. Surface slope was calculated based on LiDAR elevation data. Volumes 3 and 5 of the SWMMWW provide infeasibility criteria ranging from greater than 15 to 25 percent for surface slope infiltration BMPs. A conservative approach was taken for the STIA analysis as slopes greater than 25 percent were deemed infeasible for infiltration. As shown on Figure 10, relatively little of the STIA study area has steep slopes greater than 25 percent.

2.6 Other Considerations

Other factors that were assessed but did not influence the STIA infeasibility mapping are described below:

- **Landslide Hazard Areas:** In steep slope hazard areas, increased groundwater recharge can, in some situations, increase the potential for landslides. Therefore, infiltration facilities generally should not be located close to slopes that may be susceptible to landslides (referred to as steep slope hazard areas). Landslide hazard areas are indicated on the King County Landslide Hazard Area GIS maps:

  - http://www5.kingcounty.gov/sdc/Metadata.aspx?Layer=annexed_landslide_sao1990

- http://www5.kingcounty.gov/sdc/Metadata.aspx?Layer=landslide_hazard
- http://www5.kingcounty.gov/sdc/Metadata.aspx?Layer=lsr_ds_landslideoutline

Review of the King County data indicated that no landslide hazards are mapped within the STIA study area.

- **Erosion Hazards:** Areas designated as erosion hazards are considered infeasible for infiltration. Review of data provided in the King County Erosion Hazard Area GIS maps (http://www5.kingcounty.gov/sdc/FGDCDocs/ERODE_faq.htm) indicated that no erosion hazards are mapped within the STIA study area.

- **Shallow groundwater and frequently flooded areas:** The SWMMWW considers infiltration infeasible in areas where seasonal high groundwater or an underlying low permeable layer would create saturated conditions within 1 foot or 3 feet of the base of the facility. This determination must be based on a preponderance of evidence. Areas with well-documented groundwater seepage, prolonged flooding, or seasonal high groundwater within 3 feet of the ground surface are likely to meet the infeasibility criteria provided in the SWMMWW. This analysis did not review direct measurements of depth to groundwater in wells and subsurface explorations or observations of seepage or flooding. Future updates of the infeasibility map may incorporate these direct measurements and observations.

- **Landfills:** The SWMMWW considers infiltration infeasible within 100 feet of a closed or active landfill and areas with deep soil contamination. These areas have not been identified within the STIA study area.

- **Utility Conflicts:** Where threat to safety or reliability of pre-existing utilities may be posed, a licensed professional must evaluate infiltration infeasibility based on site-specific conditions. Numerous utility conflicts exist within the STIA study area. However, since site-specific delineations would be needed to more accurately depict the extent of the utility conflicts, these areas were considered feasible for infiltration for the purpose of this study.

3 Infiltration Infeasibility Criteria Used for STIA Mapping

3.1 Requirements for Infeasibility Mapping

Infeasibility criteria for infiltration are described in Chapter 3.1.1 of Volume 3 and Chapters 5.3 and 7.4 in Volume 5 of the SWMMWW. As stated in Chapter 5.3.1 Volume V of the SWMM: *"a local government can map areas that meet a specific infeasibility criterion listed above provided they have an adequate data basis. Criteria that are most amenable to mapping are:*

- *Where land for bioretention is within an area designated by the local government as an erosion hazard, or landslide hazard;*
- *Within 50 feet from the top of slopes that are greater than 20 percent and over 10 feet vertical relief;*
- *Within 100 feet of a closed or active landfill."*

Chapter 5.3.1 Volume V of the SWMM also indicates that infeasibility mapping based on high groundwater and low infiltration rates must be based upon a preponderance of field data, collected within the area of concern, that indicate a high likelihood of failure to achieve the minimum groundwater clearance or infiltration rates identified in the infeasibility criteria. The local government must develop a technical report, and make it available upon request by Ecology. The technical report must be authored by a professional with appropriate expertise (e.g., registered engineer, geologist, hydrogeologist, or certified soil scientist), and document the location and pertinent values/observations of data that were used to recommend the designation and boundaries for the geographic area. The types of pertinent data include, but are not limited to:

- Standing water heights or evidence of recent saturated conditions in observation wells, test pits, test holes, and well logs;
- Observations of areal extent and time of surface ponding, including local government or professional observations of high water tables, frequent or long durations of standing water, springs, wetlands, and/or frequent flooding; and
- Results of infiltration tests.

This analysis did not include review of field evidence that could help provide the "preponderance of evidence" that Ecology requires for delineating infeasibility based on high groundwater and low infiltration rates. However, additional analyses may be conducted in the future that could provide the required preponderance of evidence. The infeasibility map can be updated in the future to include additional analyses.

The infiltration infeasibility criteria that were used for the STIA infiltration infeasibility mapping are described in the sections below.

3.2 Proximity to Surface Water and Wetlands

Surface water bodies and wetlands were classified as infeasible for infiltration. Buffers were not incorporated for the surface water bodies or wetlands.

3.3 Proximity to Steep Surface Slopes

Slopes greater than 25 percent were deemed infeasible for infiltration. Buffers were not incorporated for the steep surface slopes.

3.4 Proximity to Third Runway Embankment

The Third Runway Embankment fill was considered infeasible for infiltration based on competing needs (see Section 1.3). Buffers were not incorporated for the Third Runway Embankment fill.

3.5 Proximity to FAA Operation Zones, IWS Area, and AOA Pavements

The AA and IWS drainage areas and the AOA pavements were considered infeasible for infiltration based on competing needs (see Section 1.3). Buffers were not incorporated for these areas.

3.6 Proximity to Drinking Water Wells

One area containing a Group A or Group B drinking water well was designated infeasible for infiltration, including a 100-foot-buffer.

4 Results

4.1 Infiltration Infeasibility Map

The infiltration infeasibility map (Figure 11) identifies in red the areas at STIA that are infeasible for infiltration in accordance with the LID Guideline. For these areas, additional infiltration feasibility assessment is not required to demonstrate infeasibility for satisfying Minimum Requirements #5 (On-site Stormwater Management), #6 (Runoff Treatment), or #7 (Flow Control).

4.2 Limitations of Analysis and Conditions of Use

Given that this work product may be available to the public and/or Port staff that may not be aware of the limitations of the analysis, it is important to communicate the limitations of analysis and conditions of use to all potential users. These limitations and conditions of use include the considerations described below:

- The infiltration infeasibility map is intended to assist developers, their engineers, and Port staff in determining when infiltration may be considered infeasible for proposed development sites, or portions of proposed development sites. As required by the SWMMWW, STIA Stormwater Management Manual and LID Guideline, for areas not mapped as infeasible the developer or their engineer is expected to conduct their own site-specific analysis regarding the feasibility of infiltration to assess potential impacts with stormwater infiltration, and to support design and construction of their project.

- The mapping is based on approximate information provided by others and has not been verified in the field. It is possible that conditions at any location will differ from the generalized conditions shown on the maps.

- This analysis does not include a slope stability assessment. The locations of landslide hazard and erosion hazard areas are based on qualitative criteria such as geologic setting, and quantitative criteria based on slope angles. Adding water to the subsurface is known to increase the potential for landslides, and erosion and buffer zones should be incorporated to provide sufficient protection from future landslides and erosion.

- The Port and Aspect do not provide any guarantees regarding the accuracy of information provided on these maps. The user of these maps will indemnify and defend the Port and Aspect for any damages incurred due to use of these maps.

5 References

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Limitations

Work for this project was performed, and this report prepared in accordance with, generally accepted professional practices for the nature and conditions of work completed in the same or similar localities, at the time the work was performed. This report does not represent a legal opinion. No other warranty, expressed or implied, is made.

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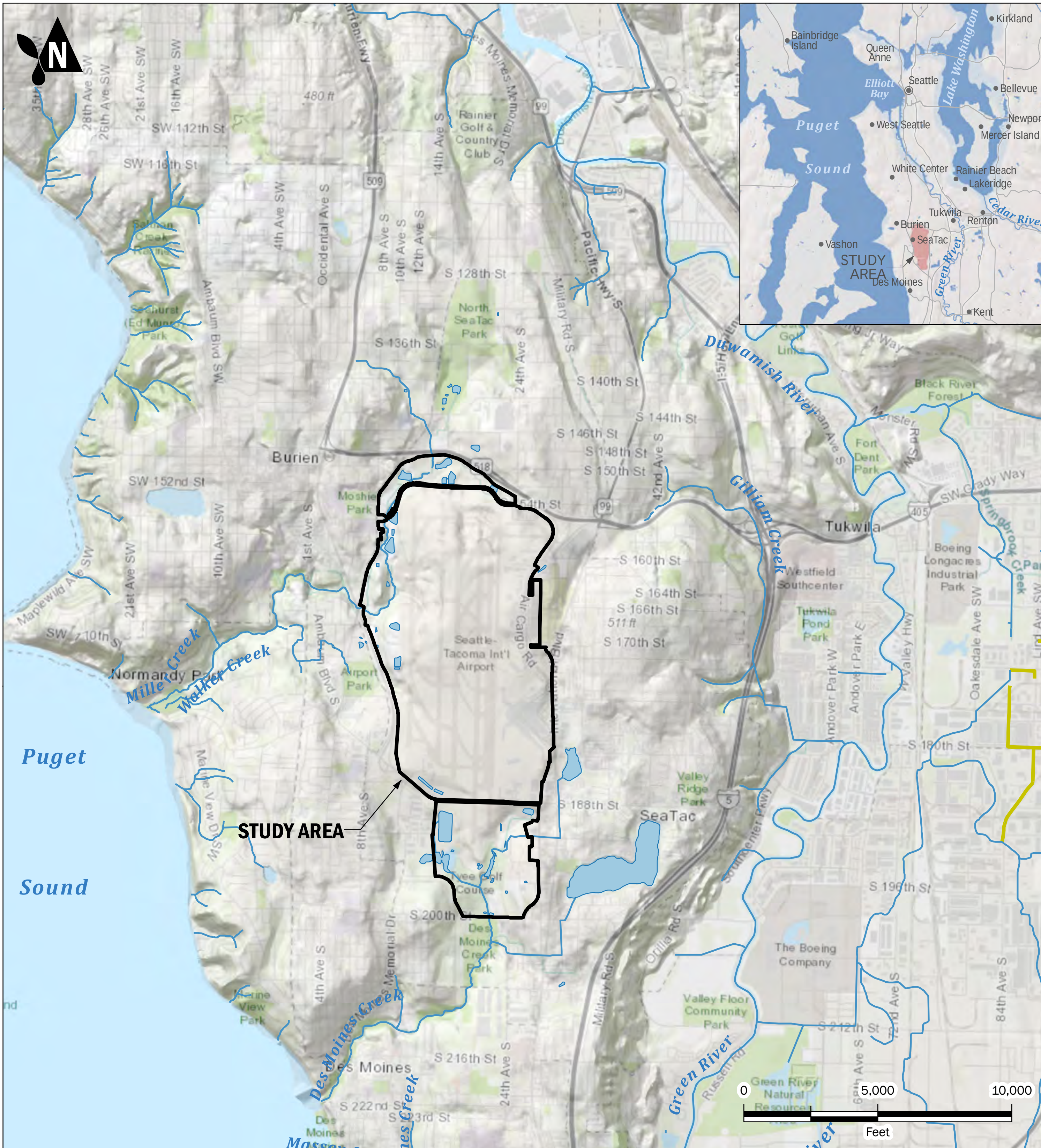
FIGURES



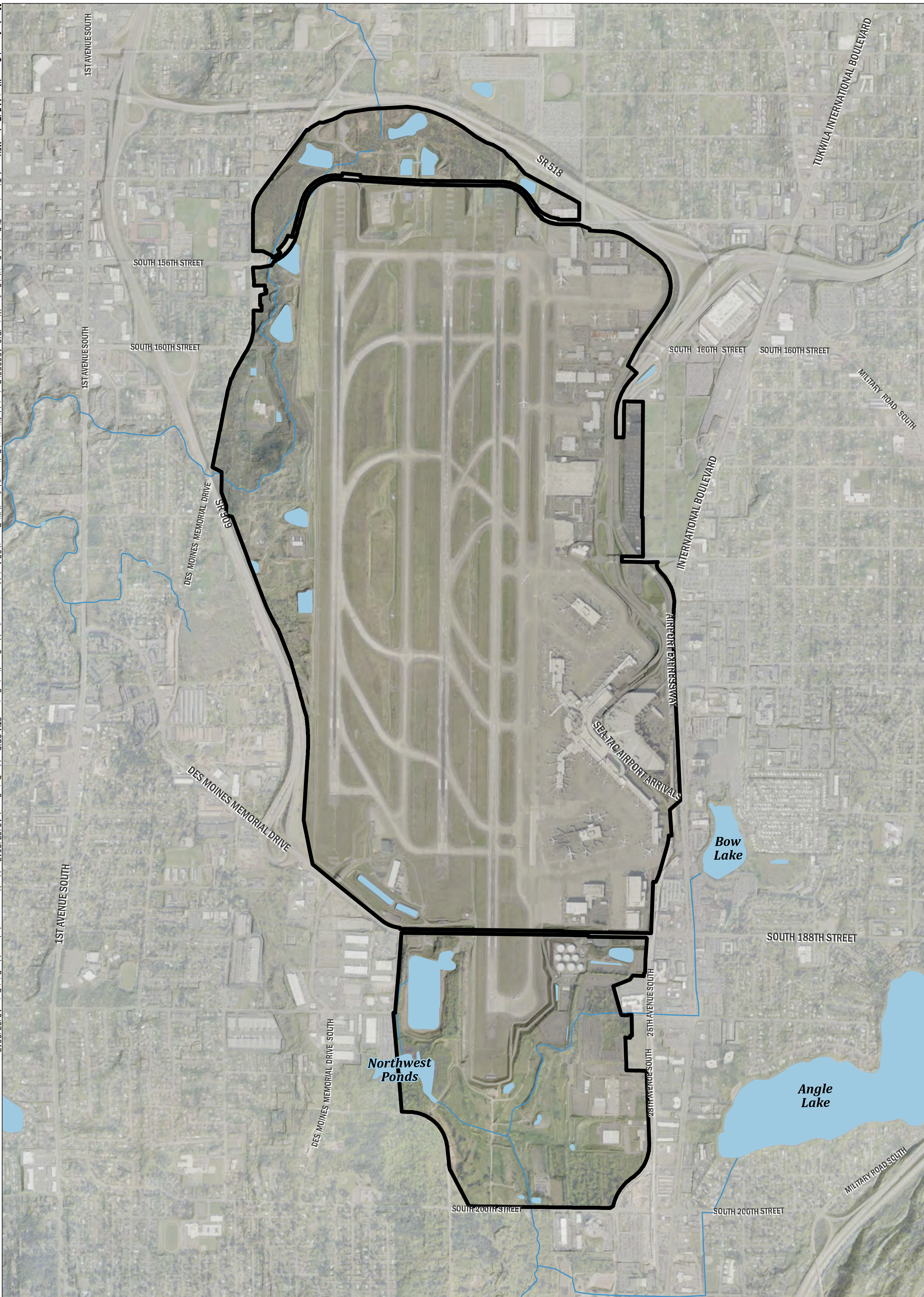
Vicinity Map

Infiltration Infeasibility Assessment
Seattle-Tacoma International Airport
SeaTac, Washington

Aspect CONSULTING	DEC-2017	BY: EAC	FIGURE NO. 1
	PROJECT NO. 150050	REVISED BY: ---	

GIS Path: T:\projects_8\Port_of_Seattle\SurfaceWaterIDIQ_150050\Projects\Infiltration\Delivered\InfeasibilityReport\01 Vicinity Map.mxd || Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet || Date Saved: 12/27/2017 || User: ecrumbaker || Print Date: 12/27/2017

Basemap Layer Credits || Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community



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Project Extent
Surface Waterbody
Stream/river

N

0 1,250 2,500
Feet

MAP BY: Aspect CONSULTING

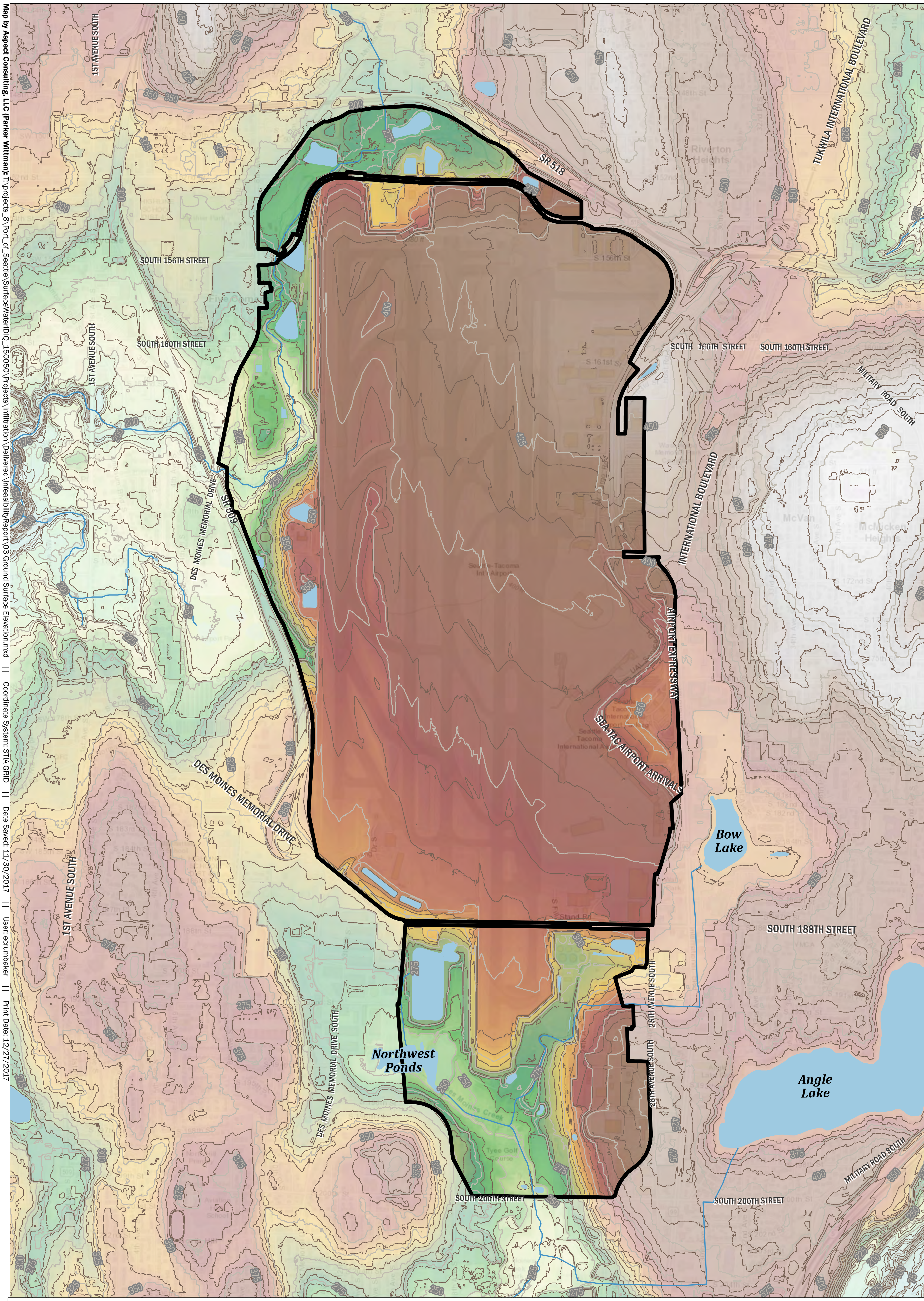
ROBIN KIRSCHBAUM, INC.

Port of Seattle

FIGURE 2

Aerial Imagery

Seattle Tacoma International Airport Infiltration Infeasibility Assessment



Map by Aspect Consulting, LLC (Parker Wittman): T:\projects_8\Port_of_Seattle SurfaceWaterDIQ_150050\Projects\Infiltration\Delivered\InfeasibilityReport\03 Ground Surface Elevation.mxd || Coordinate System: STIA GRID || Date Saved: 11/30/2017 || User: ecrumbaker || Print Date: 12/27/2017

25-ft LiDAR Contours
10-ft LiDAR Contours
Project Extent
Surface Waterbody
Stream/river

LiDAR Ground Surface Elevation (ft)
High : 513
Low : 59

0 1,250 2,500
Feet

FIGURE 3
Ground Surface Elevation
Seattle Tacoma International Airport Infiltration Infeasibility Assessment

MAP BY: Aspect CONSULTING
ROBIN KIRSCHBAUM, INC.
Port of Seattle

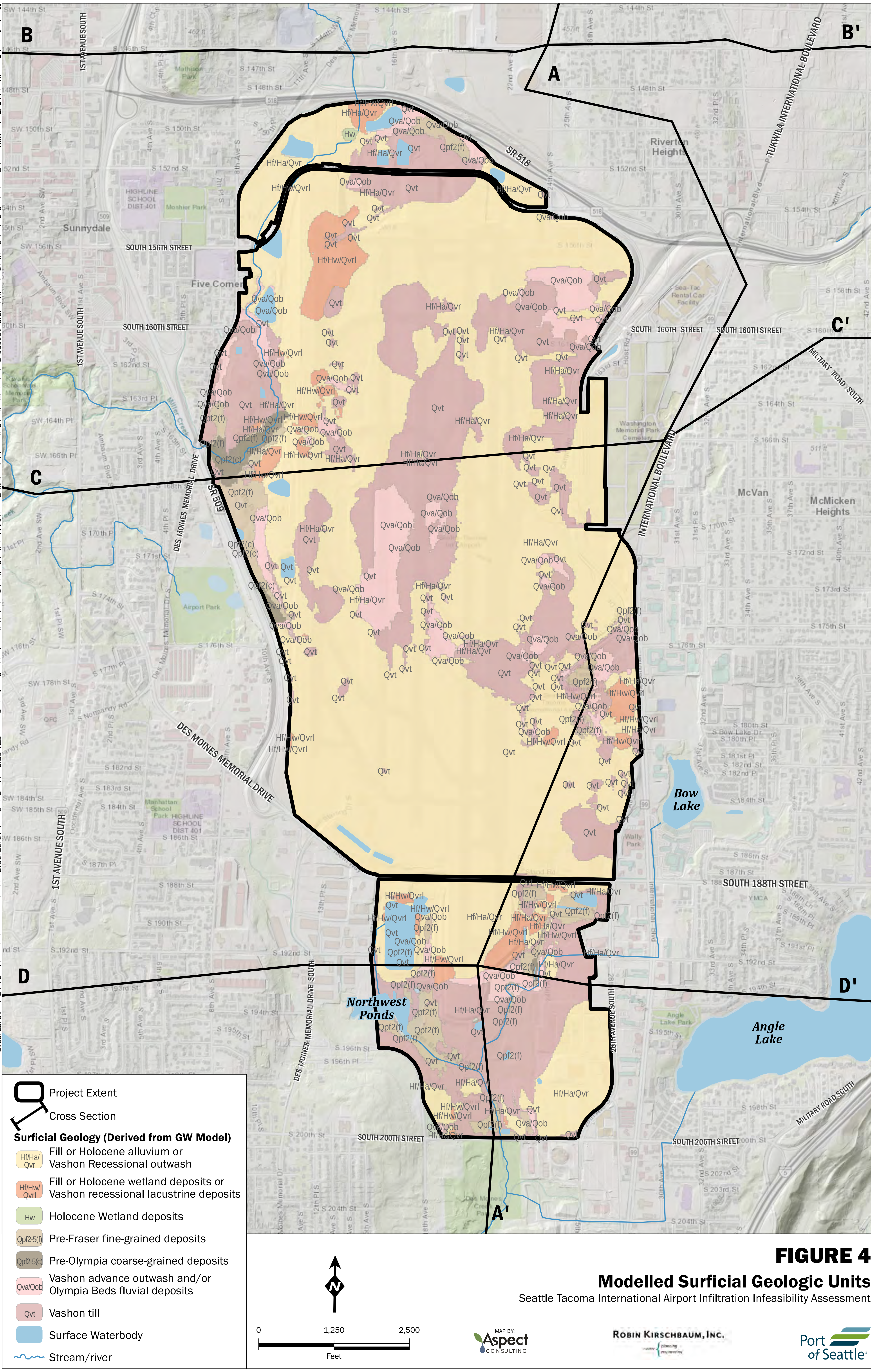
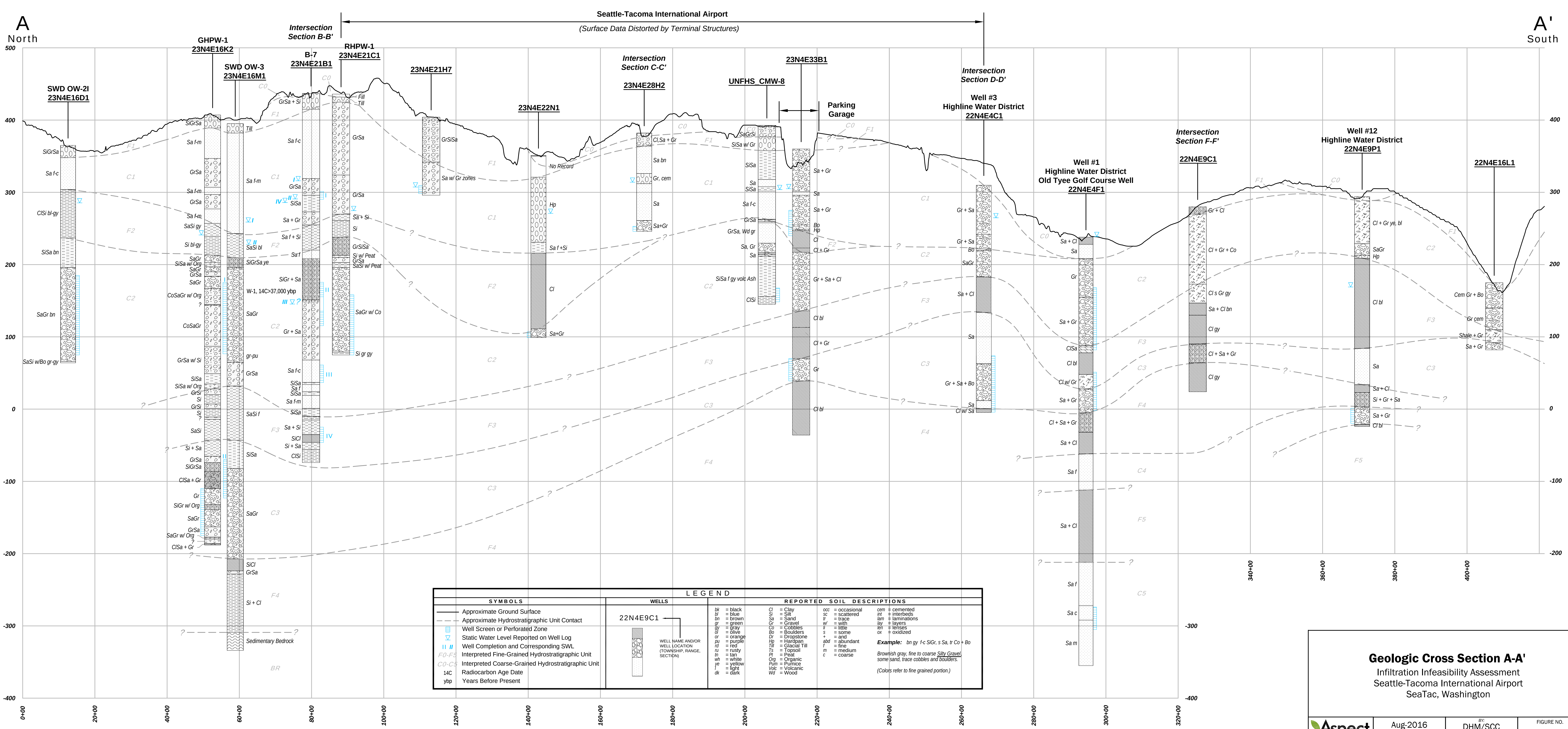


FIGURE 4

Modelled Surficial Geologic Units

Seattle Tacoma International Airport Infiltration Infeasibility Assessment

Map by Aspect Consulting, LLC (Parker Wittman): T:\projects_8\Port_of_Seattle\SurfaceWater\DIQ_150050\Projects\Infiltration\Delivered\InfeasibilityReport\04 Modelled Surficial Geologic Units.mxd || Coordinate System: StIA GRID || Date Saved: 12/27/2017 || User: ecrumbaker || Print Date: 12/27/2017



LEGEND

SYMBOLS

- Approximate Ground Surface
- Approximate Hydrostratigraphic Unit Contact
- Well Screen or Perforated Zone
- Static Water Level Reported on Well Log
- II *II* Well Completion and Corresponding SWL
- F0-F5 Interpreted Fine-Grained Hydrostratigraphic Unit
- C0-C5 Interpreted Coarse-Grained Hydrostratigraphic Unit
- 14C Radiocarbon Age Date
- ybp Years Before Present

WELLS

22N4E9C1 — WELL NAME AND/OR WELL LOCATION (TOWNSHIP, RANGE, SECTION)

REPORTED SOIL DESCRIPTIONS

bk = black	*Cl* = Clay	*occ* = occasional	*cem* = cemented
bl = blue	*Si* = Silt	*sc* = scattered	*int* = interbeds
bn = brown	*Sa* = Sand	*tr* = trace	*lam* = laminations
gr = green	*Gr* = Gravel	*w/* = with	*lay* = layers
gy = gray	*Co* = Cobbles	*li* = little	*len* = lenses
ol = olive	*Bo* = Boulders	*s* = some	*ox* = oxidized
or = orange	*Dr* = Dropstone	+ = and	
pu = purple	*Hp* = Hardpan	*abd* = abundant	
rd = red	*Till* = Glacial Till	*f* = fine	
ru = rusty	*Ts* = Topsoil	*m* = medium	
tn = tan	*Pt* = Peat	*c* = coarse	
wh = white	*Org* = Organic		
ye = yellow	*Pum* = Pumice		
l = light	*Volc* = Volcanic		
dk = dark	*Wd* = Wood		

Example: *bn gy f-c SiGr, s Sa, tr Co + Bo*

Brownish gray, fine to coarse Silty Gravel, some sand, trace cobbles and boulders.

(Colors refer to fine grained portion.)

Geologic Cross Section A-A'

Infiltration Infeasibility Assessment
Seattle-Tacoma International Airport
SeaTac, Washington

Aspect CONSULTING	Aug-2016	BY: DHM/SCC	FIGURE NO. 5
	PROJECT NO. 150050	REVISED BY: –	

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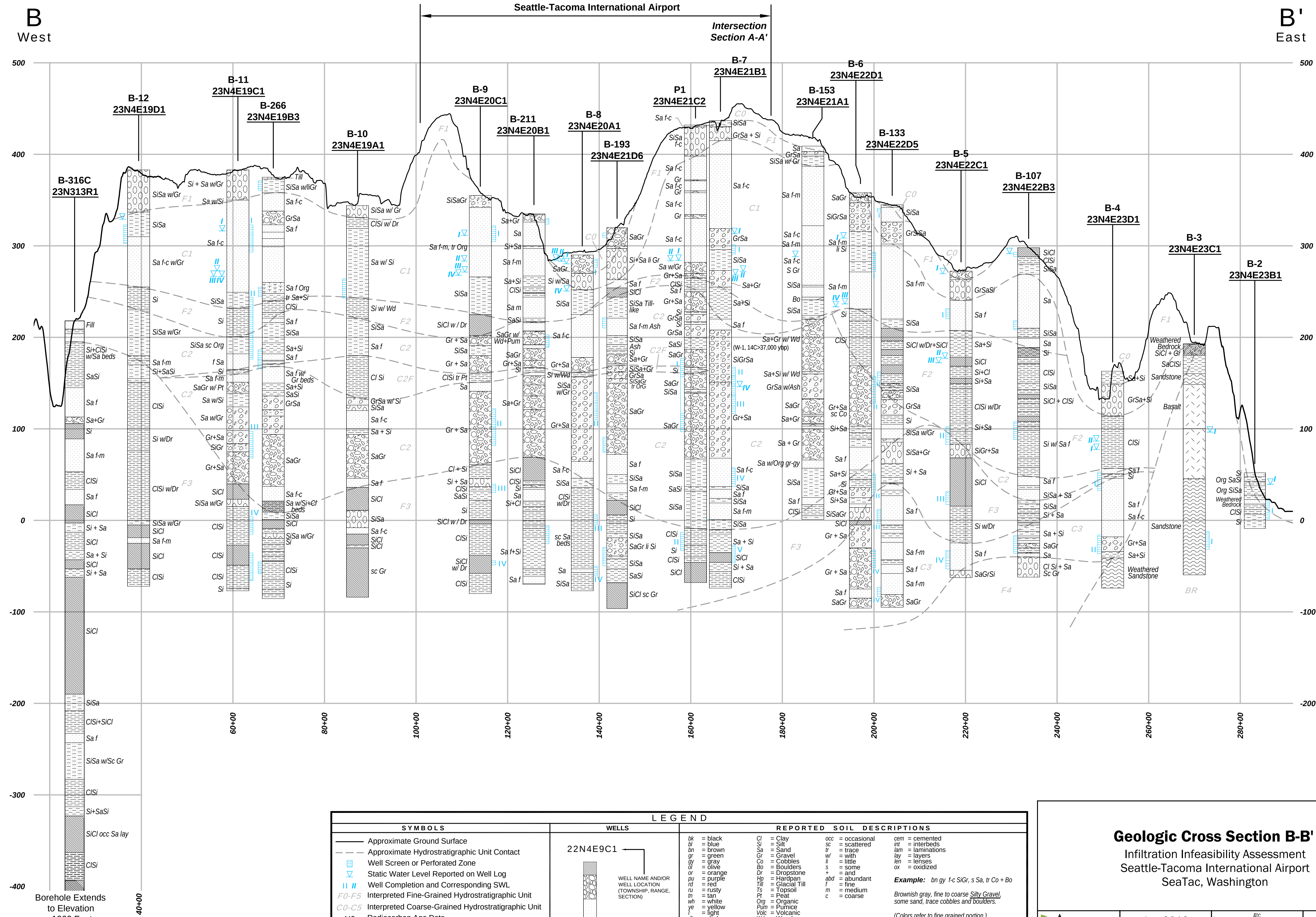

LEGEND

SYMBOLS

- Approximate Ground Surface
- Approximate Hydrostratigraphic Unit Contact
- Well Screen or Perforated Zone
- Static Water Level Reported on Well Log
- I II Well Completion and Corresponding SWL
- F0-F5 Interpreted Fine-Grained Hydrostratigraphic Unit
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WELLS

22N4E9C1 — WELL NAME AND/OR WELL LOCATION (TOWNSHIP, RANGE, SECTION)

REPORTED SOIL DESCRIPTIONS

bk = black	Cl = Clay	occ = occasional	cem = cemented
bl = blue	Si = Silt	sc = scattered	int = interbeds
bn = brown	Sa = Sand	tr = trace	lam = laminations
gr = green	Gr = Gravel	w/ = with	lay = layers
gy = gray	Co = Cobbles	li = little	len = lenses
ol = olive	Bo = Boulders	s = some	ox = oxidized
or = orange	Dr = Dropstone	+ = and	
pu = purple	Hp = Hardpan	abd = abundant	
rd = red	Till = Glacial Till	f = fine	
ru = rusty	Ts = Topsoil	m = medium	
tn = tan	Pt = Peat	c = coarse	
wh = white	Org = Organic		
ye = yellow	Pum = Pumice		
lt = light	Volc = Volcanic		
dk = dark	Wd = Wood		

Example: bn gy f-c SiGr, s Sa, tr Co + Bo

Brownish gray, fine to coarse Silty Gravel, some sand, trace cobbles and boulders.

(Colors refer to fine grained portion.)

Geologic Cross Section B-B'

Infiltration Infeasibility Assessment
Seattle-Tacoma International Airport
SeaTac, Washington

Aspect CONSULTING

Aug-2016	BY: DHM/SCC	FIGURE NO. 6
PROJECT NO. 150050	REVISED BY: –	

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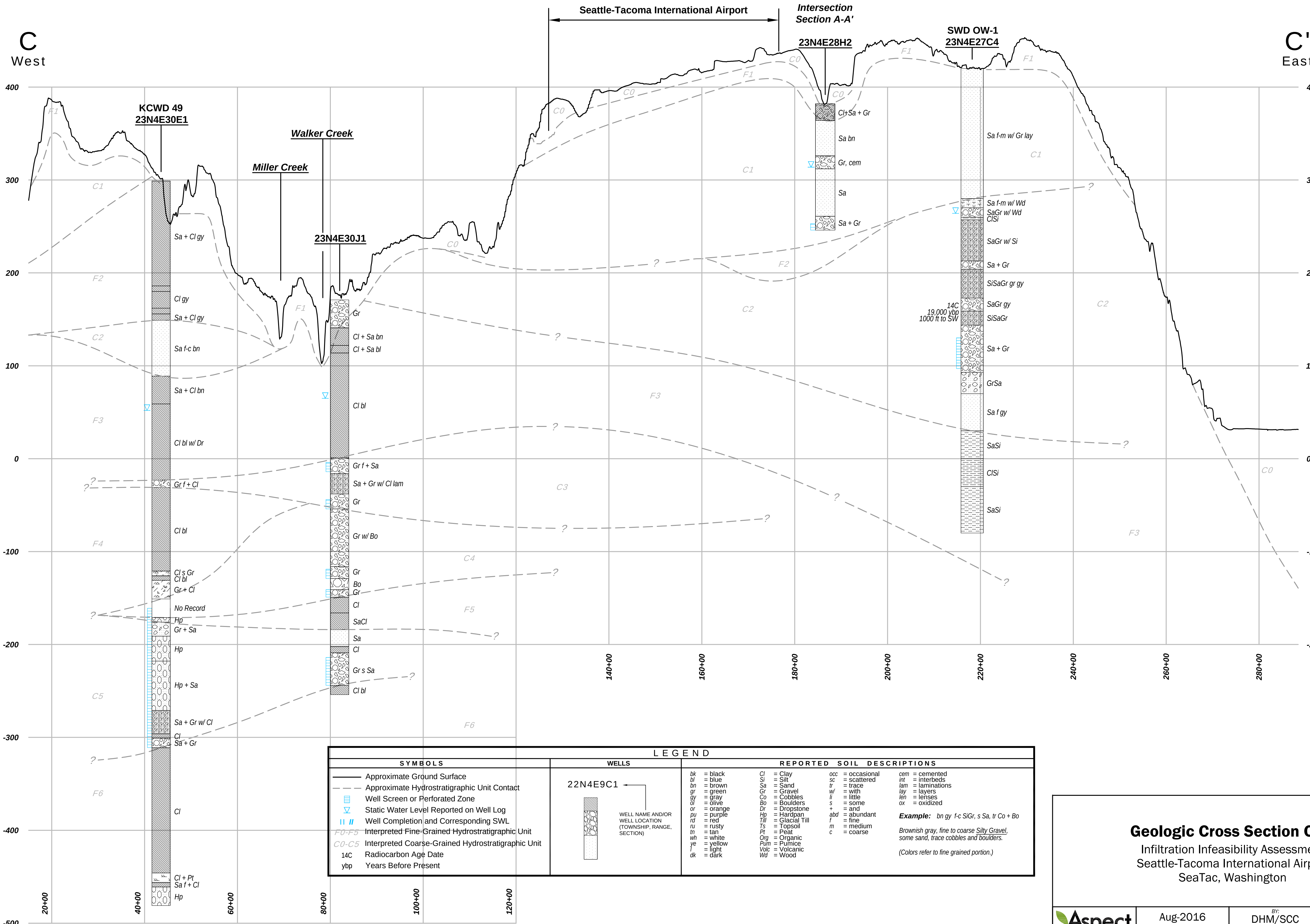


LEGEND

SYMBOLS

- Approximate Ground Surface
- Approximate Hydrostratigraphic Unit Contact
- Well Screen or Perforated Zone
- Static Water Level Reported on Well Log
- Well Completion and Corresponding SWL
- F0-F5 Interpreted Fine-Grained Hydrostratigraphic Unit
- C0-C5 Interpreted Coarse-Grained Hydrostratigraphic Unit
- 14C Radiocarbon Age Date
- ybp Years Before Present

WELLS

22N4E9C1 — WELL NAME AND/OR WELL LOCATION (TOWNSHIP, RANGE, SECTION)

REPORTED SOIL DESCRIPTIONS

bk	= black	Cl	= Clay	occ	= occasional	cem	= cemented
bl	= blue	Si	= Silt	sc	= scattered	int	= interbeds
bn	= brown	Sa	= Sand	tr	= trace	lam	= laminations
gr	= green	Gr	= Gravel	w/	= with	lay	= layers
gy	= gray	Co	= Cobbles	li	= little	len	= lenses
ol	= olive	Bo	= Boulders	s	= some	ox	= oxidized
or	= orange	Dr	= Dropstone	+	= and		
pu	= purple	Hp	= Hardpan	abd	= abundant		
rd	= red	Till	= Glacial Till	f	= fine		
ru	= rusty	Ts	= Topsoil	m	= medium		
tn	= tan	Pt	= Peat	c	= coarse		
wh	= white	Org	= Organic				
ye	= yellow	Pum	= Pumice				
l	= light	Volc	= Volcanic				
dk	= dark	Wd	= Wood				

Example: *bn gy f-c SiGr, s Sa, tr Co + Bo*

Brownish gray, fine to coarse Silty Gravel, some sand, trace cobbles and boulders.

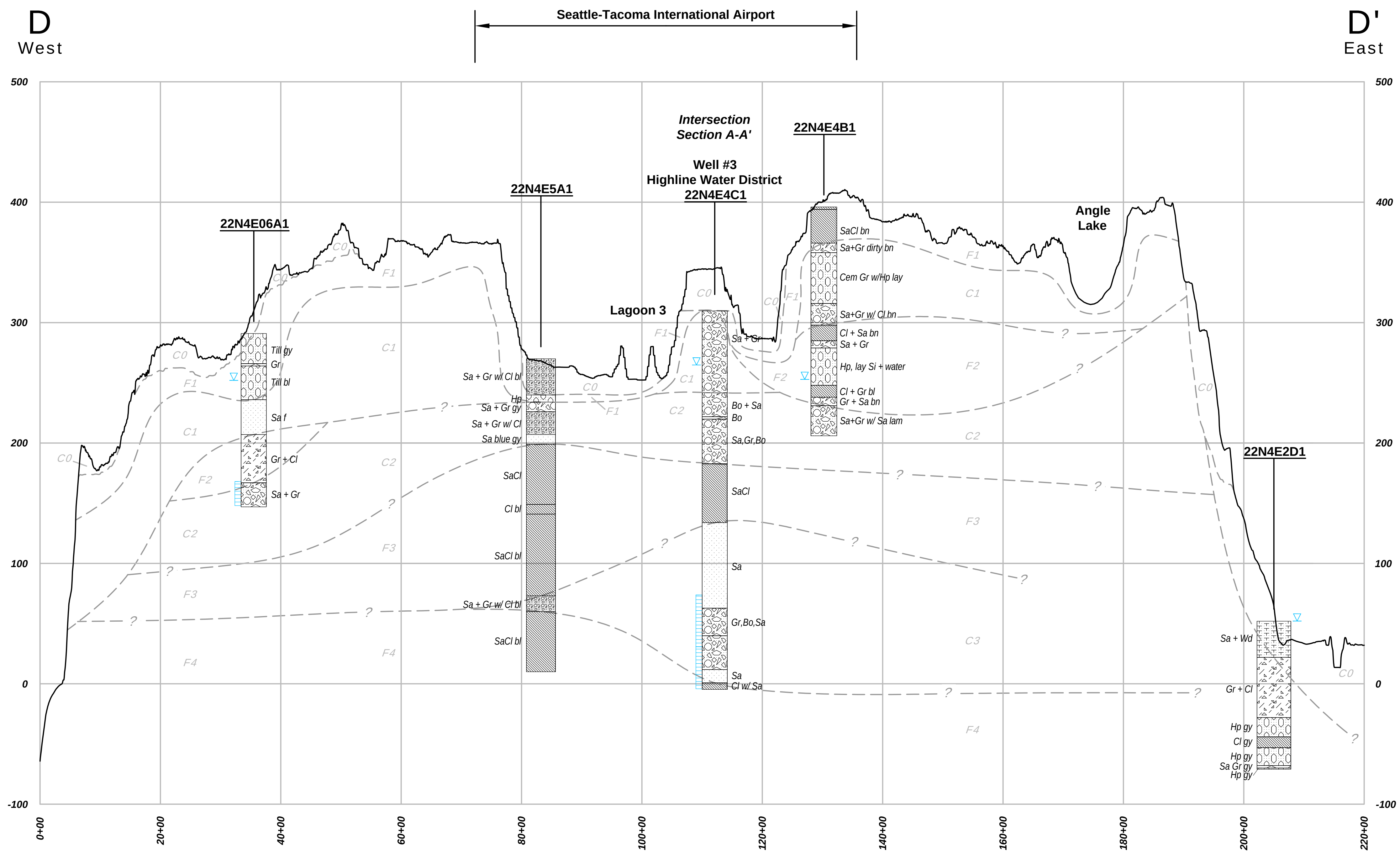
(Colors refer to fine grained portion.)

Geologic Cross Section C-C'

Infiltration Infeasibility Assessment
Seattle-Tacoma International Airport
SeaTac, Washington

Aspect CONSULTING	Aug-2016	BY: DHM/SCC	FIGURE NO. 7
	PROJECT NO. 150050	REVISED BY: –	

CAD Path: Q:\STIA\150050 Infiltration Feasibility Assessment\150050 CC.dwg C-C' || Date Saved: Aug 12, 2016 12:31pm || User: scudd



LEGEND

SYMBOLS	
——	Approximate Ground Surface
– – –	Approximate Hydrostratigraphic Unit Contact
	Well Screen or Perforated Zone
▽	Static Water Level Reported on Well Log
I I / I I	Well Completion and Corresponding SWL
F0-F5	Interpreted Fine-Grained Hydrostratigraphic Unit
C0-C5	Interpreted Coarse-Grained Hydrostratigraphic Unit
14C	Radiocarbon Age Date
ybp	Years Before Present

WELLS

22N4E9C1 — WELL NAME AND/OR WELL LOCATION (TOWNSHIP, RANGE, SECTION)

REPORTED SOIL DESCRIPTIONS

bk = black	Cl = Clay	occ = occasional	cem = cemented
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ol = olive	Bo = Boulders	s = some	ox = oxidized
or = orange	Dr = Dropstone	+ = and	
pu = purple	Hp = Hardpan	abd = abundant	
rd = red	Till = Glacial Till	f = fine	
ru = rusty	Ts = Topsoil	m = medium	
tn = tan	Pt = Peat	c = coarse	
wh = white	Org = Organic		
ye = yellow	Pum = Pumice		
l = light	Volc = Volcanic		
dk = dark	Wd = Wood		

Example: bn gy f-c SiGr, s Sa, tr Co + Bo

Brownish gray, fine to coarse Silty Gravel, some sand, trace cobbles and boulders.

(Colors refer to fine grained portion.)

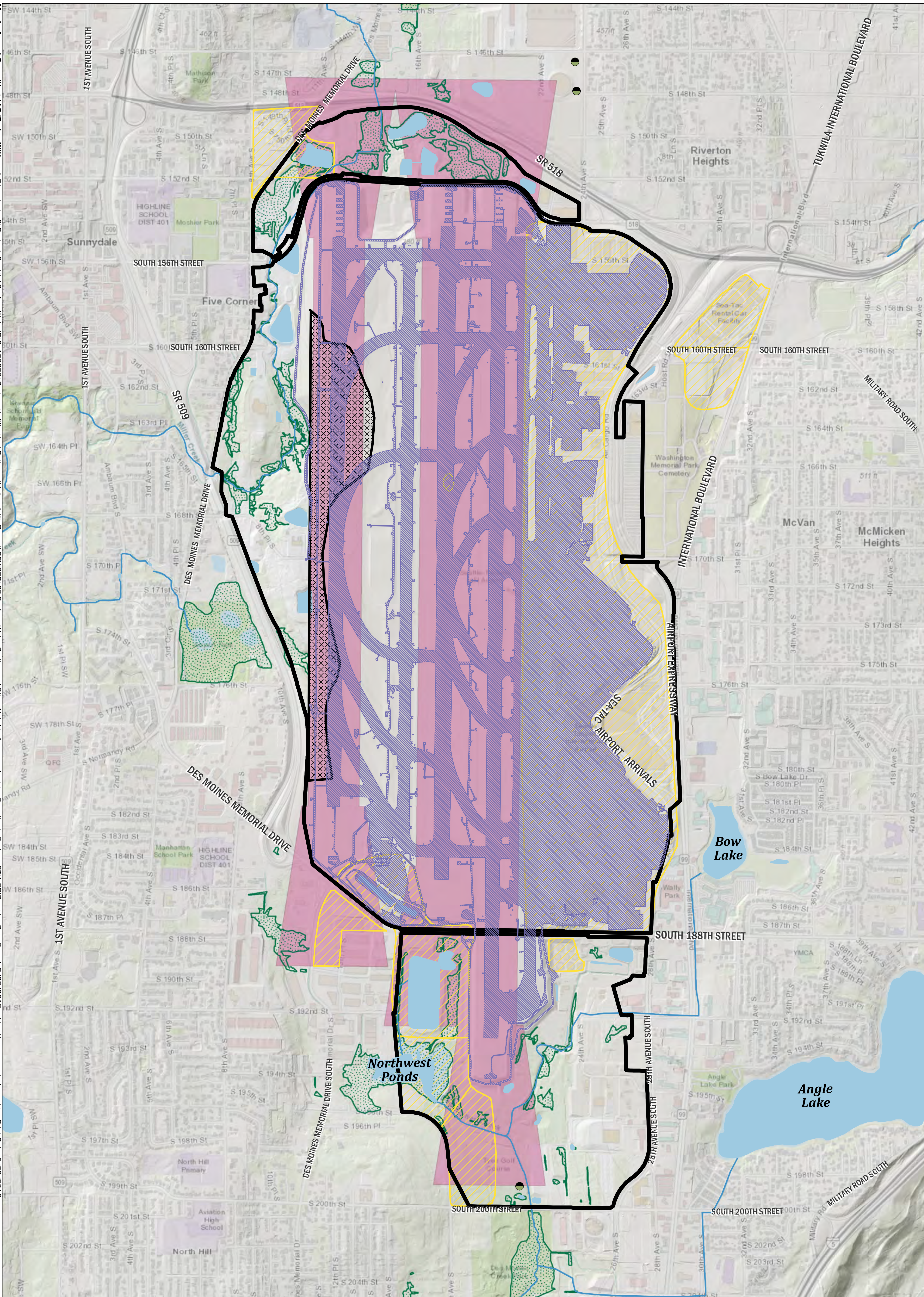
Geologic Cross Section D-D'

Infiltration Infeasibility Assessment
Seattle-Tacoma International Airport
SeaTac, Washington

Aspect CONSULTING

Aug-2016	BY: DHM/SCC	FIGURE NO.
PROJECT NO. 150050	REVISED BY: –	8

CAD Path: Q:\STIA\150050 Infiltration Feasibility Assessment\150050-DD.dwg D-D' || Date Saved: Aug 12, 2016 12:32pm || User: scudd



Map by Aspect Consulting, LLC (Parker Wiltman): T:\projects_8\Port_of_Seattle\SurfaceWaterDIQ_150050\Projects\Infiltration\Delivered\InfeasibilityReport\REVISED\09 Surface Water Bodies and Other Notable Areas.mxd || Coordinate System: STIA GRID || Date Saved: 5/22/2018 || User: ecrumbaker || Print Date: 5/22/2018

- Municipal Water Supply Wells
- Project Extent
- Third Runway Embankment
- Wetland (ESA, 2017)
- Impervious Area within AOA Boundary
- Areas of Historical Industrial Activity
- FAA Regulated Area
- Surface Waterbody
- Stream/river

N

0 1,250 2,500
Feet

FIGURE 9

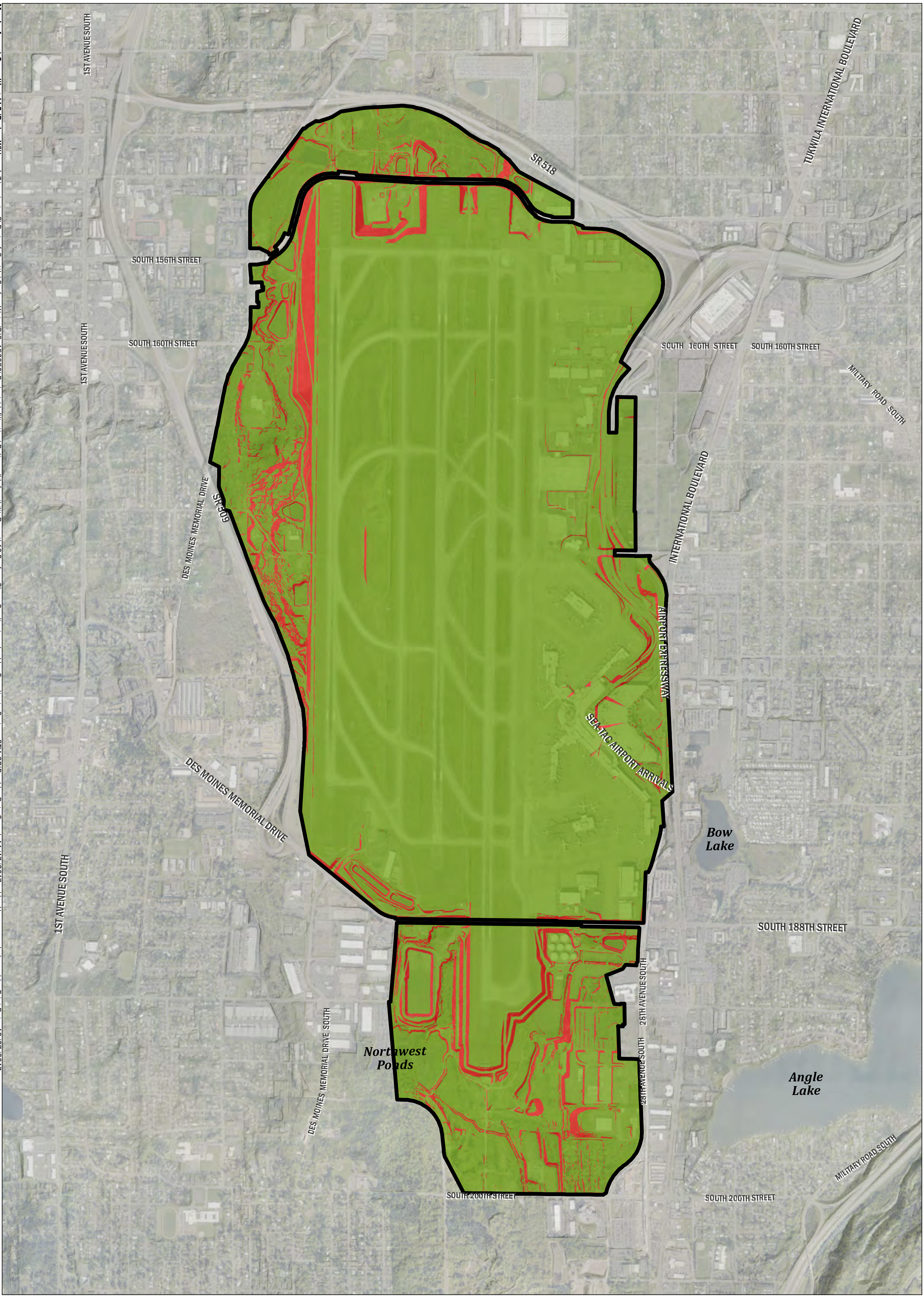
Surface Water Bodies and Other Notable Areas

Seattle Tacoma International Airport Infiltration Infeasibility Assessment

MAP BY: Aspect CONSULTING

Robin Kirschbaum, Inc.

Port of Seattle



Map by Aspect Consulting, LLC (Parker Wittman): T:\projects_8\Port_of_Seattle\SurfaceWaterDIQ_150050\Projects\Infiltration\Delivered\InfeasibilityReport\10 Surface Slope Gradient.mxd || Coordinate System: STIA GRID || Date Saved: 11/17/2017 || User: ecrumbaker || Print Date: 12/27/2017

Project Boundary

Surface Slope (2016 King County LiDAR)

< 25%

> 25%

0 1,250 2,500
Feet

FIGURE 10

Surface Slope

Seattle Tacoma International Airport Infiltration Infeasibility Assessment

MAP BY: Aspect CONSULTING

ROBIN KIRSCHBAUM, INC.

Port of Seattle

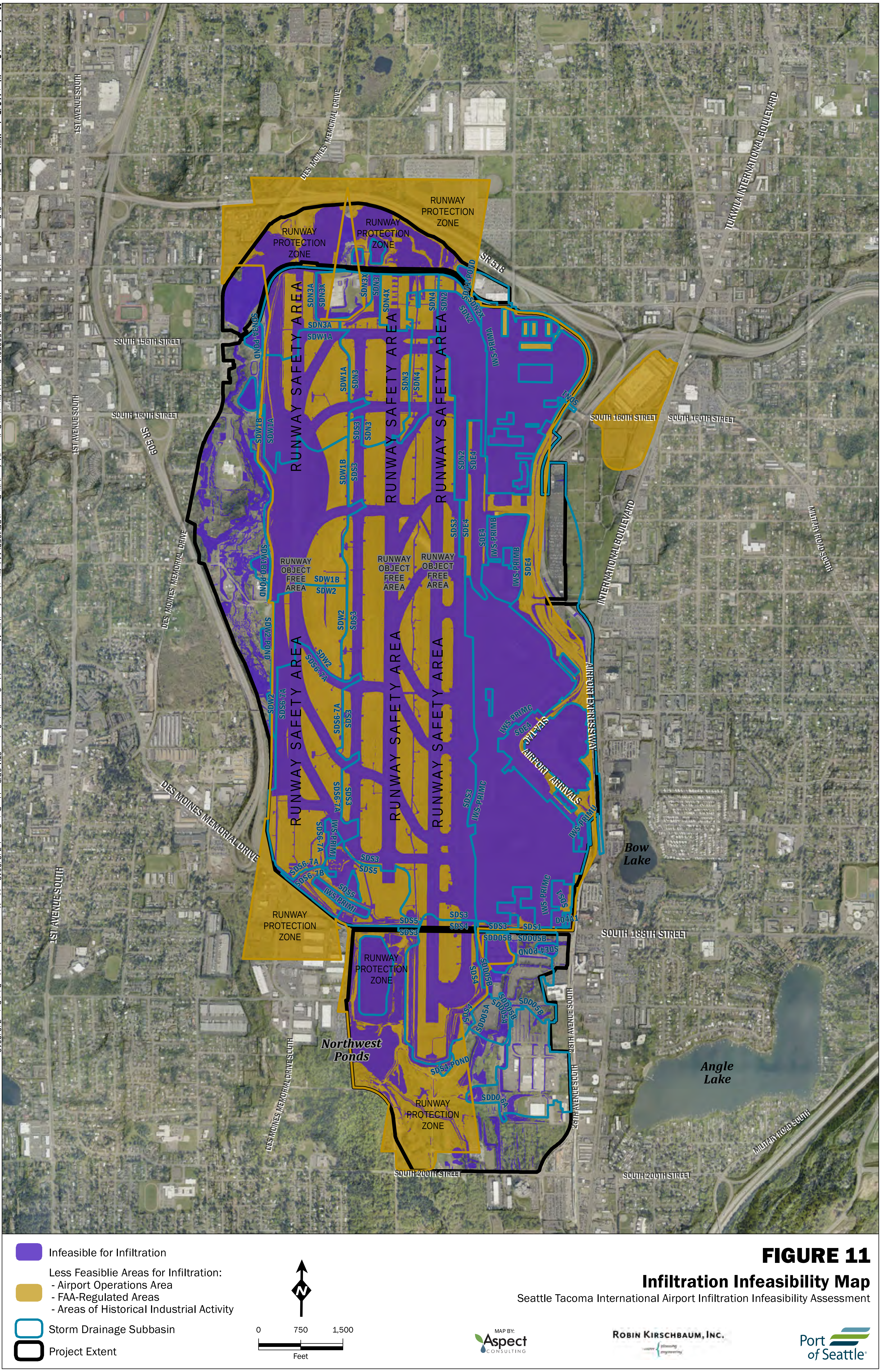


FIGURE 11

Infiltration Infeasibility Map

Seattle Tacoma International Airport Infiltration Infeasibility Assessment

MAP BY: Aspect CONSULTING

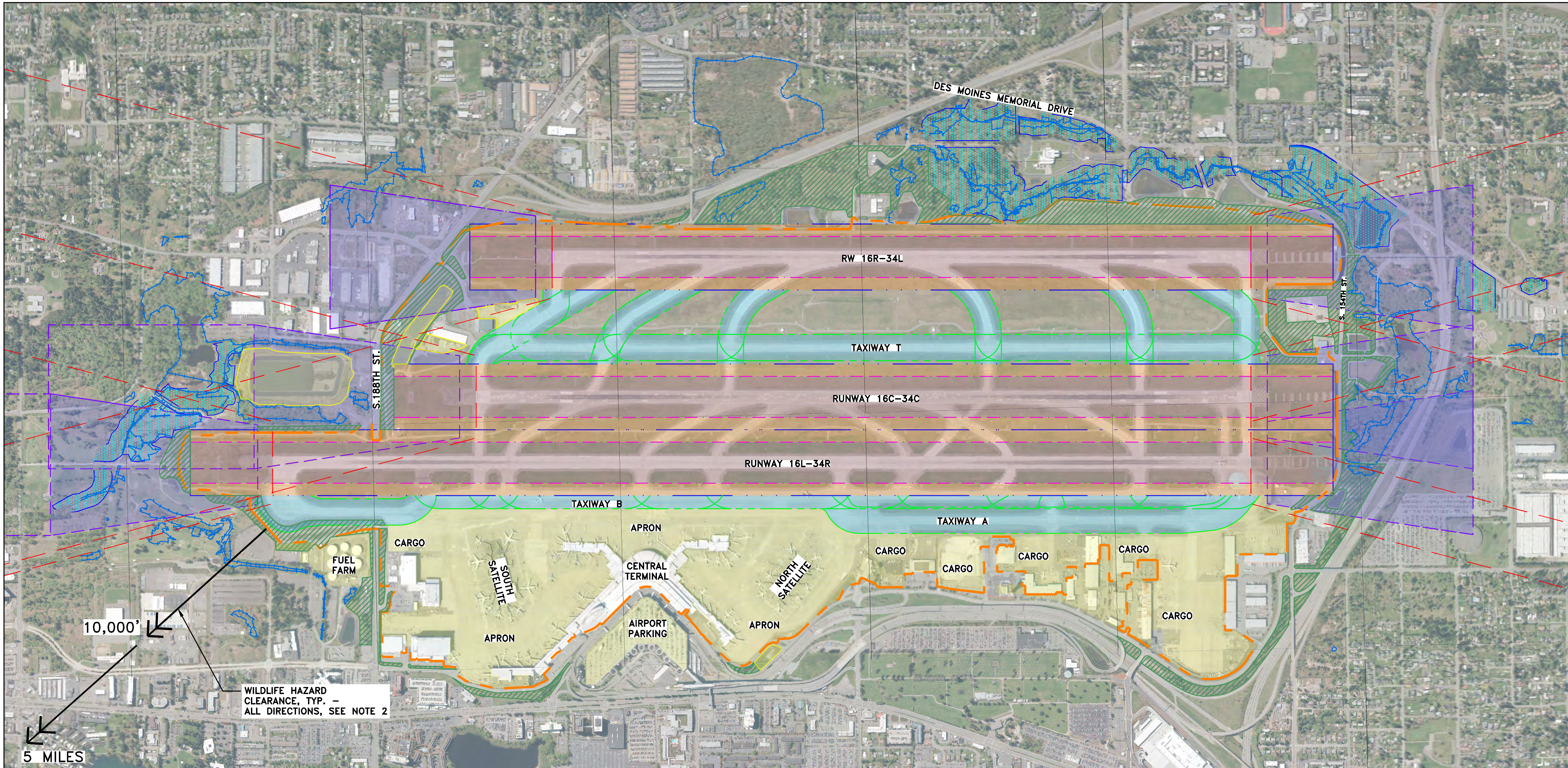
ROBIN KIRSCHBAUM, INC.

Port of Seattle®

Map by Aspect Consulting, LLC (Parker Witman): T:\projects_8\Port_of_Seattle\SurfaceWaterIDIQ_150050\Projects\Infiltration\Delivered\InfeasibilityReport\REVISED\11 Infiltration Infeasibility Map.mxd || Coordinate System: STIA GRID || Date Saved: 7/3/2018 || User: ecrumbaker || Print Date: 7/3/2018

APPENDIX A

STIA FAA Regulated Operation Zones



LEGEND:

- RUNWAY SAFETY AREA (RSA)
- RUNWAY PROTECTION ZONE (RPZ)
- APRON: AIRCRAFT PARKING, CARGO HARDSTAND OR OTHER INDUSTRIAL USE AREAS DRAINING TO IWS (INCLUDES FUELING AND AIRCRAFT DEICING AREAS)
- RUNWAY OBJECT FREE AREA (ROFA)
- TAXIWAY OBJECT FREE AREA (TOFA)
- RESTRICTED COVENANT
- AOA BOUNDARY
- WETLAND BOUNDARY
- RUNWAY DEPARTURE SURFACES
- MSE WALL AND CONSTRUCTED EMBANKMENT AREAS SUPPORTING AIRPORT, FAA AND PUBLIC INFRASTRUCTURE

NOTES:

1. WHERE ZONES OVERLAP, THE MORE STRINGENT STANDARDS APPLY.
2. "FAA ADVISORY CIRCULAR NUMBER 150/5200-33B, HAZARDOUS WILDLIFE ATTRACTANTS ON OR NEAR AIRPORTS" RECOMMENDS A SEPARATION DISTANCE OF 10,000 FEET BETWEEN ANY HAZARDOUS WILDLIFE ATTRACTANTS AND THE AIRPORT'S AOA AND 5 STATUTE MILES OF SEPARATION FOR WHERE THAT ATTRACTANT COULD CAUSE HAZARDOUS WILDLIFE MOVEMENT INTO OR ACROSS THE APPROACH OR DEPARTURE AIRSPACE. THIS INCLUDES THE LANDSIDE AND TERMINAL AREAS EAST OF THE AIRFIELD.

HNTB

N

600 0 600 1200
Scale Feet

FIGURE 3-2: STIA FAA DESIGNATED OPERATION ZONES LIMITING LOW IMPACT DEVELOPMENT IMPLEMENTATION

JUNE 30, 2016

APPENDIX B

Restrictions on LID implementation at STIA Based on Regulatory Requirements of the FAA, Ecology, and Local Jurisdictions

Table 3-1
Summary of LID Restrictions Based on Competing Needs for STIA Operations

LID Restriction	Applicable Operation Zones	Summary of Regulatory Competing Need
1. No infiltration permitted in IWS service area	AA	• Ecology – Permit does not allow non-stormwater discharges to groundwater • Ecology – Compliance with groundwater management standards is required (degradation in quality not permitted) • Ecology – Mobilization of existing subsurface contamination is not permitted • FAA – Apron's drainage design consistency with FAA standards and NFPA fire containment and life safety regulations
2. Airfield soils compaction requirements	All zones within AOA	• FAA – Requirements for structural subgrade soil compaction • FAA – Non-pavement surfaces required to support snow removal and firefighting equipment, and occasional passage of aircraft without causing structural damage • FAA – Standing water not allowed to flow conveyance unless covered (i.e., pipes, vaults, structures)
3. Runways, taxiways, and shoulders slope and grade limitations	All zones within AOA	• FAA – Slope and grade change criteria limitations apply beyond runway pavements • FAA – Hazardous ruts, humps, depressions, and surface features projecting above adjacent runway grades not permitted • FAA – Rapid removal of drainage required through efficient drainage collection and conveyance systems
4. Runway embankment and wall zone infiltration limitations	All zones within AOA	• FAA – Requirements to maintain the structural integrity of third runway embankment fill and associated MSE wall in the zone of hydrologic influence • FAA – Requirements for efficient subgrade drainage to avoid runway subgrade saturation • Ecology – Requirements to limit infiltration above steep slope hazard areas
5. Wildlife hazard management	All zones within and beyond AOA	• FAA – Standing water not allowed to depth greater than 4 inches for durations exceeding 48 hours • FAA – Requirements to avoid creation of hazardous wildlife roosting or refuge habitats • FAA – Requirements to avoid actions that could cause hazardous wildlife movement across the STIA approach or departure airspace
6. Airfield vegetation use limitations	All zones within AOA	• FAA – Requirement to limit airfield vegetation to turf to limit FOD generation • FAA – Requirements for vegetation type consistency with WHMP limitations
7. Landside vegetation use limitations	All zones beyond AOA	• FAA – Requirements for vegetation types consistency with WHMP limitations • FAA – Requirements for vegetation heights not extending into defined airspace obstacle clearance surfaces

LID Restriction	Applicable Operation Zones	Summary of Regulatory Competing Need
8. Airfield FOD management	All zones within AOA	• FAA – Requirement that non-pavement areas are limited to turf • FAA – No loose materials or permeable pavements permitted that could generate FOD, which can be mobilized by jet-blast or vehicles track-out
9. Transportation facility/corridor space limitations	All zones	• Ecology and WSDOT – LID use may be excluded where future expansion or multi-modal public transportation needs take precedence in high-density rights-of-way/corridors with space limitations
10. STIA and local jurisdiction stormwater facilities, critical areas, and NPDES compatibility	All zones	• Ecology – Existing stormwater facilities operations consistency with NPDES IP and associated outfall effluent limitations • Local Jurisdiction – Receiving water stormwater facilities suitability, critical areas impacts, and consistency with NPDES Phase II MS4 Permit regulations (beyond AOA)

Abbreviations:

AA= Apron Area
AOA = Airport Operations Area
Ecology = Washington State Department of Ecology
FAA = Federal Aviation Administration
FOD = Foreign Object Debris
IWS = Industrial Wastewater System
LID = low impact development
IP = Individual Permit
MSE = mechanically stabilized earth
MS4 = Municipal Separate Storm Sewer System
NFPA = National Fire Protection Act
NPDES = National Pollutant Discharge Elimination System
STIA = Seattle Tacoma International Airport
WHMP = *Wildlife Hazard Management Plan, Seattle-Tacoma International Airport*
WSDOT = Washington State Department of Transportation

Appendix C: Infiltration Feasibility Assessment Procedures

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This appendix provides the minimum soil and groundwater investigation requirements for infiltration best management practices (BMPs) feasibility and design. This information does not preclude the use of professional judgment to evaluate and manage risk associated with design, construction, and operation of infiltration BMPs. It is the responsibility of the licensed professional to determine the actual scope of investigation, analysis, and reporting necessary to meet the Standard of Practice with respect to the project and its geotechnical requirements. The report must be signed and sealed by the Geotechnical Engineer or Engineering Geologist, Geologist, or Hydrogeologist.

Recommendations that deviate from the minimum investigation requirements specified in this appendix shall be contained in a stamped and signed letter from a State of Washington licensed Geotechnical Engineer or Engineering Geologist, Geologist, or Hydrogeologist, herein referred to as licensed professional, who has experience in infiltration and groundwater testing and infiltration facility design and must provide rationale and specific data supporting their professional judgment.

Refer to the SWMMWW for infiltration feasibility assessment procedures to be used for the following steps in accordance with Step 4: Assess Infiltration Feasibility (Section 3.4 in the main body of the Guideline):

- ***Step 4.3:*** Conduct subsurface investigation and evaluate vertical separation requirements
- ***Step 4.4:*** Conduct infiltration testing
- ***Step 4.5:*** Determine design infiltration rate
- ***Step 4.6:*** Conduct groundwater monitoring, receptor characterization, and mounding and seepage analysis, and acceptance testing, if applicable

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Appendix D: STIA SDS and IWS Drainage Systems, Basins, and Receiving Waters (Full Size, Electronic Copy Only)

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