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PORT OF SEATTLE

ANCHOR QEA

Implementation Plan
Seattle-Tacoma International Airport
Flight Corridor Safety Program

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IMPLEMENTATION PLAN
SEATTLE-TACOMA INTERNATIONAL AIRPORT FLIGHT CORRIDOR SAFETY PROGRAM

Prepared for

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LIST OF ACRONYMS AND ABBREVIATIONS

ALSF	approach lighting system with flashing lights
AOA	Air Operation Area
BMP	best management practice
Port	Port of Seattle
Program	Flight Corridor Safety Obstruction Management Program
ROW	right-of-way
SR	State Route
STIA	Seattle-Tacoma International Airport
WSDOT	Washington State Department of Transportation

LIST OF SPECIES NAMES

Common Name	Latin Name
American linden	*Tilia americana*
Apple	*Malus* sp.
Big-leaf maple	*Acer macrophyllum*
Bitter cherry	*Prunus emarginata*
Black cottonwood	*Populus balsamifera*
Black locust	*Robinia pseudoacacia*
Common holly	*Ilex aquifolium*
Common laurel	*Prunus laurocerasus*
Deodar cedar	*Cedrus deodara*
Douglas fir	*Pseudotsuga menziesii*
English ivy	*Hedera helix*
Giant sequoia	*Sequoiadendron giganteum*
Himalayan blackberry	*Rubus ameriacus*
Japanese maple	*Acer palmatum*
Lombardy poplar	*Populus nigra*
Mountain ash	*Sorbus* sp.
Pacific madrone	*Arbutus menziesii*
Paper birch	*Betula papyrifera*
Pine	*Pinus* sp.
Red alder	*Alnus rubra*
Western red-cedar	*Thuja plicata*
Scotch broom	*Cytisus scoparius*
Scots pine	*Pinus sylvestris*

1 INTRODUCTION

As a condition of the Federal Aviation Administration-issued Airport Operating Certificate, the Port of Seattle (Port) is required to ensure there are no obstacles or obstructions on or around the Seattle-Tacoma International Airport (STIA) that could affect aviation safety. In 2014, the Port conducted a comprehensive obstruction analysis that used Light Detection and Ranging (LiDAR) remote sensing and imaging technology to identify obstructions that extend into, or very near (within a 6-foot threshold of), navigable airspace. In 2015, the obstruction quantities identified through this analysis were refined through a ground-truthing field exercise. The field reconnaissance also characterized the obstructions by species type and size (stem diameter and estimated height). On Port sites, the reconnaissance also identified future obstructions, and where applicable, quantified the understory trees that would be removed or impacted during removal activities. Overall the process has identified 2,747 trees (1,799 obstructions and 948 non-obstruction understory features) for removal. The purpose of this report is to provide a detailed methodology and timeline for management of obstructions on Port, public, and private properties surrounding STIA.

1.1 Components of Implementation Plan

This report includes an introduction to the sites that have been identified; a characterization of obstructions and potential obstructions; a discussion of obstruction management methods; site plans that describe how these methods should be applied to these various Port, public, and private sites; cost estimates that can be used for budget planning; and a detailed schedule for implementing the Flight Corridor Safety Program (Program).

1.2 Overview of Port, Public, and Private Sites

Obstructions occur on Port, state, city, and private commercial and residential parcels. The following section introduces the grouping of these parcels into 14 discrete sites. See Figure 1 for a project vicinity map.

1.2.1 Port Sites

Obstructions on Port property (shown in Figure 2) have been grouped into the following seven sites based on geographic location, site conditions, and access considerations:

- Site P-1 is the only site located north of STIA. This site includes obstructions within a steep slope sensitive area.
- Site P-2 is located west of STIA near the Port's west side office. The majority of the obstructions within this site are outside of sensitive areas, though several obstructions are within wetland buffers or on steep slopes.
- Site P-3 (P-3a and P-3b) is located south of STIA and north or northeast of Des Moines Creek. Many obstructions in these sites are within wetlands, wetland buffers, stream buffers, or on steep slopes.
- Site P-4 is located south of STIA and south or southwest of Des Moines Creek. Obstructions on this site are all outside of sensitive areas. The obstructions at the south end of this site are within a parcel that includes trails used by the public.
- Site P-5 is located south of STIA, and is a forested parcel that includes walking and biking trails used by the public. Some obstructions on this site are within steep slope sensitive areas.
- Site P-6 is located south of STIA and north of Des Moines Creek, within the Tyee mitigation site. The majority of obstructions within this area are within wetlands or wetland buffers.

1.2.2 Public Sites

Obstructions on public property (shown in Figure 2) have been grouped into the following three sites based on property ownership (school district property is presented by the city jurisdictions they fall within):

- Site WP-1 is located within the city of SeaTac, and includes both active right-of-way (ROW) and unconstructed ROW owned by the Washington State Department of Transportation (WSDOT). The site includes areas to the west and southwest of STIA. The obstructions on this site are all outside of sensitive areas.
- Site SP-1 includes publically owned utility, ROW, natural resource, and school district sites in the city of SeaTac. This site includes two locations, one of which is

located north of STIA, the other located southwest of STIA. The southwest area includes wetland and wetland buffer sensitive areas.

- Site BP-1 includes publically owned ROW within the city of Burien. This site is located northwest of STIA. These obstructions are all outside of sensitive areas.

1.2.3 Private Sites

Obstruction sites on private property (shown in Figure 2) have been grouped into the following four sites, based on local jurisdiction and type of land use (Commercial/Institutional versus Residential):

- Site SC-1 is located in the city of SeaTac and includes commercial lots owned by Boeing (one parcel), commercial lots owned by car rental companies (three parcels), and one church institutional site (one parcel). This site includes two locations, one of which is located northeast of STIA, the other located southwest of STIA. The southwest area includes wetland and wetland buffer sensitive areas.
- Site SR-1 includes 32 private residential properties within the city of SeaTac, located to the northeast and southwest of STIA. These obstructions are all outside of sensitive areas.
- Site BR-1 includes 17 private residential properties within the city of Burien, located to the northwest and southwest of STIA. These obstructions are all outside of sensitive areas.
- Site DR-1 includes 25 private residential properties within the city of Des Moines, located to the southwest of STIA. A portion of this site is located within wetland and wetland buffer sensitive areas.

2 OBSTRUCTION INVENTORY

Table 2.1 provides a summary of existing and potential obstructions for different types of property ownership within three local jurisdictions. The presence of sensitive areas (wetlands, wetland buffers, stream buffers, and steep slopes) in proximity to obstructions is also identified. Figure 2 illustrates the location of these obstructions within the three local jurisdictions.

Table 2.1

Obstruction Removal Summary by Location

Jurisdiction Property Ownership	Obstruction Removal						Understory Tree Removal	Total Trees Removed
	Existing Obstructions[1]	Potential Obstructions[2]	Total Obstructions	Obstructions Within Sensitive Areas				
				Existing	Potential	Total[3]		
City of SeaTac								
Port	362	478	**840**	149	238	**387**	327	**1,167**
WSDOT	484	119	**603**	0	0	**0**	621[4]	**1,224**
Public	87	41	**128**	4	11	**15**	0	**128**
Residential	46	22	**68**	0	0	**0**	0	**68**
Commercial/Religious	22	22	**44**	2	5	**7**	0	**44**
Subtotal	**1,001**	**682**	**1,683**			**409**	**948**	**2,631**
City of Burien								
Public	6	0	**6**	0	0	**0**	0	**6**
Residential	58	14	**72**	0	0	**0**	0	**72**
Commercial	0	0	**0**	0	0	**0**	0	**0**
Subtotal	**64**	**14**	**78**			**0**	**0**	**78**
City of Des Moines								
Public	0	0	**0**	0	0	**0**	0	**0**
Residential	16	22	**38**	1	1	**2**	0	**38**
Commercial	0	0	**0**	0	0	**0**	0	**0**
Subtotal	**16**	**22**	**38**			**2**	**0**	**38**
Total	**1,081**	**718**	**1,799**			**411**	**948**	**2,747**

Notes:

1. Existing obstructions are trees that are currently within the navigable airspace for STIA.
2. Potential obstructions are trees that are predicted to enter the navigable airspace within 5 years.
3. Totals are adjusted to reflect the actual number of tree obstructions within sensitive areas, and remove double counting (e.g., individual trees that are within both steep slope and wetland buffer areas).
4. Estimated understory quantity is preliminary and subject to change (derived from aerial photograph analysis).

3 OBSTRUCTION REMOVAL AND SITE MANAGEMENT METHODS

The methods for obstruction removal and site management are discussed here for the following key implementation steps:

1. Site preparation
2. Obstruction removal and material disposal
3. Site treatment
4. Monitoring

In addition, the best management practices (BMPs) that will be applied during implementation are presented. The detailed implementation plans for individual sites (provided in Section 4) will draw upon the methods and BMPs presented here.

3.1 Site Preparation

Site preparation activities prior to obstruction removal include verifying/inspecting site conditions; identifying and installing access barriers, access routes, and staging areas; identifying and installing erosion and sediment control measures; salvaging vegetation; and marking obstructions and other features to be removed.

3.1.1 Site Visit

Before any site work commences, a site visit will be held with both the contractor and Port engineer in order for the contractor to verify the following:

- **Hazardous features of the site:** Permanent features should be marked/flagged to protect site personnel, biological hazards (e.g., unsanitary conditions, discarded syringes) should be identified and removed.
- **Site access issues:** Traffic control measures may be required for sites along busy or congested public ROWs.
- **Utilities in need of protection:** Stormwater and electrical utilities, including large stormwater ponds, will likely be the main utilities that will require protection. However, any sites that will require excavation for obstruction removal will also require a utility location/verification through the Utility Notification Center.
- **Existing facilities in need of protection:** These features could include STIA features such as the Air Operation Area (AOA) perimeter fence, the Port's west side office, or supports

for runway approach lighting systems with flashing lights (ALSF). Existing facilities on private sites include structures, grounds, and landscaping outside of the obstruction removal area. Additional steel plates or mats and barricades will likely be required to safely remove obstructions on private sites without impacting existing structures.

- **Sensitive areas in need of protection:** These features could include steep slopes, wetlands, streams, and their buffers. In addition, topographic swales/ditches that could direct additional stormwater or sediment-laden runoff to these sensitive areas, and areas of potential erosion, should also be identified.

3.1.2 Site Access and Safety

Access barriers are necessary to control the site from trespass or unintentional entrance by unauthorized personnel. While most Port sites have adequate access control from existing fencing, the more congested Site P-2, near the Port's west side office, will need to be barricaded. Additionally Port sites that currently host informal public access will require access control measures. Temporary chain-link fencing, with 20-foot-wide lockable gates along the construction equipment access route(s), can provide a suitable barrier. Small public or private sites, or those along roadways, may require additional signs, barricades, or competent flagmen to ensure the public is protected from hazards associated with tree removal.

Access and exit points should be limited to one route, if possible. This truck or equipment driveway should be stabilized to avoid tracking sediment on adjacent roadways. Stabilization can include placing a minimum 12-inch layer of 4- to 8-inch-sized quarry spalls over geotextile fabric, for a length of 25 feet and width of at least 15 feet. Longer access routes into a site may be required depending on the substrate/groundwater site characteristics and the size and weight of equipment used; pads of quarry spalls and geotextile can also be used for this application.

3.1.3 Clearing Limits and Tree Marking

Prior to obstruction removal, clearing limits will be marked with fencing. The trees that will be removed should be confirmed and marked in multiple places on the trunk. This process is an important extra security step to make sure that only the intended trees are removed.

3.1.4 Erosion and Sediment Controls Installation

Prior to obstruction removal, erosion and sediment controls will need to be planned and installed. Planning items will include development of a spill prevention, control, and countermeasures plan, and consideration of overall site layout during construction. Fuel storage should be segregated from other materials and located at least 20 feet from streams and wetlands. The fuel storage area must be graded to ensure containment of any leaks or spills.

3.1.5 Plant Salvage – Optional Action

Through community service events, or partnering with native plant organizations, the Port may salvage native shrub and groundcover plant materials within the obstruction removal clearing limits for reuse. Plant materials should be carefully stockpiled for later relocation, exercising care when moving the plant materials to avoid breaking branches or roots. Salvaged vegetation may be used within cleared areas during the site treatment step in the process. This vegetation may also be used on other Port properties, or provided for restoration work by other agencies (e.g., King County, EarthCorp).

3.2 Tree Obstruction Removal and Material Disposal

3.2.1 Tree Removal and Clearing Methods

Obstruction removal methods and equipment vary depending on site characteristics, the distribution and characteristics of obstructions on a site, and the type of disposal method or sale of the cleared material. The range of tree removal and clearing methods, and their suitability, are summarized in Table 3.2-1, followed by a more detailed discussion.

Table 3.2-1

Summary of Obstruction Removal and Clearing Methods

Method Description	Suitability
Clearing and Grubbing	
Clearing involves removal of trees and vegetation, including invasive species, as well as other understory and groundcover vegetation above the soil surface. Fell and limb trees using mechanical equipment such as a feller buncher; harvester equipment may also buck the logs into smaller pieces. Remove invasive species as well as other understory and groundcover vegetation. Grubbing a cleared area entails removing organic matter in the soil, often to a minimum of 12 inches in depth, provides an opportunity for stripping topsoil to be used in future restoration planting efforts. Salvaged topsoil can be segregated and stockpiled separately from other cleared material; it can be spread over disturbed areas upon completion of obstruction removal activities.	Suitable for areas with dense obstruction groupings where adjacent areas are not congested or major traffic corridors
Tree Removal (excludes stump grubbing)	
Fell, limb, and buck trees using mechanical means and/or chain saws (manual) as needed. Remove invasive species, and retain, as practical, the remaining understory.	Suitable for areas with dense obstruction groupings where adjacent areas are not congested or major traffic corridors, and where full stump removal (grubbing) is not required
Selective Clearing and Tree Removal (manual work)	
Fell, limb, and buck trees using chain saws. Remove invasive species, but retain remaining understory.	Suitable within or near sensitive areas, and/or where isolated obstructions occur, particularly on congested sites
Retain Stumps	
Follow tree removal or selective removal of trees, which leaves a 1- to 2-foot stump above the ground surface. To inhibit resprouting, stumps can be treated using broad-spectrum glyphosate or fungus (mycilia) tablets that encourage fungus to eat away at the remaining structure.	Suitable where isolated or small groupings of obstructions occur, and retaining stumps is used to protect sensitive areas like steep slopes or wetlands
Remove Stumps	
Cut or grind and mulch stumps, and the associated root mass below the ground level, using a stumper or stump grinder attachment. Another option is to use a grubbing blade mounted on the front of a carrier vehicle, or cut a tree part-way down and push it over (clearing and grubbing operation).	Suitable on sites outside of sensitive areas

Tree removal could take the form of selectively removing trees with a chain saw or using mechanical means. Manual removal involves felling, limbing, and bucking trees using chain saws. A site that is congested and/or contains many existing facilities or grounds to be preserved, or is inaccessible to large equipment, will require manual methods of removal. Selective removal within the Port Site Plans denotes manual removal methods for felling trees; all other removal methods will involve mechanical felling operations.

Mechanical felling has worker safety, productivity, and efficiency benefits compared to manual removal; however, this method is infeasible for certain sites where equipment cannot fit, or where equipment would damage existing facilities or impact sensitive areas. Where feasible, mechanical felling is the best option for preparing timber for sale, which is an obstruction "disposal" option for many of the Port and WSDOT sites for this Program.

Common equipment used for large mechanical felling operations includes the following:

- Feller buncher, which has motorized vehicle base (tracked or wheeled) with a head that can cut and gather several trees at once; the most common tracked feller bunchers in the western United States are 12 feet wide, with excavator bases and swing booms with a 25-foot reach (USDA 2016)
- Delimber, which is used to remove branches from felled trees
- Harvester, which consolidates felling, delimbing, and bucking (cutting tree into appropriate lengths) into one machine
- Skidder, which is used to bundle and pull logs out of a forest
- Forwarder, which is a vehicle that uses a boom arm to load and carry logs out of the forest clear of the ground

Stump removal can occur through the use of a grubbing blade (for clearing and grubbing operations) that can be mounted on the front of a carrier vehicle. Using this method, or cutting a tree part-way down and pushing it over, is an option to harvest material for large woody debris applications for restoration projects. Another option for stump removal is to cut or grind and mulch stumps, and the associated root mass below the ground level, using a stumper or stump grinder attachment. Grinding stumps can lead to sinkholes and grade irregularities when the remaining root systems decompose overtime. These grade irregularities are not an issue within natural forested areas, but they do have moderate safety

implications on sites used by the public. Within private sites and recreation areas, grubbing, rather than grinding of stumps, is recommended.

Grubbing a clearing area (i.e., removing organic matter in the soil, often to a minimum of 12 inches in depth), provides an opportunity for stripping topsoil to be used in future restoration planting efforts. Salvaged topsoil should be segregated and stockpiled separately from other cleared material; it can be spread over disturbed areas upon completion of obstruction removal activities. If a site will not support future planting, topsoil can alternatively be transported to other sites for use in restoration and revegetation efforts.

Areas within sites that are on steep slopes or in wetlands will benefit from retaining stumps after tree removal in order to stabilize soils and minimize impacts to these sensitive areas. To inhibit resprouting, stumps can be treated using broad-spectrum glyphosate, or using fungus (mycilia) tablets that encourage fungus to eat away at the remaining structure.

Erosion and sediment control measures will need to be actively managed during the obstruction removal phase of the Program. If monitoring or inspection shows that the control measures are ineffective, repairs should be made or replacement measures should be installed. If sediment reaches one-third of the exposed height of the control measure, the sediment should be removed and disposed of properly.

3.2.2 Material Disposal Options

Options for disposal of cleared obstructions, potential obstructions, and associated vegetation (e.g., invasive species, vegetation impacted during removal) are summarized in Table 3.2-2, followed by a more detailed discussion.

Table 3.2-2
Summary of Material Disposal Methods

Method Description	Suitability
On-site Disposal (including chipping and mulching)	
Leave cleared materials on site with minimal processing, though cutting large tree pieces into manageable log segments may be required. Alternatively, material may be processed into wood chips/mulch, which can provide benefits to the site through invasive species control and soil nutrient inputs.	Suitable for most sites (with owner's permission), outside of wetlands
Off-site Disposal	
Remove material from site and dispose at an approved location, or to a beneficial reuse site identified by the Port.	Suitable for wetland areas where on-site disposal is not feasible, or other sites at owner's discretion
Timber Sale	
Establish board foot volumes, market, and prepare trees for sale.	Large, forested tracts with merchantable timber

3.2.3 On-site Material Disposal

Cleared materials may be left on site with minimal processing, though cutting large tree pieces into manageable log segments may be required. Alternatively, material may be processed into wood chips/mulch, which can provide benefits to the site through invasive species control and soil nutrient inputs. For small diameter trees, this mulching option can be combined with the obstruction removal step through the use of a mechanical mulcher. Disposing of material on site is not suitable for non-Port sites unless permission for this disposal method is approved by the owner. Disposing of material within wetland areas is also prohibited as this material could be interpreted as wetland fill.

3.2.4 Off-site Material Disposal

Cleared material may be disposed of off site through the contractor taking ownership of the material and disposing of it at an off-site, permit-compliant location of their choosing. Alternatively, the Port may wish to take ownership of some of the cleared obstruction material for beneficial uses in other Port locations as restoration (e.g., large woody debris) or site furnishings (e.g., log edging, seating, art features). This Port beneficial reuse option can

be facilitated by identifying this material on site and specifying a location where the contractor can deliver the material to be stockpiled.

3.2.5 Marketing and Selling Timber

The Port and WSDOT may consider a timber sale as another option for material disposal. This option could provide significant revenue, but it also requires additional planning steps. Generally the timber selling process would include the following:

- Researching the timber market condition and trends as they relate to desired species, minimum quantities, sizes, and material quality
- Refining a tree inventory in order to project the available timber volumes
- Developing a marketing strategy, guided by the following questions:
  - What are the products and when will they be available?
  - How will products be sold (stumpage [i.e., standing timber] or as logs)?
  - What is the current market value for these products?
  - Who are the potential buyers?
- Clearly laying out property lines of sale area and marking timber
- Promoting the products through actively contacting potential buyers and providing a prospectus
- Evaluating offers and drawing up a timber sale contract, and a logging contract for log products
- Actively monitoring the operation

3.3 Site Treatment

Site treatment following obstruction removal will involve stabilizing soils using vegetation and, in certain instances, geotechnical methods. Closeout of the work will include removing temporary facilities and erosion/sediment control measures, and cleaning up the site.

3.3.1 Planting Bed Preparation

Soil preparation and the installation of erosion control fabrics (if warranted) will precede plant installation tasks. Soil amendment may be needed for areas with compacted soil or areas

where an excessive amount of topsoil was removed through obstruction removal operations. Soil amendment can be placed in planting areas and rototilled into the existing subgrade.

The installation of jute matting is recommended for sites with slopes greater than 4:1 (4 horizontal to 1 vertical) to control slopes during plant establishment. This material consists of unbleached, single jute yarn, which is woven into a mat. Jute matting is installed by rolling out the fabric and, where multiple strips of mat are required, overlapping adjacent mats by a minimum of 4 inches. The upslope end of the mat is secured by burying and staking the ends in a trench and then backfilling the trench. The matting is further secured with wooden stakes spaced every 2.5 feet along the length of the material.

3.3.2 Plant Installation

Plant installation should be performed within the wet season if possible (between October and May) unless an irrigation system is available. The specific plant species recommended for each of the Port sites are identified on the plant schedules provided in Figures 5, 8, 11, 14, 17, and 20. For non-Port sites, Appendix A provides a list of replacement tree species with mature tree heights that are well below obstruction levels.

Plant materials for Port properties can be supplemented with salvaged material removed during site preparation activities. Purchased plant materials can include both container-grown stock and livestake cuttings. Container-grown stock should be inspected prior to installation to ensure plants meet the following standards:

- Neither overly loose in the container with underdeveloped root systems, nor container bound
- Free of weeds, disfiguring knots, injuries/abrasions, and all forms of infestation

Trees that are installed in public spaces and ROWs are generally higher grade material, and must meet location jurisdiction requirements (Burien Code Chapter 19.25, Interlocal Agreement Landscape Design Standards, SeaTac Development Standards Chapter 15.445). Within applicable sites in the cities of SeaTac and Burien, these requirements include the following:

- Deciduous trees shall have a caliper of at least 1.75 inches (Burien) or 2 inches (SeaTac)

- Evergreen trees shall be at least 6 feet (Burien) or 8 feet in height (SeaTac)

Additional requirements may include the following:

- Conifer trees should have only one leader (growing apex)
- Deciduous trees that have a solitary leader shall have only lateral branches thinned by pruning
- Pruning requirements for low branches for accessibility on sidewalks and clear sight distances (branches typically pruned 5 to 8 feet above ground level)

Container plants should be installed according to the following requirements:

- Remove plants from containers in a manner that prevents damage to their root system. Containers may require vertical cuts down the full depth of the container to accommodate removal. All circling roots shall be loosened to ensure natural directional growth after planting.
- Install plants within pits that are sized at least twice the diameter of the root system or container, with scarified sides and bottom.
- Set plant material in the planting pit to proper grade and alignment. Set plants upright, plumb, and faced to give the best appearance or relationship to each other or adjacent structure. Set the crown of plant material at the finish grade. No filling will be permitted around trunks or stems or above grafts on grafted trees.
- After plants are set, water in soil mixture around bases of root balls and fill all voids.
- Mulch shrub beds immediately after planting. Thoroughly water mulched areas. After watering, rake mulch to provide a uniform finished surface. Mulch shall be feathered back from base of trees and shrubs to reduce potential plant rot.

Livestake cuttings are live plant materials without a previously developed root system; this type of material is often used for willow installations within moist areas, livestake installation is not suitable for non-irrigated, dry soils. The source material for livestakes should be dormant when the cuttings are made, and cut from material on a plant that is 1 to 2 years old. Cuttings can only be stored for 2 weeks (kept moist and shaded) before installation. Installation during fall to early spring (October 15 to March 15) is recommended. The top cut for the stake should occur immediately above a bud. The lower root end shall be cut at about a 45-degree angle. Livestake cuttings should be cut and

installed with the bark intact, but with no other branches or stems included. Prior to installation, the stakes should be soaked continuously.

Livestake plants should be installed according to the following requirements:

- Pound livestakes into the ground with a mallet or create a hole using a pilot bar in firm soils
- Plant at least 80% of the stake length within the ground and ensure that two to five bud scars are present above the ground
- Tamp soil around the stake
- Mulch the livestake planting area and thoroughly water mulched areas

3.4 Monitoring

Where black cottonwood or maple stumps remain (steep slopes and wetlands), they should be monitored to ensure resprouting does not lead to future obstructions. Sprouts from stumps can rarely achieve heights above 80 feet, but in certain areas near STIA, these sprouts may still reach obstruction levels. Stumps can be treated using broad-spectrum glyphosate, or using fungus (mycilia) tablets that encourage fungus to eat away at the remaining structure.

Long-term monitoring will be required to document potential future obstructions and provide regular maintenance of areas with low-height obstructions. Monitoring will occur for two years on all sites to ensure revegetation mitigation measures meet performance standards below. If monitoring reveals that the revegetation mitigation measures are not meeting the performance standards, corrective action will occur in accordance with SeaTac Municipal Code 15.700.120 as follows:

- **Performance Standard 1:** Average survival of all native planted stock will be 100% at the end of Year 1 and at least 80% at the end of Year 2.
- **Performance Standard 2:** Invasive plant species are maintained at levels below 20% cover averaged over the entire obstruction removal area.

Including a 1-year plant warranty requirement within the contract specifications is recommended. This will require the Contractor to warrant plant materials to remain alive and be in healthy, vigorous condition for a period of 1 year after the date of physical

completion. The warranty will require replacement of plants that are dead or in unhealthy conditions. Typically plant warranties do not include damage or loss of plants caused by fires, floods, freezing rains, lighting or wind storms, extreme winter weather conditions, vandalism, or negligence on the part of the Owner.

3.5 Erosion and Sediment Control Best Management Practices

A construction stormwater pollution prevention plan and erosion and sediment control measures will be required to control the quantity and quality of stormwater that may pass through the obstruction management sites. The regulatory memorandum provides detail on the construction stormwater general permit associated with this work. This section outlines the most appropriate BMPs that can be used during obstruction management implementation. More detail on the BMPs identified here is available through the *Stormwater Management Manual for Western Washington* (Ecology 2012).

3.5.1 Preserve Vegetation/Mark Clearing Limits

Natural vegetation and the duff layer/native topsoil outside of the obstruction removal zones should be protected as these materials not only provides long-term ecological function, but also control stormwater erosion. Clearly marking the limits of clearing will ensure this material is not mistakenly removed during construction activities. Appropriate BMPs for this element include the following:

- BMP C101: Preserving Natural Vegetation
- BMP C102: Buffer Zones
- BMP C103: High Visibility Fence

3.5.2 Establish Construction Access

Constructing a clear construction access and exit location provides safety benefits (e.g., clear understanding of vehicle traffic), and also provides an opportunity to control sediment from being tracked outside of the construction site. Appropriate BMPs for this element include the following:

- BMP C105: Stabilized Construction Entrance/Exit
- BMP C107: Construction Road/Parking Area Stabilization

3.5.3 Install Sediment Controls

Earth moving on a construction site increases the risk of sediment being washed "downstream" and, in turn, impacting adjacent sites and/or sensitive areas such as wetlands or streams. Sediment control measures trap sediment on site where it can be managed. Appropriate BMPs for this element include the following:

- BMP C233: Silt Fence
- BMP C234: Vegetated Strip
- BMP C235: Wattles

3.5.4 Stabilize Soils and Protect Slopes

Soil that has been worked can be protected from erosion and sedimentation by soil stabilization measures. Soils must not remain exposed and unworked for more than 7 days during the dry season (May 1 to September 30), or for more than 2 days during the wet season (October 1 to April 30). Appropriate BMPs for this element include the following:

- BMP C120: Temporary and Permanent Seeding
- BMP C121: Mulching
- BMP C122: Nets and Blankets
- BMP C123: Plastic Covering

3.5.5 Maintain Best Management Practices and Manage the Project

Managing the project will include accounting for the dry and wet seasons as they relate to the construction schedule. During construction, a designated Certified Erosion and Sediment Control Lead person will lead the inspection and monitoring of BMPs, and will work with the contractor to improve BMP performance over the life of the project. Appropriate BMPs for this element include the following:

- BMP C160: Certified Erosion and Sediment Control Lead
- BMP C162: Scheduling

4 SITE PLANS

This section provides detailed obstruction removal and revegetation methods for the Program. A summary of the quantities of tree removal and replacement for the different property types is shown in Table 4.1-1. The required tree planting quantities are based on revegetation ratios, which vary based on jurisdiction requirements.

Table 4.1-1

Summary of Tree Removal and Replacement Quantities – All Sites

Jurisdiction Ownership	Total Obstructions	Understory Removal	Total Trees Removed	Required Tree Replacement
City of SeaTac				
Port	840	327	1,167	1,489[2]
WSDOT	603	621[3]	1,224	1,224[4]
Public	128	0	128	143
Residential	68	0	68	68
Commercial/Religious	44	0	44	51
Subtotal	**1,683**	**948**	**2,631**	**2,975**
City of Burien				
Public	6	0	6	18
Residential	72	0	72	72
Commercial	0	0	0	0
Subtotal	**78**	**0**	**78**	**90**
City of Des Moines				
Public	0	0	0	0
Residential	38	0	38	40
Commercial	0	0	0	0
Subtotal	**38**	**0**	**38**	**40**
Total	**1,799**	**948**	**2,747**	**3,105**

Notes:

1. Required tree replacement quantities based on mitigation ratios established by the Port and local agencies. Actual tree replacement quantities may exceed the required ratios.
2. See Table 4.1-2 in Section 4.1 for more information on tree replanting for Port properties.
3. Estimated understory quantity is preliminary and subject to change (derived from aerial photograph analysis). To be confirmed with WSDOT, the replacement requirement may be as large as 4:1 ratio.

4.1 Port Properties

The Port properties include seven sites requiring removal of existing obstructions and future obstructions. These sites are to the north, west, and south of STIA. Access to five of the sites is actively controlled by the Port—either because they are located in close proximity to active Port operations (west side office) or they occur within Port property that is restricted from public use and fenced. Two of the sites contain areas accessible by the public for recreational use. A summary of tree removal and replacement for Port sites is presented in Table 4.1-2.

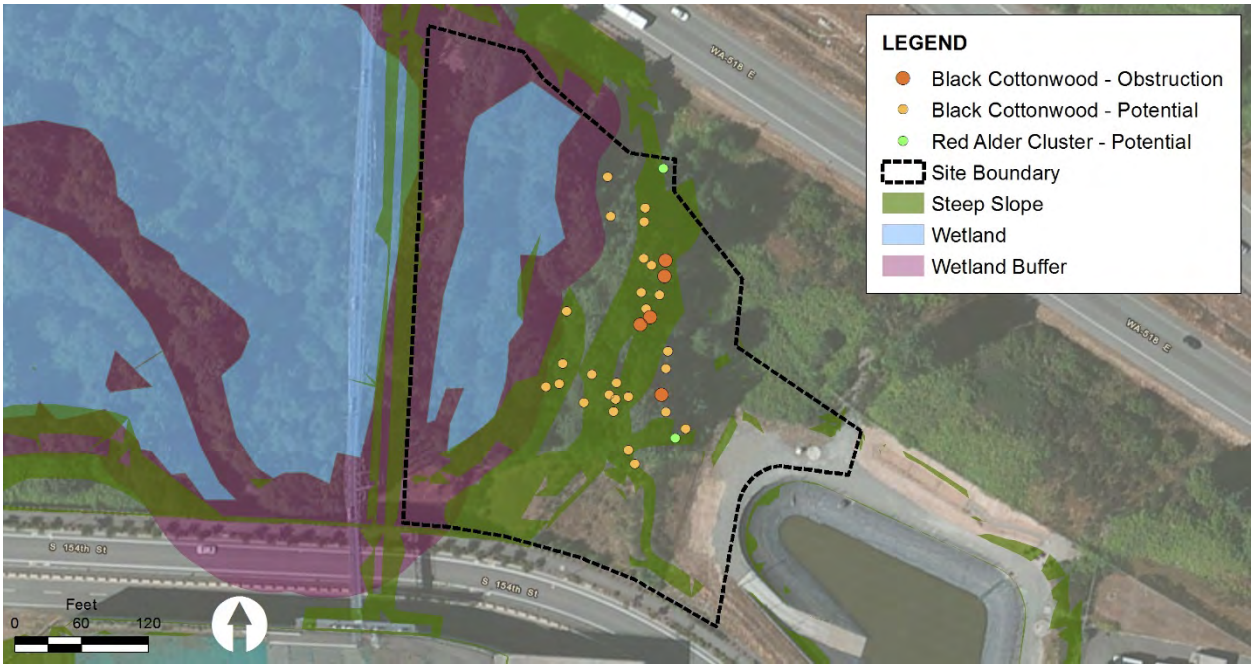
Table 4.1-2
Summary of Tree Removal and Replacement – Port Sites

Port Site	Total Obstructions	Understory Removal	Total Trees Removed	Required Tree Replacement	Trees Replaced Within Site	Trees Replaced Outside of Site
P-1	56	0	56	56	41	15
P-2	239	0	239	290	16	274
P-3a	247	0	247	551	310	241
P-3b	51	0	51			
P-4	95	0	95	95	198	-103
P-5	134	327	461	461	92	369
P-6	18	0	18	36	48	-12
Total	**840**	**327**	**1,167**	**1,489**	**705**	**784**

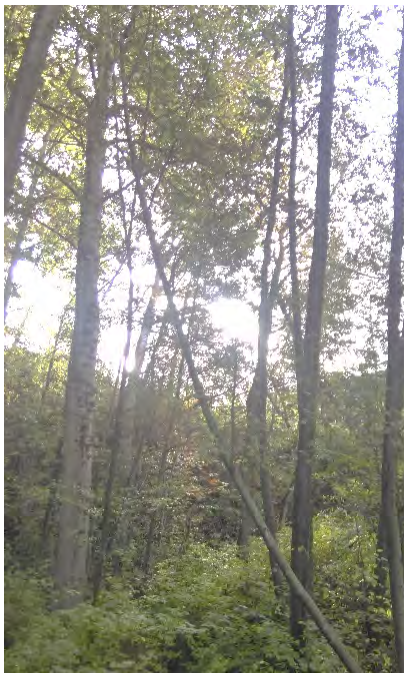
4.1.1 Site P-1

4.1.1.1 Site Description

This 2.5-acre site is the only Port site located north of STIA, and includes a wetland, wetland buffer, and steep slopes. In addition to 5 tree obstructions and 51 potential tree obstructions, the site contains invasive species (including English ivy, common holly, and Himalayan blackberry). The site contains artificial fill, predominately within the sloped areas, which includes plastic barrels, riprap, concrete rubble, and potentially sharp, steel construction waste.



Site P-1 Overview Diagram



Site P-1 Representative Site Photographs

Table 4.1-3
Port Site P-1 Obstruction Summary

Species	Quantity	Diameter at Breast Height	Estimated Height
Existing Obstructions (5 total)			
Black cottonwood	5	28 – 37"	125 – 140'
Potential Obstructions (51 total)			
Black cottonwood	26	6 – 55"	20 – 140'
Red alder	Cluster 1: 10 trees Cluster 2: 15 trees	Cluster 1: 8" Cluster 2: 9"	Both clusters: 25'

4.1.1.2 Site Implementation Plan

Access and Construction Staging (Figure 3)

Site P-1 can be accessed from the north via Highway 518 East, which will require a temporary access agreement through WSDOT ROW.

An area suitable for construction staging to support work at Site P-1 is located adjacent to the eastern portion of the site. This area is located near a stormwater retention basin, which must be protected. The staging area and access route from Highway 518 would need to be restored to pre-project conditions following obstruction removal work.

Site Condition Review

1. Site P-1 hazards include steep slopes, with a number of obstructions located on slopes up to 35 degrees. In addition, artificial fill with potentially sharp materials and thorny invasive plants constrain access.
2. Sensitive areas that will be encountered on the site consist of steep slopes. Sensitive areas adjacent to the site to the west include a wetland and wetland buffer. While roads are present to the west of the site (within the wetland buffers), no access from these roads will be permitted in order to protect the wetland and wetland buffers.
3. Stormwater outfalls discharge water at the south and northeast corners of Wetland 3. No work or staging is permitted on this side of the site.
4. ALSF structures are present to the west of the site. No work or staging is permitted on this side of the site.
5. Other STIA-related infrastructure to be protected includes one stormwater retention basin.

Site Preparation (See Figure 3)

1. **Secondary access improvements:** Access to the site will require cutting through brush and placing a base material for access from Highway 518.
2. **Sensitive area protection:** Install sediment controls downstream of the work area and outside of the wetland boundary.
3. **Infrastructure protection:** Protect the culvert that transports water from the east to west wetland complex by ensuring sediment control measures are in place prior to commencing obstruction removal site work. Biodegradable silt fencing is recommended as it can be left in place, further minimizing wetland impacts following projection completion.
4. **Geotechnical investigation:** Further geotechnical evaluation for stability may be needed prior to obstruction removal on steep slopes. This investigation may prescribe slope stability mechanisms that are more conservative (e.g., armoring) than the geotechnical fabric application presented below.

Obstruction Removal and Material Disposal (See Figure 4)

1. Remove and retain stumps of all black cottonwoods (5 obstructions, 26 potential obstructions).
2. Clear two clusters of 25 total red alder potential obstructions; these clusters are on steep slopes. Retain all stumps.
3. Clear invasive species (English ivy, common holly, and Himalayan blackberry) within clearing limits shown in Figure 3.
4. Dispose of material by chipping and mulching, and placing processed material on site (outside of the wetland). Removed black cottonwood trees may provide merchantable timber for fiber; however, removing the material unprocessed from this site using a cable-logging operation, would increase cost, and the necessary cranes and cables would penetrate the navigable airspace.

Site Treatment (See Figure 5)

The objective of site treatment measures is to control establishment of future obstructions, stabilize slopes and soil disturbed by obstruction removal, and replace trees on site to the extent possible.

1. Drill and treat stumps that remain with broad-spectrum glyphosate or fungus (mycilia) tablets in order to discourage sprouting.
2. Install geotechnical fabric (jute) in all cleared areas with slopes greater than 4:1 prior to revegetation efforts.
3. Revegetate cleared areas per the planting plan and planting schedule (Figure 5). The planting categories allow for the following maximum heights for installed vegetation, though species selected for each category were selected to grow far below the following thresholds:
    a. **Short height upland planting:** 100 to 140 feet
    b. **Shrub upland planting:** 80 to 100 feet
    c. **Groundcover planting:** 40 to 80 feet
4. The required tree replacement quantity associated with obstruction removal from Site P-1 is 56 trees, with 41 trees planted within the site, and 15 trees planted on other Port sites or another location within the drainage basin..
5. The estimated planting quantities on Site P-1 will include the following:
    a. **Trees planted on site:** 41
    b. **Shrubs:** 1,600
    c. **Groundcovers:** 2,000
    d. **Seeded areas:** 37,500 square feet

Monitoring

1. Monitor stumps and treat with broad-spectrum glyphosate or fungus (mycilia) tablets to control resprouting. While black cottonwood sprouts from remaining stumps are unlikely to exceed 100 feet in height, these sprouts may still become future obstructions within the higher topography areas of the site.
2. Monitor for future obstructions.
3. Monitor to ensure revegetation areas meet the following performance standards:
    a. **Performance Standard 1:** Average survival of all native planted stock will be 100% at the end of Year 1 and at least 80% at the end of Year 2.
    b. **Performance Standard 2:** Invasive plant species are maintained at levels below 20% cover averaged over the entire obstruction removal area.

4.1.1.3 Best Management Practices

The following BMPs are suitable measures for controlling sediment and erosion on Site P-1.

Table 4.1-4
Port Site P-1 Best Management Practices

BMP Category	BMP Numbers and Titles
Preserve Vegetation/Mark Clearing Limits	• BMP C101: Preserving Natural Vegetation • BMP C102: Buffer Zones • BMP C103: High Visibility Plastic, Metal, or Biodegradable Fence • BMP C103: Silt Fence
Establish Construction Access	• BMP C105: Stabilized Construction Entrance/Exit • BMP C107: Construction Road/Parking Area Stabilization
Install Sediment Controls	• BMP C235: Wattles • BMP C233: Silt Fence
Stabilize Soil and Protect Slopes	• BMP C120: Temporary and Permanent Seeding • BMP C121: Mulching
Maintain BMPs and Manage the Project	• BMP C160: Certified Erosion and Sediment Control Lead • BMP C162: Scheduling